Brand Equity among Producers of Chinese Mitten Crab

by

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Abstract

In the Shanghai area of China there is considerable product differentiation among producers of Chinese mitten crab *Eriocheir sinensis*, with as many as 50 brands available in the marketplace. At the same time, the brand awareness of each brand is quite different. A consumer survey showed that brand awareness differed greatly among consumers, with 10 well-known brands recognized by more than 80% of respondents, 34 less-known brands recognized by 20%~80% and 20 unknown producers recognized by less than 20%. The cultivation method, cost structure, and profitability of these three categories also vary widely. Achieving maximization of net revenues is the same long-term goal for every producer, and how to improve the brand equity to reach this goal is one of the most important problems. Thus the overall and detailed economic situations of each type of Chinese mitten crab brand need to be analyzed, and using the appropriate method to measure the brand equity of Chinese mitten crab brands is the central issue that needs to be resolved in this thesis. Data for the study was collected from mitten crab producers on prices, yields, size distributions, costs, and a number of other variables that may serve as proxies for production technologies and marketing efforts. Cost benefit analysis and risk analysis were used to show the overall and detailed economic situations of different types of brands. Net Revenue Premium was chosen as the appropriate measure for estimating brand equity.

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I. Introduction

1.1. Background

The Chinese mitten crab *Eriocheir sinensis* is a special aquatic product in China. People began to eat the Chinese mitten crab thousands of years ago. During the mid-autumn festival, people like these crabs as well as the moon cake, and they also send Chinese mitten crabs as a holiday gift to their friends. In 2009, the annual sales of these crabs were over 1 billion RMB. In 2012, the annual sales were almost up to 1.6 billion RMB. In 2013, the annual sales were more than 2 billion RMB (Tan, 2013). The increasing trend can be shown in Figure 1. In the past few decades, the Chinese mitten crab has become one of the most popular aquatic products. Not only is the demand growing quickly but also the share in the aquatic market is increasing steadily. At the same time, the Chinese mitten crab producers have begun to export their products to other countries in Asia.

During the process of analysis and investigation of the aquatic market, it was found that the 10 famous brands, such as ‘Yangcheng Lake’, ‘Tai Lake’, ‘Gucheng Lake’, and ‘Hongze Lake’, represent 41% of the market by yield and 61% by revenue. Meantime the 34 less-known brands hold 56% and 38%, and the 20 unknown producers only hold about 3% and 1% respectively.

Chinese Mitten crabs grow well in the Yangtze River basin since the water quality and climate are much more suitable than other river basins. There are several cultivation methods for Chinese mitten crab, including lake, pond, rice field, cages, etc. In general, these methods can be divided into outdoor cultivation and indoor

cultivation. For outdoor cultivation methods, the producers usually occupy a lake or pond. After inputting crab seed, they put some purse nets into the water to stop the crabs from running away and patrol the whole area regularly to make sure everything is in good condition. Figure 2 shows this kind of cultivation method. For indoor cultivation methods, the stocking density and degree of artificial control will be much higher. Generally, there will be several adjacent pools with 30-50 cm water depth each. Meanwhile every pool has both a water inlet and outlet, connected with oxygen supply equipment and coarse filter equipment respectively. Blocking nets are also installed in case that crabs escape. Figure 3 shows this kind of cultivation method.

For all of the well-known brands and most of the less-known brands, maintaining their brand is an important task. One aspect is brand security protection. The main methods of security protection are ‘Uniform Store Signs’, ‘Distinctive Packaging’, and ‘Security Lock’. The ‘Uniform Store Signs’ is the signboard hanging on the door of a retail store or set in front of a stall in the supermarket. The ‘Distinctive Packaging’ is the special and unique packaging with the trademark on it that is used during retail process for each brand. The ‘Security Lock’ method uses a tag locked on the claw of the crab that contains a unique laser-etched identification number. This is the most expensive method since the laser technology is expensive. Figure 4 shows this kind of tag. 100% of the well-known brands use all three of these methods. 50% of the less-known brands use ‘Uniform Store Signs’, 68% of them use ‘Distinctive Packaging’, and 23% of them use ‘Security Lock’. None of the unknown producers use any of these methods.

1.2. Problem Statement

Since the Chinese seafood market has so many mitten crab brands, this industry presents a complicated structure. For different producers, besides the cultivation methods, there are also many other factors that affect the production, distribution and marketing process. These influence the yield, quality and crab size directly while affecting consumer preference and price indirectly. Moreover, there are factors in the retail and brand maintenance processes which influence consumer preference and price directly and indirectly as well.

