

Research Article

Market Structure, International Competitiveness, and Price Formation of Hainan's Fruit Exports

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Through a constant market share (CMS) model and a price index model, current research aims to analyze the impetus of the growth of Hainan, China's fruit exports and the adverse impact of rising production costs. This paper considered the changes in the international competitiveness of Hainan's fruit exports and analyzed the reasons for these changes. Additionally, this manuscript analyzed the effects of Hainan's price-bargaining power on fruit exports under the condition of asymmetric information by applying a two-tier stochastic frontier analysis model. The results show that the rising costs of labor led to the gradual loss of price advantage, and the contribution of competitiveness to the growth of Hainan's fruit exports has rapidly declined. The results also indicate that the degree of information held by both importers and Hainan has an important influence on the final exporting price, whereas the importers hold more information and have stronger price-bargaining power than Hainan. Policy suggestions based on the results are proposed.

1. Introduction

Unlike ordinary agricultural products, fruits, as high value-added agricultural products, have become an important source of income for farmers in many countries [1]. Fruits in this paper are defined by The Harmonized Commodity Description and Coding System (HS classification). The HS is edited based on the Standard International Trade Classification (SITC) and the Customs Cooperation Council Nomenclature (CCCN). The HS coding covers two major categories: CCCN and SITC code systems, meaning that it has become the world's most widely used product catalog. "Fruits" in this paper refers to all HS08 products (fruits and nuts), which include fresh or dried coconuts, brazil nuts and cashews (0801); other nuts (0802); bananas (0803); fresh or dried figs, pineapples, avocados, and guavas except coconut (0805); fresh or dried grape (0806); fresh watermelon and papaya (0807); fresh apple and pear (0808); fresh apricot, cherry, plum, and peach (0809); other fresh fruits (0810); frozen fruits and nuts (0811); temporarily preserved fruits

and nuts (0812); dried fruits and nuts (0813); and the peel of citrus fruits and watermelons (0814). The data were obtained from the United Nations Conference on Trade and Development (UNCTAD) Trade Database, Food and Agriculture Organization Database, Wind Database, China Customs Statistical Yearbook, Hainan Statistical Yearbook, and National Tropical and South Asia Crop Production Yearbook.

In many developing countries such as Poland, Chile, and some Southeast Asian countries, fruit production has developed into the dominant industry in the export of agricultural products. As a result, international competition in the world's fruit markets has become increasingly fierce [2]. Hainan, as an island province of China, has the natural conditions for the growth of tropical fruit plants. Since its establishment, Hainan has focused on its natural tropical advantages, which are unique in China, to grow tropical fruit. According to the development plans for tropical and efficient agriculture, tropical fruits have become a characteristic industry and a new growth point for Hainan's agricultural economy. In 2017, the output value of tropical fruit

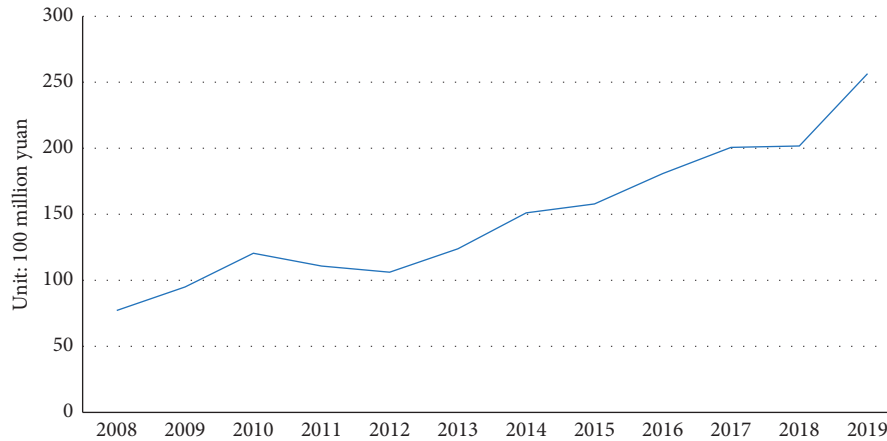


FIGURE 1: The chart of total output value of Hainan's fruits from 2008 to 2019.

in Hainan reached 410 billion tons, which was an increase of 3.7% compared with 2016. Vigorously developing tropical fruits has positive and practical significance for further optimizing the structure of Hainan's agricultural industry, promoting agricultural efficiency, and increasing farmers' incomes. However, due to the labor-intensive nature of fruit farming, the cost of producing fruit in developed countries is much higher than in developing countries. Therefore, many developed countries define fruit as "sensitive products" using tariff barriers and fruit safety standards [3], which further raises the threshold of the export of fruit in various provinces and cities of China, including Hainan. Hainan's fruit exports face not only strong competition from developing countries but also increasing trade barriers in importing countries, especially technical barriers to trade [4]. Therefore, studying the main factors influencing Hainan's fruit export growth to maximize the export potential of Hainan's fruit agriculture is theoretically and practically significant (Figure 1).

The underlying reason that the country's exports can maintain a steady growth is its international competitiveness [5], as some researchers mentioned that a suitable pricing strategy in supply chain operation management is very important [6, 7], especially in the fruit distribution [8]. Dyadkova and Momchilov [2] performed considerable amounts of research into international competitiveness, with the theory of comparative advantage as the research foundation. Ma et al. [9–12] developed the dynamic model adapted on the complicated system measurements in different situations. Xu and Rong [3], by comparing the production costs, labor productivity, and market prices in China with those of other countries, analyzed the competitiveness of Chinese fruits based on the constant market share (CMS) model. Gao et al. [5] explained the role and changing tendency of Chinese fruits in the international market by calculating the revealed comparative advantage index (RCA), market share, and resource endowment coefficient. More recently, the CMS model has gradually been adopted by scholars in the study of the sources of international trade due to its comprehensive and multi-angle analysis perspective. CMS can be used to effectively

incorporate the theory of competitiveness in its system to allow for a comprehensive analysis of the structure and source of trade growth [13, 14].

We contribute here to the analysis of the export market of Hainan's fruit from the following perspectives. First, in most of the literature, only the export status of Chinese fruit is studied. No study has been dedicated to analyzing the fruit import and export situation in Hainan province using a CMS model, which can accurately capture the effects of structural changes. Second, for studies of fruits, most papers only cover fresh frozen fruits and do not consider fruit juice and other processed fruits, which account for over 50% of Hainan's total fruit export. Third, the literature has shown that the contribution of Hainan's international competitiveness in fruit production to the growth of exports is declining. However, the reasons for the decline are not explained from the perspective of the loss of price advantage, which is the most direct and simplest indicator that can be used to indicate competitive strength and reflect the degree of international competitiveness. Considering the price-bargaining power of Hainan, we estimated the impact of this power on the formation of export price by applying a two-tier stochastic frontier model using the asymmetry information.

The layout of this paper is as follows. In Section 2, we analyze the impetus of the growth of Hainan's exports and show how to effectively avoid the adverse effects of rising production costs using a CMS model. In Section 3, the comparative advantage of Hainan's fruit is calculated. In Section 4, we construct a bargaining power measurement model for the exporting price of Hainan's fruit under the condition of asymmetric information and perform empirical tests on the bargaining power. We conclude the paper in Section 5 and provide some policy suggestions.

2. Market Structure

According to Zhang et al. [15], the international competitiveness of a country's products is mainly determined by price and non-price factors. Non-price factors include product quality, government policy, and other factors that

cannot be quantified and are difficult to include in the model for quantitative analysis. Therefore, Bowen et al. [16] considered indirectly analyzing the data of a country's share of exports to reflect the changes in the international competitiveness of its products. Based on this idea, Tyszynski [17] and Jepma [18] introduced the CMS model, which can accurately capture the effects of structural changes. Based on Zhang et al. [15] and Jepma [18], we used a modified CMS model that introduces new components to explain the reasons for the change in a country's trade. The price index of Hainan's exported fruit was calculated.

Assuming Hainan is exporting n kinds of fruit to m markets and choosing the world as the reference, then we can divide the total growth (Δq) of Hainan's fruit into three parts:

$$\Delta q = \sum_i \sum_j s_{ij}^0 \Delta Q_{ij} + \sum_i \sum_j \Delta S_{ij} \Delta Q_{ij}^0 + \sum_i \sum_j \Delta S_{ij} \Delta Q_{ij}^0, \tag{1}$$

where Δq represents the change value of Hainan's fruit exports in a certain period of time, s_{ij} represents that

Hainan's export of fruit i to country j accounts for the share of fruits exports to it from other countries, ΔQ_{ij} represents the change value of the world's exported fruit i to country j , and superscript 0 indicates the initial period of the study. The first term in this equation is called the structural effect, which represents the change in Hainan's fruit exports caused by the change in the world's fruit exports; the second term is the competitive effect, which represents the change in the competitiveness of Hainan's fruit exports caused by the change in Hainan's fruit exports; and the third term is indicated as the second-order effect, which represents the change in Hainan's fruit exports caused by the interaction between changes in fruit production competitiveness and the world's fruit exports.

We divided the structural effect into the growth effect, market effect, goods effect, and structural interaction effect [19]. The competitive effect is divided into the whole competitive effect and the detailed competitive effect. The second-order effect is divided into the pure second-order effect and the dynamic structural residual effect. Then, we obtain the following equation:

$$\begin{aligned} \Delta q = & S^0 \Delta Q + \left(\sum_i \sum_j s_{ij}^0 \Delta Q_{ij} - \sum_i s_i^0 \Delta Q_i \right) + \left(\sum_i \sum_j s_{ij}^0 \Delta Q_{ij} - \sum_j s_j^0 \Delta Q_j \right) \\ & + \left[\left(\sum_i s_i^0 \Delta Q_i - S^0 \Delta Q \right) - \left(\sum_i \sum_j s_{ij}^0 \Delta Q_{ij} - \sum_j s_j^0 \Delta Q_j \right) \right] \\ & + Q^0 \Delta S + \left(\sum_i \sum_j Q_{ij}^0 \Delta S_{ij} - Q^0 \Delta S \right) + (Q^1/Q^0 - 1) \sum_i \sum_j Q_{ij}^0 \Delta S_{ij} \\ & + \left[\sum_i \sum_j Q_{ij}^0 \Delta S_{ij} - (Q^1/Q^0 - 1) \sum_i \sum_j Q_{ij}^0 \Delta S_{ij} \right], \end{aligned} \tag{2}$$

where s represents the value of Hainan's total exported fruit accounting for the world's total exported fruit, s_j represents the share of Hainan's exported fruit to country j over the world's total exported fruit to country j , s_i represents the share of Hainan's export of fruit in the world's export of fruit i , Q represents the value of the world's total exported fruit, Q_j represents the value of global total exported fruit to country j , Q_i represents the total value of fruit i exported globally, and superscript 1 means the end of the study period. The detailed meaning of each part of equation (2) can be found in Table 1.

Because the CMS model does not directly include the price effect, it cannot be used to set up the relationship between the production costs, especially rising labor costs and the change in Hainan's fruit exports. Generally, the competitive advantage of Hainan's fruit exports mainly depends on low labor costs; i.e., the rising costs of fruit production weaken the price advantage, thus affecting the contribution of the competition effect to the export growth, where the contribution of the competitive effect to the export growth of fruit can be calculated by the CMS model.

Therefore, the main goal was quantitatively measuring the price advantage of Hainan's fruit exports. With the price index model [4], the price index P of Hainan's exported fruit was calculated, where $P < 1$ indicates that Hainan's exported fruit has a price advantage and $P > 1$ indicates that Hainan's exported fruit does not have a price advantage. The equation is as follows:

$$P_{ak} = \prod (P_{aki}/P_{bki})^{w_{aki}}, \tag{3}$$

where P_{ak} is the price index of fruit country a importing to country k , P_{aki} is the price of fruit i that country a imports to country k , P_{bki} is the price of fruit i that country b imports to country k , and w_{aki} is the proportion of the fruit volume that country a imports to country k , which accounts for the total trade volume of all fruit exports to country k .

In 1998–2015, events such as the Southeast Asian financial crisis in 1998, China's accession to the World Trade Organization (WTO) in 2001, the American subprime mortgage crisis in 2008, and the establishment of the China-ASEAN (Association of Southeast Asian Nations) free trade

TABLE 1: Detailed meanings of different parts of equation (2).