We will assume that for every producer the main objective is maximizing profit. Thus the overall and detailed economic conditions of each type of Chinese mitten crab brand need to be analyzed first. Then, we need to find an efficient method to measure brand equity and suggest how to improve brand equity. These are the central issues that are investigated in this thesis.

To solve the central issues, the first step is to do a cost benefit analysis and a risk analysis to show the overall and detailed economic situations and profitability of different types of brands. The second step is to apply appropriate methods to estimate the influence various factors have in determining brand equity.

To accomplish these two steps, cost and return data are necessary, as well as a suitable methodology. In this study, the data are collected from several provinces around the Shanghai area. There are 64 producers represented in this survey who provided their data. Brands were initially divided into three types according to their brand awareness as determined from a survey of consumers. When the recognition of

a brand is more than 80%, it is defined as a “well-known” brand. If the recognition is less than 80% but more than 20%, it is a “less-known” brand, and if the recognition is less than 20%, it is an “unknown” producer, of which 86% of these had 0% recognition. Thus there are 10 well-known brands, 34 less-known brands and 20 unknown producers. Meanwhile, the costs can be divided into distinct processes, such as production costs, retail selling costs and brand maintenance costs, and there are several detailed cost factors that need to be considered within each of these three processes. Revenues are related to the price and yield, and price is thought to be determined by brand awareness, perceived quality and crab size. Therefore, the price of each crab size and the size distribution needs to be taken into account as well.

To achieve the first step, cost benefit analysis and risk analysis were both used to show the overall economic situations of different types of Chinese mitten crab brands and to point out the differences in profitability for each category of brand. Cost benefit analysis is used to measure the profitability of each brand. Risk analysis focuses on the distribution of net returns to management. To complete the cost benefit analysis, the Benefit Cost Ratio (BCR) is used here. For the risk analysis, the entire probability distribution of net returns to management is simulated.

To achieve the second step of evaluating the factors that influence brand equity, an appropriate method needs to be chosen first. Although there are many different variables that can be used as measures of brand equity, they usually have high correlation with each other. There are mainly three types of measure depending on the source of the data. The product-based level method is more complete than the

customer-based level method. It is also more convenient to get the needed data than the firm-based level method (Ailawadi, 2003). The ‘net revenue premium per kilogram’ will be used as the principal method to measure brand equity here. This measure can combines high external validity, strong conceptual grounding, completeness and ease of calculation.

In summary, this thesis will mainly focus on estimating the influence that various factors have in determining brand equity, and will suggest strategies to improve brand equity. For producers, this will increase profits and brand awareness, while also protecting the quality and image of the authentic Chinese mitten crab. Thus, both consumers and producers can look forward to long-term benefits from a sustainable industry.

1.3. Thesis Organization

This thesis includes six major chapters. Chapter I includes an introduction to the Chinese mitten crabs including the background and problem statement. Chapter II presents a review of relevant literature relating to the Chinese mitten crab, cost benefit analysis, risk analysis and brand equity. Chapter III discusses the data used in this study. The data include the key production factors, market prices, cost factors, and gross and net revenues. Chapter IV describes the methods involved with the Benefit Cost Ratio (BCR), the simulated probability distribution of net returns to management and models to evaluate the factors that influence the revenue premium as a measure of brand equity. The latter part of chapter V discusses the results of the three analyses.

Chapter VI presents a summary of the study and the main conclusions drawn from it.

II. Literature Review

2.1. Chinese Mitten Crab

There are many studies on the Chinese mitten crab *Eriocheir sinensis* in China. These studies include environment conditions, cultivation methods, nutritional value, and many other topics.

Li (2006) showed that the Chinese mitten crab grows best on a diet of fish, shrimp, oysters, snails and rough rice. The Yangcheng Lakes in the Yangtze River Delta are the ideal place for crab culture owing to the full sunshine, clear water, adequate plankton and abundant aquatic plants. Compared to other common aquatic foods, the crab is rich in protein, lipids, carbohydrates, and vitamin A. In addition to their high nutritional value, these crabs are believed to possess other health related benefits such as digestive illnesses.

Chen, et al. (2007) state that the mitten crab is native to the coastal rivers and estuaries of the Yellow Sea. However, from accidental releases it has now spread to Europe and California (Rudnick, et al., 2003). Although Chinese mitten crab is considered as a harmful invasive species in Europe and the USA, it constitutes a promising freshwater fishery industry in China where its annual output has increased from 200,000 tons in 2000 to 420,000 tons in 2004 and to 593,000 tons in 2010 (China Fishery Yearbook, 2011). Chinese mitten crab is a traditional savory food in China. The crab not only has a delicious taste and unique pleasant aroma, but also has

good nutritive value.