Change in export		Equation	Amount of change in the total value of a Country's export
	Growth effect	$S^0 \Delta Q$	Assuming the country's export competitiveness of agricultural products and the structure of its exports equate with global agricultural export markets, the country's agricultural products increase as a result of the growth of global agricultural exports.
Structural effect	Market effect	$\sum_i \sum_j S_{ij}^0 \Delta Q_{ij} - \sum_i S_i^0 \Delta Q_i$	Assuming the country's export competitiveness of agricultural products equals that of the world's, the change in the export value of agricultural products is due to market distribution.
	Goods effect	$\sum_i \sum_j S_{ij}^0 \Delta Q_{ij} - \sum_j S_j^0 \Delta Q_j$	Assuming the country's export competitiveness of agricultural products equals the world's, the change in the export value of agricultural products is due to the export commodity structure.
	Structural interaction effect	$(\sum_i S_i^0 \Delta Q_i - S^0 \Delta Q) - (\sum_i \sum_j S_{ij}^0 \Delta Q_{ij} - \sum_j S_j^0 \Delta Q_j)$	Assuming the country's export competitiveness of agricultural products is the same as that of the world, the changes in the value of agricultural exports are due to the interaction between the effects of specific export commodities and export markets.
Competitive effect	Entire competitive effect	$Q^0 \Delta S$	Assuming the export structure of the country's agricultural products remains unchanged, the change in the export value of agricultural products in the country is the result of changes in overall competitiveness.
	Detailed competitive effect	$\sum_i \sum_j Q_{ij}^0 \Delta S_{ij} - Q^0 \Delta S$	Assuming the global export structure of agricultural products remains unchanged, the change in the export value of the country's agricultural products is due to the changes in the export structure of the country's agricultural products.
Second-order effect	Pure second-order effect	$(Q^1/Q^0 - 1) \sum_i \sum_j Q_{ij}^0 \Delta S_{ij}$	Assuming the demand structure of global agricultural products remains unchanged, the level of exports of agricultural products in the country changes as a result of the interaction between changes in the share of agricultural export in the country and changes in the global export levels of agricultural products.
	Dynamical structural residual effect	$\sum_i \sum_j \Delta Q_{ij}^0 \Delta S_{ij} - (Q^1/Q^0 - 1) \sum_i \sum_j Q_{ij}^0 \Delta S_{ij}$	The change in the value of agricultural exports in the country is the result of the interaction between changes in the country's agricultural export structure and the changes in the global export structure of agricultural products.

area in 2010 affected the fruit trade in Hainan. Therefore, to further compare the impact of these external environmental changes on Hainan's fruit trade, we separately studied the 1998–2001, 2002–2007, 2008–2010, and 2011–2015 stages of Hainan's fruit export growth. As seen from Table 2, from 1998 to 2001, the total value of Hainan's exported fruit only increased by USD \$0.080 billion because of the Southeast Asian financial crisis in 1998. From 2002 to 2007, because in 2001, the total value of Hainan's exported fruit increased by USD \$0.819 billion, China acceded to the WTO. From 2008 to 2010, due to the American subprime mortgage crisis in 2008, the total value of Hainan's fruit exports only increased by USD \$0.336 billion. After 2010, due to the establishment of the China-ASEAN free trade area and the Chinese One Belt One Road strategy, the total value of Hainan's fruit exports increased by USD \$1.207 billion.

According to the results of the CMS model in Table 2, we obtained the following results:

- (1) The loss of price advantage led to the declining contribution rate of Hainan's fruit production competitiveness. From 1998 to 2007, the competitive effect of Hainan's fruit exports was around 30%, but during and after the American subprime mortgage crisis in 2008, the competitive effect declined to only 5.95% and remained lower until 2015, when it was approximately 15.16%. Further analysis of the overall competition effect and the specific competition effect showed that the downward trend of the competition effect was mainly due to the decline of the specific competition effect being higher than that of the overall competition effect, and the net effects of both were the lowest in 2008.

TABLE 2: Results of the constant market share (CMS) model for Hainan's exported fruits.

X	1998–2001		2002–2007		2008–2010		2011–2015	
	Change value (USD billion)	%	Change value (billion dollars)	%	Change value (billion dollars)	%	Change value (billion dollars)	%
Total effect	0.080	100.00	0.819	100.00	0.336	100.00	1.207	100.00
Structural effect	0.046	57.50	0.332	40.54	0.292	86.90	0.840	69.59
Growth effect	0.010	12.50	0.228	27.84	0.102	30.36	0.384	31.81
Market effect	0.020	25.00	0.103	12.58	0.212	63.10	0.592	49.05
Goods effect	−0.006	−7.50	−0.092	−11.23	−0.104	−30.95	−0.253	−20.96
Structural interaction effect	0.022	27.50	0.093	11.36	0.082	24.40	0.117	9.69
Competitive effect	0.021	26.25	0.327	39.93	0.020	5.95	0.183	15.16
Entire competitive effect	0.022	27.50	0.338	41.27	0.029	8.63	0.496	41.09
Detailed competitive effect	−0.001	−1.25	−0.011	−1.34	−0.009	−2.68	−0.313	−25.93
Second-order effect	0.013	16.25	0.160	19.54	0.024	7.14	0.184	15.24
Pure second-order effect	0.001	1.25	0.274	33.46	0.013	3.87	0.293	24.28
Dynamical structural residual effect	0.012	15.00	−0.114	−13.92	0.011	3.27	−0.109	−9.03

More recently, the agricultural production costs in Hainan, especially the trend of increasing labor costs, are obvious. According to the statistics, the producer price index of fresh fruit in Hainan increased from USD \$358.9/ton in 1998 to USD \$1108.7/ton in 2015, with an average annual growth rate of 11.6%. The rising production costs, especially labor costs, may be an important reason for the decline in the export competitiveness of Hainan's fruit.

Current research used the price index model to find that the rising costs of production can reduce the competition effect by weakening the exporting price advantage of fruit. Figure 2 shows the price index of Hainan's exported fruit calculated using equation (3). Before 2008, although the relative price of Hainan's exported fruit to various trading partners showed an upward trend, it was below the global average for a long time. The sharp drop in the exporting price index of fruit in 2003 was mainly due to the outbreak of SARS (severe acute respiratory syndrome) in China, which resulted in the decline in the purchasing demand and sluggish sales of fruit. However, after 2008, the relative price of various trading partners of Hainan's exported fruit exceeded the world average, and the exporting price advantage of Hainan has been lost since, which means that 2008 not only served as a starting point for the rapid rise in labor costs in Hainan but also contributed to the export growth of fruit in Hainan. Therefore, to a certain extent, due to the increase in labor costs in Hainan, the price of exported fruit has risen, and the price advantage was lost in 2008.