Cheng, et al. (2008) described the increase in Chinese mitten crab culture as mainly resulting from breakthroughs and improvements in hatchery techniques over the last 20 years. During the 1990s, the hatchery techniques for mitten crabs were gradually developed and improved for practical, large-scale production of megalopae, juveniles, and adults. Other innovations included broodstock dietary enrichment, breeding systems, indoor intensive larviculture and outdoor extensive larviculture, and improvement of pond conditions for larval rearing. Stocking densities range from 1500–9000 juvenile crabs per ha, depending on the habitat conditions of the net enclosure site and feeding conditions. These variations in successful approaches to culture and stocking of mitten crabs have spread extensively across China.

Sui (2008) stated that in its native range in China, mitten crabs are mainly distributed in the Liao, Yangtze and Ou River basins and comprise different populations due to long term geographical and ecological isolation. Most demanded is the crab originating from the Yangtze River, due to their better growth rates and delicate flavor, and these stocks are therefore most frequently used in hatcheries and farms.

Paterson (2009) suggested crab farming has largely developed in advance of formal research programs, so there is probably still scope for significant improvements in production practices, particularly in the area of feed and genetics. Ongoing progress in mitten crab farming is evidenced by the emergence of genetics and broodstock quality as significant issues, while farming of portunid crabs has only

achieved reliable hatchery production relatively recently. The most desirable mitten crabs reputedly come from the water of Yang Cheng Lake in Jiangsu Province. However, it is widely reported in the Chinese media and elsewhere that total sales of 'Yang Cheng' crabs regularly exceed the lake's actual production figures. To counter a burgeoning trade in these 'counterfeit' crabs, increasingly sophisticated labelling and tagging methods are being adopted by Yang Cheng growers to defend their product quality, prestigious image and premium prices (Paterson, 2009).

Wang (2011) emphasized that no matter which cultivation method is used, ample, fresh and non-polluted water is required for optimal production. For indoor cultivation, culture vessels are fitted with both oxygen supply and coarse filter equipment. In pond culture, before producers put juvenile crabs into the water, ponds and pools are disinfected with quicklime and bleaching powder to kill pathogens and natural enemies such as frogs, snakes, and black fish. Furthermore, 30% of the water surface should be covered with aquatic plants for water quality improvement and to provide places for crabs to moult. The first step of cultivation is to condition the water, mixing in calcium, magnesium and iron until the PH is between 6 and 8. After that, the water needs to be oxygenated to at least 3mg/L. The temperature of water should be 20-29℃ at stocking. Filtration, oxygenation and temperature control characterize the recirculating system.

According to the statistical report of the Ministry of Agriculture of China (China Fishery Yearbook, 2011), the annual output of Chinese mitten crab has been increasing sharply in recent years, almost doubling in a decade. Nowadays,

aquaculture of *E. sinensis* has become the largest commercial crustacean industry.

From a document entitled “The administrative measures for protection of original Chinese mitten crab of Yangcheng lake” (Su Zhou government, 2005), there appear to be some policies that explain some of the differences among the types of brands listed in the data section. For example, No.5, the producers can enter Yangcheng Lake only when they have some brand foundation and meet the standards set up by the relevant departments. No.9, the relevant departments deal with the entry requirements for producers and manage their entry process. No.11, when the producers get permission to enter Yangcheng Lake, they need to register and provide the basic information including cultivate location, total area, seed source, stocking density, etc. No.17, the producers who obtain the appropriate permissions should also meet following conditions: (1) Have a business license and suitable places of business; (2) Have the eligible storage conditions and business conditions; (3) After filing of an application, the producers need to pass an examination by the relevant departments.

2.2. Cost Benefit Analysis and Risk Analysis

Cost benefit analysis is a systematic process for calculating and comparing benefits and costs of a project, decision or government policy. It is also a process by which multiple business decisions may be evaluated and compared. The benefits of a given situation or business-related action are summed and then the costs associated with taking that action are subtracted. Cost benefit analysis, a common economic analysis method, is used in many researches and studies, including the aquaculture

area.

Risk analysis helps to define preventive measures to reduce the probability of detrimental factors occurring and to identify countermeasures to successfully deal with constraints. Risk analysis refers to the uncertainty of forecasted future cash flows streams, variance of returns on assets, statistical analysis to determine the probability of a project's success or failure, and possible future economic states, all of which can also be applied to aquaculture enterprises.