- (2) The optimized market structure drives the export growth of Hainan's fruit. As shown in Table 2, the structural effect played a decisive role in the export

growth of Hainan's fruit. Considering Hainan's fruit export situation in 2011–2015, the contribution of the structural effect was USD \$0.840 billion, which accounted for 69.59% of the total effects. The growth effect was 31.81%, which means that when Hainan's fruit competitiveness and exporting structure are the same as those of the rest of the world, the growth in the world's exports leads Hainan's fruit exports to grow by 31.81%. The market effect was 49.05%, which means that when Hainan's fruit competitiveness is the same as that of the rest of the world, Hainan occupies 49.05% of the world's fruit market. From the perspective of the market structure of Hainan's fruit exports, Hainan's exports to United States, Japan, Russia, and the ASEAN area account for more than 50% of Hainan's total fruit exports, which is still rising. Therefore, during the stage when the rising costs of labor in Hainan caused a decline in export competitiveness, the establishment of the China and ASEAN free trade zone quickly opened markets for Hainan, overcoming the adverse impact of declining competitiveness. The effect of growth and the effect of the market are not much different, whereas the effect of goods and the effect of structure interaction are both negative. When the value of the goods effect is negative, when the competitiveness of Hainan's fruit is the same as that of the world, Hainan's fruit exports are slower than that of the world. The structural interaction effect is also negative, indicating that when Hainan's export competitiveness of fruit is the same as the rest of the world, the interaction of the goods effect and market effect restricts the export of Hainan's fruit. The above analysis shows that the structural effect of Hainan's exported fruit depends mainly on the growth and market effects.

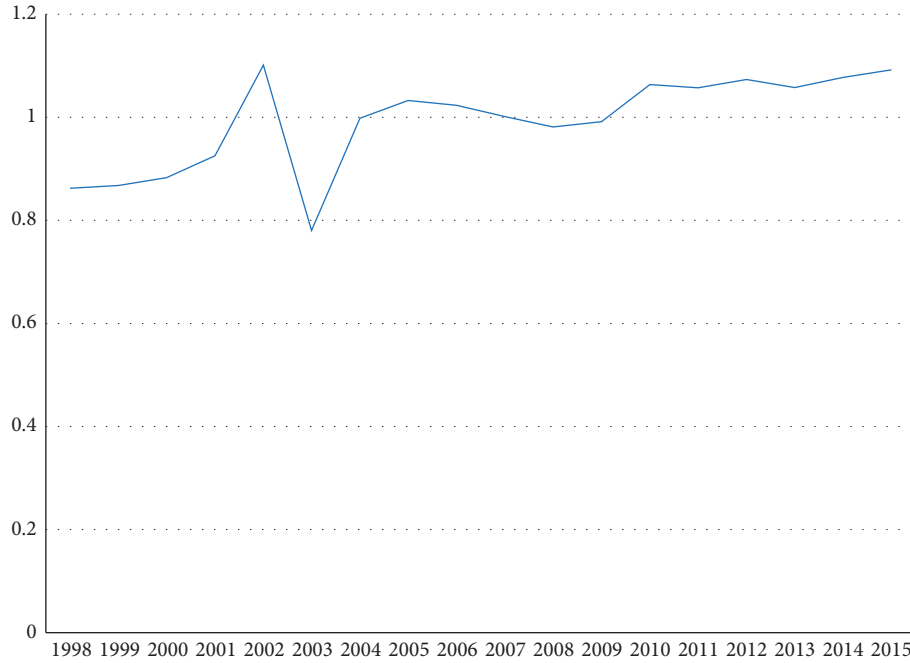


FIGURE 2: The price index of Hainan's fruits from 1998 to 2015.

3. International Competitiveness

From the results of the CMS model, we concluded that the change in competitiveness is one of the important factors influencing the export of Hainan's fruit. However, the competitive effect in the CMS model is the residuals that are deducted from the market demand effect, product structure effect, and market structure effect, which is not the concept of international competitiveness in the common sense. Therefore, it was necessary to construct an index system of international competitiveness, such as the revealed comparative advantage (RCA) index, to measure the international competitiveness of Hainan's exported fruit.

The international competitiveness of agricultural products, which has been widely used to study the export of fruit through the establishment of an international competitiveness evaluation index system, refers to the ability of agricultural products produced by one country (or region) to occupy and maintain market share in international market competition [20, 21]. The strength of international competitiveness can be analyzed from three aspects [22]: competitive performance analysis, that is, the analysis of market performance and profitability of the agricultural industry in the international competition; the analysis of competitiveness, which is the analysis of the factors that affect the market competitiveness of products, including the price, cost, quality, and marketing; and the analysis of competitive potential, which is used to analyze five key factors and two supporting factors that affect the international competitiveness of agriculture, including production, domestic demand, related and supporting industries and markets, market behavior and market structure, and agricultural policy environment and institutional environment.

Market share is the most direct and simplest indicator of the outcome of international competitiveness [23]. The higher the market share, the stronger the international competitiveness. Market share can also be used to reflect dynamic changes in the strength of international competitiveness. If the market share increases over a certain period of time, the international competitiveness is enhanced. Conversely, the international competitiveness weakens when market share decreases. We thus obtain the following formula:

$$MS_{ij} = \frac{X_{ij}}{X_{wj}}, \quad (4)$$

where MS_{ij} represents the market share of goods j of country i , X_{ij} indicates the total value of exported goods j of country i , and X_{wj} represents the total value of exported goods j in the world.

The RCA index is [24] (Yu et al., 2009)

$$RCA_{ij} = \frac{X_{ij}/X_{it}}{X_{wj}/X_{wt}}, \quad (5)$$

where X_{it} represents the total value of country i 's exports and X_{wt} represents the total value of global exports. If RCA is greater than one, goods i of country j have a comparative advantage; if RCA is less than one, goods i of country j have a comparative disadvantage. The higher the RCA value, the greater the comparative advantage of this good. Using the international competitiveness evaluation index system, the international competitiveness of Hainan's exported fruit from 2008 to 2015 was calculated, as listed in Tables 3 and 4.

The results in Table 3 show that, from 2008 to 2015, the average value of the market share of Hainan's exported fruit was around 0.15%, but from 2012, the market share of Hainan's exported fruit increased, reaching 0.181% in 2015. Also, different fruits have different characteristics in terms of

TABLE 3: The market share of Hainan’s exported fruits (%).

Year	Fruits	Pineapple	Banana	Lychee	Longan	Mango
2008	0.092	0.174	0.043	0.102	0.084	0.066
2009	0.087	0.193	0.041	0.117	0.094	0.057
2010	0.136	0.188	0.036	0.136	0.097	0.054
2011	0.128	0.201	0.035	0.108	0.116	0.063
2012	0.152	0.247	0.030	0.095	0.104	0.048
2013	0.151	0.259	0.028	0.129	0.113	0.042
2014	0.158	0.266	0.027	0.120	0.148	0.040
2015	0.181	0.248	0.028	0.117	0.122	0.040

TABLE 4: The revealed comparative advantage index of Hainan’s exported fruits.

Year	Fruits	Pineapple	Banana	Lychee	Longan	Mango
2008	0.283	0.842	0.635	0.486	0.387	0.753
2009	0.262	0.954	0.667	0.592	0.352	0.834
2010	0.275	1.073	0.624	0.504	0.391	0.802
2011	0.247	1.242	0.708	0.636	0.326	0.764
2012	0.263	1.198	0.722	0.842	0.294	0.884
2013	0.284	1.216	0.658	0.709	0.300	0.852
2014	0.298	1.127	0.685	0.775	0.306	0.747
2015	0.281	1.183	0.663	0.716	0.317	0.773

market share and changing trends. Pineapple, banana, lychee, longan, and mango are the most important exported fruits in Hainan (Figure 3). Among all fruits, pineapple has the highest market share in the international market, and since 2008, the international market share of pineapple has been on the rise from 0.174% in 2008 to 0.248% in 2015, indicating that Hainan’s international competitiveness for pineapple has significantly enhanced. Banana is Hainan’s next most exported fruit; however, since 2008, the international market share for banana has decreased from 0.043% in 2008 to 0.028% in 2015. Lychee is Hainan’s third-most exported fruit. Since 2008, the international market share of Hainan’s lychee has fluctuated at around 0.1%.

The results in Table 4 show that the RCA index of Hainan’s exported fruit was relatively low and has fluctuated around 0.28% since 2008. Of all fruit varieties, only the RCA index of pineapple was around one, indicating that pineapple is internationally competitive. The RCA index of Hainan’s pineapple shows an overall upward trend. Before 2010, the RCA index of pineapple in Hainan basically remained below one; after 2010, the RCA index increased significantly, which shows that, after 2010, the competitiveness of Hainan’s pineapple has somewhat increased. The RCA index of Hainan’s bananas fluctuated. From 2008 to 2011, the RCA index of bananas in Hainan showed an upward trend, increasing from 0.635% in 2008 to 0.708% in 2011. After 2011, the RCA index of bananas in Hainan showed a downward trend, decreasing from 0.722% in 2012 to 0.663% in 2015. Hainan’s lychee RCA index also showed an upward trend, from 0.486% in 2008 to 0.716% in 2015. The RCA indices of Hainan’s longans and mangoes were both below one, indicating that these fruits lack international competitiveness.

4. Price Bargaining

With the gradual disappearance of the advantage of low labor costs, the profits of export-oriented enterprises in Hainan have declined, and their foreign trade has been affected. The ability to increase export bargaining power has become a pressing issue. In reality, due to the transaction costs and other issues, the importer tries to reduce the price, resulting in the exporter obtaining a true price that deviates from the benchmark price, which is caused by asymmetric information (Figure 4). If an exporter has information superiority and stronger bargaining power, the exporter can procure a more advantageous price; conversely, the importer can lower the importing price as much as possible to save costs and lead the exporter to obtain a price that is lower than the fundamental price. The final export price is the result of the bilateral role of both the importer and exporter. We measured the extent of the deviation in the export price by measuring how much the two parties have left. Based on the literature [25, 26], we relaxed the assumption of a perfect competitive market to analyze the export price formation mechanism from the perspective of asymmetrical information.

Assuming both importer and exporter have some information to exchange, they bargain and reach the final price to affect the transaction. The final pricing of exported fruit can be expressed as

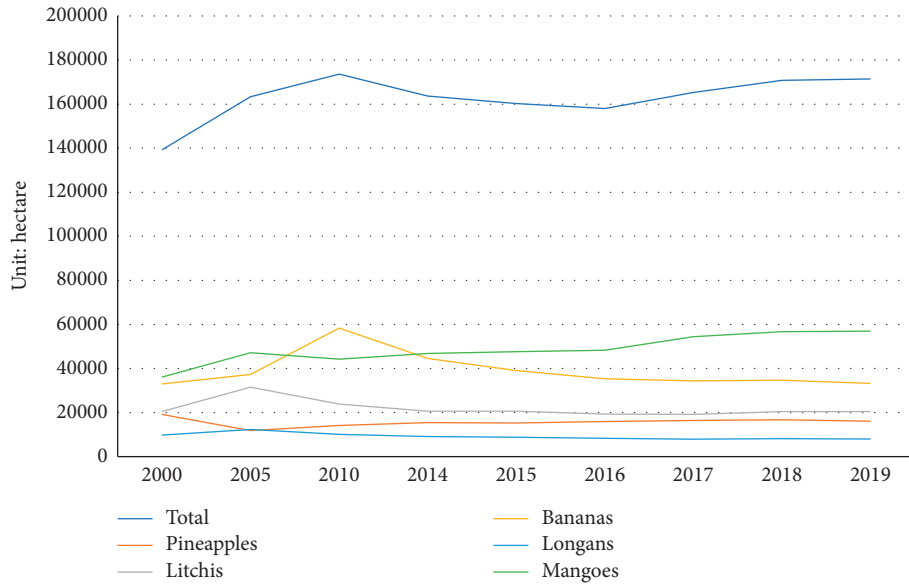
$$P = \underline{P} + \beta(\bar{P} - \underline{P}), \tag{6}$$

where P is the real export price, \underline{P} is the lowest price that the exporter could accept, \bar{P} is the highest price that importer is willing to offer, and β is the bargaining factor, denoting the bargaining power, whose value is between 0 and 1. If an exporter has more bargaining power, β is close to 1.