2.3. Brand Equity

Aaker (1996) proposed ‘The Brand Equity Ten’ in an effort to create a set of brand equity measures. He listed ten sets of measures that were grouped into five categories. The first four categories represent customer perceptions of the brand along the classical four dimensions of brand equity—loyalty, perceived quality, associations, and awareness. The fifth category includes two sets of market behavior measures—market share and distribution that represent information obtained from market based information rather than directly from customers. Thus the ten factors are price premium, satisfaction/loyalty, perceived quality, leadership, perceived value, brand personality, organizational associations, brand awareness, market share, and indices of price and distribution.

Cravens and Guilding (1999) argued that the financial-based valuation involves various measures of price premium that may be attributable to quality perceptions on the part of customers. Several means are available for calculation of price premiums

on branded products including the cost method, market method, income method, and the formulary method. These four methods were examined in detail by Seetharaman et al. (2001). For the cost-based method, a brand is valued by considering the cost involved in developing the brand. The costs incurred are the actual costs associated with acquiring, building or maintaining the brand. The market-based method is based on the price at which a brand can be sold. To determine its market value, the future benefits associated with owning the brand are discounted to the present value. The formulary method involves multiple criteria in determining a brand's value. For computing brand profitability, the factors that need to be considered are the factors that relate directly to the brand's identity. After determining brand profitability, a multiplier is then attached to the valuation. This includes seven factors: leadership; stability; market; support; protection; international image; and trend. Net profits from the branded product are equal to profits from the branded product minus profits from a similar but unbranded product minus profits from assets that do not contribute to the strength of the brand. The value of the brand is then equal to net profits from branded products times the multiplier.

Keller (2003) described brand equity as 'a multidimensional concept and complex enough that many different types of measures are required. Multiple measures increase the diagnostic power of marketing research' (p. 477). Brand equity is supposed to bring several advantages to a firm. For example, high brand equity levels are known to lead to higher consumer preferences and purchase intentions (Cobb-Walgren et al, 1995).

Ailawadi et al. (2003) measured brand equity at the product level. They listed three measures of brand equity: customer mind-set, product-market outcomes, and financial market outcomes. They did correlations of all these measures, but found that most of them have high correlation with each other. Thus they only used the revenue premium measure in their study. They mentioned that the unit sales of one firm can be represented by a function of marketing mix, price, equity, preexisting firm strength, and category characteristics of this firm and another similar firms. And if this firm has a brand, the outcome of the brand's equity is its revenue premium. Then the brand equity equals to the revenue of a branded firm minus the revenue of an unbranded firm. To make the estimation more accurate, they suggested that the revenue premium measure be adjusted for variable costs, and defined the adjusted revenue premium as equal to the revenue premium minus costs.

Srinivasan et al. (2005) defined brand equity as 'the incremental contribution ($) per year obtained by the brand in comparison to the underlying product (or service) with no brand-building efforts' (p. 1433). Their approach takes into account three sources of brand equity: brand awareness, attribute perception biases and non-attribute preference. Their approach also reveals how much each of the three sources contributes to brand equity.

Fernández-Barcala and González-Díaz (2006) linked both marketing and transaction cost economics literature to explain factors determining brand equity from the buyer's perspective. Their main argument was that the ability of a brand name to resolve situations in which transaction costs are potentially high increases with brand

equity. They advanced four research propositions: (1) Consumer-oriented brands will be more valuable to the buyer than distributor-oriented brands; (2) Brands related to products which yield high search/measurement costs are more valuable to the buyer; (3) When the quality control of a brand name is performed by an external and independent controller, the buyer reliance on the brand name is greater than when it is only performed internally; (4) Co-branding adds more value to the product from the buyer's perspective than a single brand name. They used a case study research approach involving brand names, types of produce, owner, countries, types of brand name, addressees of brands, search cost of each type of produce, and type of quality control. Their results broadly support the argument that the higher the contractual hazards, the higher the price premium.

Liu and Sporleder (2007) proposed that brand equity requires development and maintenance expenditures, but management often questions how much investment a brand needs. This question often is complicated by the ambiguity of brand value. Brand equity is expected to exert a positive effect on the firm’s growth options value. They focus on the impact of a firm’s brand value in terms of a firm’s growth option value. These two values of can be regarded as jointly dependent variables and a simultaneous equations model is appropriate. Brand value is regarded as a function of advertising expense, disaggregated uncertainty indicators and the endogenous variable of the firm’s growth option value. Besides brand value, other explanatory variables regarded as strategic drivers for the firm’s growth option value include measures of the individual firm’s strategic factors regarding operations, investment, financing and

dividends. Results indicate that brand equity has a positive effect on the growth option value of the firm, after accounting for other major drivers of firm growth. The categorizing advertising expenditures solely as an expense item may be too narrow from a strategic viewpoint. Brand equity building strategies are long-term investments for the stakeholders of the firm, broader than mere expense items.