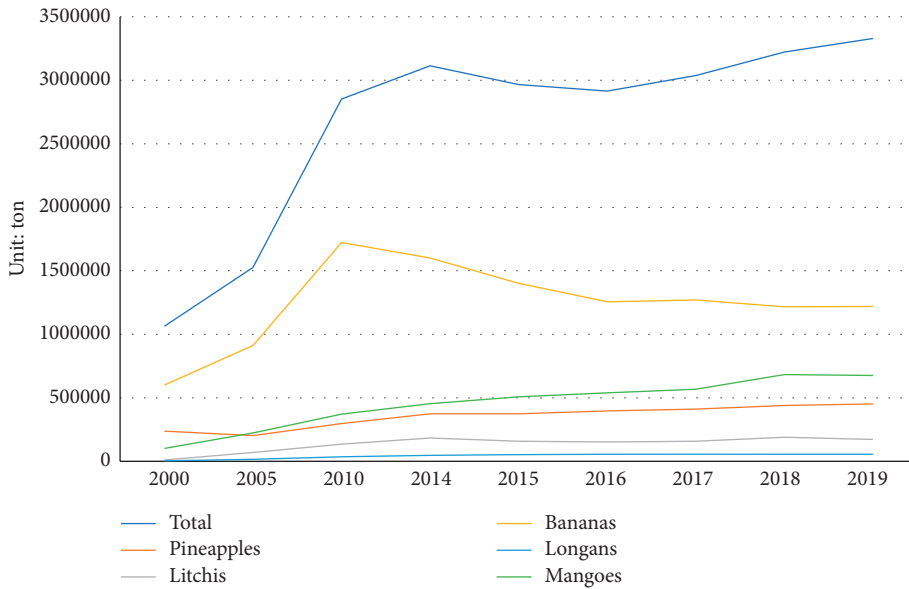
In reality, a fundamental price is provided by the market, which is denoted as $\mu(x)$. The range of $\mu(x)$ is between \underline{P} and \bar{P} , where $\mu(x) - \underline{P}$ represents the expected surplus of the exporter and $\mu(x) - \bar{P}$ represents the expected surplus of the importer. Thus, equation (6) can be rewritten as

$$P = \mu(x) + [\underline{P} - \mu(x)] + \beta(\bar{P} - \mu(x)) - \beta(\underline{P} - \mu(x)) = \mu(x) + \beta(\bar{P} - \mu(x)) - (1 - \beta)(\mu(x) - \underline{P}), \tag{7}$$

where the second part of this equation is the surplus obtained by the exporter by bargaining, and the third part of this equation is the surplus of the importer obtained by bargaining. The above equation indicates that the importer could use the expected surplus of the exporter to depress the price, with this signified by $(1 - \beta)(\mu(x) - \underline{P})$. The exporter could also use the expected surplus of the importer to increase the price, which is $\beta(\bar{P} - \mu(x))$. The bargaining ability of the exporter has a positive effect on the final price, whereas the bargaining ability of the importer has a negative effect on the final price. The final price is decided by the result of bilateral action. We rewrote the above formula into a bilateral stochastic frontier model and introduced individual and time variables to produce a bilateral stochastic frontier panel model:



(a)



(b)

FIGURE 3: Total cultivated areas and output of Hainan's fruits.

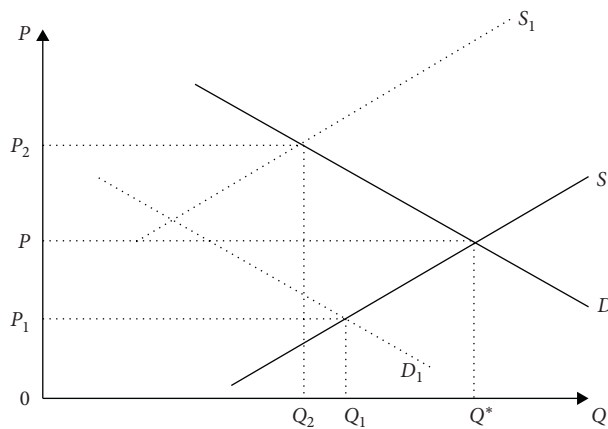


FIGURE 4: The final price derived by the asymmetrical information.

$$\begin{aligned} P_{it} &= \mu(x_{it}) + \xi_{it}, \\ \xi_{it} &= \omega_{it} - \mu_{it} + v_{it}, \end{aligned} \tag{8}$$

where $\mu(x_{it}) = x_{it}\beta$, x_{it} represents the individual characteristics variables of exported fruit, $\omega_{it} = \eta[\bar{P} - \mu(x)] \geq 0$ represents the ability of the exporter to bargain to increase the price, $u_{it} = (1 - \eta)[\mu(x) - \underline{P}] \geq 0$ represents the ability of

the importer to bargain to decrease the price, and v_{it} is the error term.

To estimate equation (8), we used the likelihood estimation method with the following assumptions: (1) both ω_{it} and u_{it} follow exponential distribution; (2) v_{it} follows normal distribution; and (3) ω_{it} , u_{it} , and v_{it} are independent, and all of them are independent of x_{it} . Then, we obtained the probability distribution of ξ_{it} , which is as follows [26]:

$$\begin{aligned} \mathcal{F}(\xi_{it}) &= \frac{\exp(a_i)}{\sigma_u + \sigma_w} \phi(c_i) + \frac{\exp(b_i)}{\sigma_u + \sigma_w} \int_{-h_i}^{\infty} \phi(z) dz = \frac{\exp(a_i)}{\sigma_u + \sigma_w} \phi(c_i) + \frac{\exp(b_i)}{\sigma_u + \sigma_w} \varphi(h_i), \\ a_i &= \frac{\sigma_v^2}{a\sigma_u^2} + \frac{\xi_i}{\sigma_u} \quad b_i = \frac{\sigma_v^2}{a\sigma_w^2} + \frac{\xi_i}{\sigma_w} \quad h_i = \frac{\xi_i}{\sigma_u} - \frac{\sigma_u}{\sigma_w} \quad c_i = \frac{\xi_i}{\sigma_v} - \frac{\sigma_v}{\sigma_w}, \end{aligned} \tag{9}$$

where Φ is the probability distribution of standard normal distribution and φ is the cumulative distribution of standard normal distribution. We also obtained the conditional distribution of ω_i and u_i :

$$\begin{aligned} \mathcal{F}(u_i/\xi_{it}) &= \frac{\lambda \exp(-\lambda u_i) \Phi(u_i/\sigma_v + h_i)}{\Phi(h_i) + \exp(a_i - b_i) \Phi(c_i)}, \\ (\omega_i/\xi_{it}) &= \frac{\lambda \exp(-\lambda \omega_i) \Phi(\omega_i/\sigma_v + c_i)}{\exp(a_i - b_i) [\Phi(h_i) + \exp(a_i - b_i) \Phi(c_i)]}, \end{aligned} \tag{10}$$

where $\lambda = 1/\sigma_u + 1/\sigma_w$. Based on the conditional distribution, we obtained the conditional expectation that is used to measure the bargaining power of the importer and exporter:

$$\begin{aligned} E(1 - e^{-u_i/\xi_i}) &= 1 - \frac{\lambda}{1 + \lambda} \frac{[\Phi(h_i) + \exp(a_i - b_i) \exp(\sigma_v^2/2 - \sigma_v c_i) \Phi(c_i - \sigma_v)]}{\Phi(h_i) + \exp(a_i - b_i) \Phi(c_i)}, \\ E(1 - e^{-w_i/\xi_i}) &= 1 - \frac{\lambda}{1 + \lambda} \frac{[\Phi(c_i) + \exp(b_i - a_i) \exp(\sigma_v^2/2 - \sigma_v h_i) \Phi(h_i - \sigma_v)]}{\exp(b_i - a_i) [\Phi(h_i) + \exp(a_i - b_i) \Phi(c_i)]}. \end{aligned} \tag{11}$$

The export of pineapple in Hainan to other countries accounted for more than 80% of the total export of pineapple in China, and the bargaining power of each country is different; thus, we chose these countries as the research object to study the specific pricing power of Hainan's fruit. Combined with the characteristics of Hainan's fruits, we chose Hainan's exporting price of pineapple to each country as the dependent variable, and the cost of fruit production, quality, exchange rate, and competitor price as independent variables. (1) The cost of production is the cornerstone of export prices. Producers are rational, and once the cost of production increases, they try to transfer these costs to consumers through the export price. So, the higher the cost of production, the higher the exporting price. The relationship between these two is positive, and the sign of production cost is expected to be positive. (2) Quality is an important factor affecting the export price. Generally, product quality is directly related to the cost and technicality of the investment. The higher the cost, the higher the

technicality and the higher the quality of the product. Whereas the costs and technologies invested are generally transferred to consumers through the export price, the sign of the quality variable is expected to be positive. We used the following regression to estimate the quality [27]: $\ln(Y_{it}) = a \ln(P_{it}) + \varnothing_{it} + \zeta_{it}$, where i represents the importer, Y_{it} is the number of goods exported to country i at time t , P_{it} represents the export price of goods i , \varnothing_{it} represents the fixed effects, and ζ_{it} is the error term. The other methods to measure quality are $\text{Quality} = (P_{it} - \text{avg}(P_{it})) / \text{sd}(P_{it})$ and $\text{Quality} = \log(P_{it} - \text{avg}(P_{it}))$. We also tried these two methods and found that the results were almost the same (Table 5). We used ζ_{it} to represent the quality of the goods. (3) The export price is also affected by the exchange rate (ER), but the sign of the ER is not certain [26]. (4) For competition price (CP) for the same target market, the higher the price of competitors, the lower the demand for competitors' fruit, the greater the demand for Hainan's fruit, and the higher the export price of Hainan's fruit, which

TABLE 5: Results of bargaining power using different quality equations.

Variable	(12)	(13)
Cost	0.089*** (0.00003)	0.092*** (0.00004)
ER	0.159*** (0.0002)	0.163*** (0.00005)
CP	-0.086*** (-0.0002)	-0.081*** (-0.0002)
Quality	0.248*** (0.0001)	0.207*** (0.0002)
Constant	0.174*** (0.00004)	0.169*** (0.00005)
Country dummy	Yes	Yes
Year dummy	Yes	Yes
Adjust R^2	No	No
Log likelihood	366.812	257.350
LR (Chi^2)	487.124	567.813
p value	0.000	0.000

Note: ***, **, and * denote significance at $p \leq 0.01$, $p \leq 0.05$, and $p \leq 0.1$ levels, respectively.

TABLE 6: Descriptive analysis and unit root test of variables. ER: exchange rate; CP: competition price.

Variable	Mean	SD	Minimum	Maximum	Result of unit root test (ADF) on log variables
Price	24	3.89	1.02	8.46	Stationary
Cost	0.69	0.22	0.37	1.64	Stationary
Quality	0	0.83	-1.72	2.54	Stationary
ER	3.04	0.53	0.73	5.36	Stationary
CP	0.49	0.28	0.23	1.97	Stationary

TABLE 7: Estimation of all models.

Variable	OLS	MLE	Bilateral stochastic boundary model			
Cost	0.182*** (0.049)	0.169*** (0.007)	0.173*** (0.144)	0.102*** (0.0002)	0.096*** (0.00006)	0.098*** (0.00004)
Quality	0.491*** (0.050)	0.203*** (0.003)	0.185*** (0.504)	0.091*** (0.0001)	0.175*** (0.0001)	0.182*** (0.00008)
ER	-0.083*** (-0.007)	-0.152*** (-0.008)	-0.127*** (-0.015)	-0.124*** (-0.0002)	-0.094*** (-0.0002)	-0.073*** (-0.0003)
CP	0.746** (0.382)	0.501*** (0.029)	0.652*** (0.068)	0.726*** (0.0005)	0.251*** (0.002)	0.190*** (0.0004)
Constant	0.029* (0.015)	0.017*** (0.0001)	0.065* (0.035)	0.010*** (0.00004)	0.162*** (0.00007)	0.155*** (0.00007)
Country dummy	No	No	No	Yes	No	Yes
Year dummy	No	No	No	No	Yes	Yes
Adjusted R^2	0.592	No	No	No	No	No
Log likelihood	No	-194.762	138.825	129.035	257.492	140.267
LR (Chi^2)	No	No	241.687	490.462	523.092	553.634
p value	No	No	0.000	0.000	0.000	0.000

OLS: ordinary least squares; MLE: maximum likelihood estimation; LR: likelihood ratio, R^2 : coefficient of determination. ***, **, and * denote significance at $p \leq 0.01$, $p \leq 0.05$, and $p \leq 0.1$ levels, respectively.

means the sign of CP is positive. Given the data availability, we used the average import price of the importing country as an alternative variable for the competitor's price. The details of the variables are provided in Table 6, where all log variables are stable.

In this study, a two-tier stochastic frontier analysis model was used to measure the bargaining power of the importer and exporter. To prove the robustness of the results, other methods were also used to estimate the bargaining power. The coefficient signs and significance of all variables in all models are consistent (Table 7), indicating the results are robust. The coefficients of production costs, quality, and competitor prices are significantly positive and in line with expectations. The exchange rate coefficient is significantly negative, indicating that the appreciation of the

RMB will lead to a decline in the exporting price of Hainan's exported fruit.

We also calculated the variance decomposition of the effect of the bargaining power on the export price of Hainan's fruit, which can be used to measure the degree of impact of the bargaining power of the exporter and importer on the export price. The results show that Hainan's bargaining power was less than that of importing countries. The final price was based on the willingness of importing countries, resulting in a price lower than the theoretical price. Further analysis of the unilateral effect shows the bargaining power of the importer was 58.93% ($\sigma_w^2 / (\sigma_w^2 + \sigma_u^2)$), indicating that, in the process of exporting fruit and negotiations, the importing countries were more powerful and lowered prices more easily. The impact of the

TABLE 8: Total surplus of importers and Hainan.

X	Mean	SD
Hainan surplus	2.573	3.814
Importer surplus	3.202	4.973
Net surplus	-0.629	6.267

TABLE 9: Annual surplus distribution characteristics of exporters and Hainan.

Year	Hainan surplus	Importer surplus	Net surplus	SD
2008	1.832	4.641	-2.809	2.791
2009	2.063	3.576	-1.513	3.652
2010	2.562	4.031	-1.469	3.751
2011	3.025	5.482	-2.457	4.028
2012	2.836	3.179	-0.343	4.001
2013	2.614	4.768	-2.154	3.857
2014	3.703	3.591	0.112	3.296
2015	3.960	4.153	-0.193	4.461

bargaining power of Hainan was 41.07% ($\sigma_u^2/(\sigma_w^2 + \sigma_u^2)$), indicating that Hainan's impact was less than that of the importing countries, and the formation of the export price depended more on the importing countries.

The prerequisite for international trade is that both the importer and exporter can gain profits or at least no losses. Therefore, accurately measuring the degree of deviation between the actual price and fundamental price and estimating the net surplus obtained by both exporter and importer and the net surplus between these two are necessary. From Table 8, Hainan increased the real price 2.573% higher than the fundamental price through bargaining. The importers reduced the actual price by 3.202% through bargaining. Overall, the actual price was 0.629% lower than the fundamental price, indicating that both importers and Hainan had roughly the same ability to obtain a surplus, and the ability of importers was slightly higher than that of Hainan.

Table 9 shows the ability of importers and Hainan to obtain a surplus in different years. In almost all years (except 2014), Hainan's surplus was smaller than that of the importers, and the net surplus was negative, which shows the exporting price of Hainan's fruit has been below the fundamental price level for a long time period, and the export bargaining power has not significantly improved.

5. Conclusions

The agricultural production costs in Hainan, especially the rising costs of labor, have had a significant impact on the export of fruit. We used a CMS model and price index model to analyze the source of Hainan's fruit export growth and the role of competitiveness in this export growth. As labor costs increased, the price advantage of Hainan's fruit exports was completely lost in 2008, and the contribution of its competitiveness to Hainan's fruit export growth dropped rapidly. The implementation of the One Belt One Road strategy has strongly promoted the export growth of many kinds of in-

dustries [28] include Hainan's fruit and overshadowed the adverse effect of the decline in competitiveness [29, 30].

As the scholar suggested, more information acquisition will have positive influence on the market competition [31]. Thus, the level of information held by both importers and Hainan had an important impact on the final export price. The combined effect of asymmetrical information on the final export price of Hainan's fruit was -0.629%, indicating that asymmetrical information results in a price that is lower than the fundamental price. By the unilateral effect analysis of the importer and exporter, we found that, in the export pricing process of fruit, Hainan's held information increased the final price by 2.573%. The importing country, by virtue of its level of information and bargaining power, reduced the price of fruit by 3.202%. These two opposite effects result in the final price dropping by 0.629% relative to the fundamental price. From 2008 to 2015, importers dominated pricing by their information superiority and bargaining power, resulting in the real export price of fruit being lower than the fundamental price for a long time [31-33], while Hainan's fruit export bargaining power did not substantially improve. According to the analysis in this paper, the following policy suggestions are proposed:

- (1) For the quick and healthy development of the economy, it should not be too active to be chaotic which is difficult to forecast and control, nor too faded to lose the energy [34]. Hainan should optimize the structure of its fruit exports. However, with global economic development, people's consumption levels have risen, and the structure of global fruit demand has gradually diversified. Hainan should export more high-quality specialty tropical fruits.
- (2) Because product's quality matters more than the market structure [35], Hainan should enhance the quality of its fruit. With the improvement of people's living standards, the fruit quality requirements have also risen, but Hainan's quality control system lags behind, seriously affecting the trust of foreign markets in Hainan's fruit. Due to the fact that sometimes the cost of returning tax can stimulate the market and eventually gain more profits for the government [36], Hainan should implement the international standards of product quality and technical specifications and actively seek international certification to lay the foundation for smooth access to the international market. The planning should be done based on the characteristics of different locations to efficiently build a large base of fruit varieties considering market segments.
- (3) Hainan should change the mode of competitive promotion. Although the pure second-order effect can promote the export of fruit, this effect is declining continuously. In other words, for a long time, the export of Hainan's fruit depended on a cost advantage. The comparative advantage of these costs is static and determined by the country's natural resource advantages. Participation in international

trade and competition based solely on this comparative advantage will eventually be marginalized or even eliminated by the market. The long-term advantage should be established by improving the technological innovation ability and survival skills of agricultural producers. The success rate of production has positive influence on the strategic selection and cooperative stability of both producers and consumers [37]. Hainan needs to increase investment in scientific research and market research to transition from a comparative advantage to competitive advantage. At the same time, it is very necessary for the government to provide innovation subsidies, increase enterprises' R&D funds, and turn enterprises' innovation ideas into reality [38].

- (4) The quality information tracing technology, farmers and marketers' fair distribution of profits and risks, and consumers' capabilities to safeguard their legal rights are the three key factors to maintain the effectiveness and stability of quality assurance systems [39]. So, Hainan should attach importance to nurturing export bargaining power and take advantage of favorable conditions and factors for bargaining to meet the needs of market changes and development. Combined with these conclusions, to increase the promotion of Hainan's fruit export bargaining power, and reduce the friction of information asymmetry, Hainan should build an export information platform to provide timely and comprehensive information services.

Data Availability

The data were collected from Hainan Statistical Yearbook issues from 2008 to 2020 and processed by the authors.

Disclosure

Hailing Fu and Chongli Huang are co-first authors.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

Hailing Fu and Chongli Huang contributed equally to this article.

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