III. Data

The dataset used in this thesis is from a survey of producers of 10 well-known brands of Chinese mitten crab, 34 less-known brands and 20 unbranded products. Here the well-known brands are defined as the brands that are recognized by more than 80% people in consumer survey, and the less-known brands are known by 20-80% of the consumers while the unknown producers are rarely known by people or just do not have a brand. The dataset contains key production factors, market price, gross revenues and cost factors.

3.1. Key Production Factors

These factors include the basic information from survey respondents about cultivation method, survival rate, stocking density, harvest density, yield, and harvest size distributions. The latter two factors are used directly in the calculation of gross revenues while cultivation method, stocking density, harvest density and survival rate indirectly reflect management characteristics of the producer. Averages of these factors for the three type of brands are shown in Table 1.

3.1.1. Cultivation Method

There are several cultivation methods for Chinese mitten crab depending on the cultivation area and process. These include lake, pond, rice field, industrial, and cages, etc. These methods can be divided into outdoor cultivation and indoor cultivation. For the well-known brands, all producers used the outdoor cultivation method in lakes. For the less-known brands, some of them used outdoor cultivation while others of them used indoor cultivation. For the unknown producers, most of them used indoor cultivation.

3.1.2. Stocking Density

The average stocking density of the well-known brands is 5,287 juveniles per acre, the average stocking density of the less-known brands is 6,516 juveniles per acre, and the average stocking density of the unknown producers is 10,458 juveniles per acre. The higher rates reflect high-density cultivation in indoor, recirculating systems, so they are not directly comparable on a per acre basis.

3.1.3. Harvest Density

The average harvest density for each type of brands is 4,265, 4,590, 6,445 adult crabs per acre for the well-known, less-known and unknown producers respectively.

3.1.4. Yield

The average yield of the well-known brands is 682 kg/acre while the average

yield of the less-known brands is 705 kg/acre and it is 893 kg/acre for the unknown producers. Again, these value are not directly comparable in terms of production efficiency.

3.1.5. Survival Rate

The survival rate reflects a variety of management aspects in production, including quality of juveniles, stocking density, and cultivation techniques. Survival was calculated from the survey data in the following way. At the beginning of the survey, the number of juveniles purchased was elicited; thus the amount of adult crabs can be estimated by the formula 'yield × proportion of each size/ estimated average weight of one crab in this size'. The survival rate equals the number harvested divided by number stocked. The average survival rate of the well-known brands is 80.5%, which is 10 percentage points higher than the less-known brands and 19 points higher than the unknown producers.

3.1.6. Size Distribution

Since the gross receipts are related to the price by size, yield, and proportion each size of crab, the size distribution is important too. For the well-known brands, the proportions of the two larger size categories (200g-250g, and more than 250g) are much higher than for the other two types of brands. The less-known brands have the largest proportion of the medium 150g-200g size. Meanwhile, the unknown producers have higher proportions of the smaller 100g-150g, and less than 100g sizes. Figure 5

shows the size distribution by brand category.

3.2. Key Market Factors

3.2.1. Market Price

Market price per kilogram is influenced differs by brand awareness, quality and notably for crustaceans size. Therefore, in estimating brand equity the market price of each size must be taken into account. The unit of price is in renminbi (RMB) which is the circulation currency of China. What is more, the price in the same crab size of the well-known brands is almost twice that of the less-known brands. There is also a marked difference between less-known brands and unknown producers as well. Figure 6 note that for most undifferentiated products the price per kilogram is a single, horizontal line regardless of size. The average market price of each size category of all three type of producers is shown in Table 2.

3.2.2. Gross Revenues

There are dramatic differences in gross revenues by brand type. For a given crab size, gross revenues are calculated as the sum of the weight in each size class times the price per kilogram of that size class. Gross revenues show phenomenal differences among the different types of brands. This can be seen in Figure 7. The average gross revenue of each size category of all three type of producers is shown in Table 2. Each category in increasing recognition returns more than twice the average gross revenue per kilogram of the previous category.

3.2.3. Recognition

Recognition reflects brand awareness, which has a relationship with revenues. Here the recognition data was taken from a consumer survey. More than 800 consumers tool this survey to answer which brands they are familiar with. For the well-known brands, the average recognition was close to 90% which means most people know the brand when shown it on a list. For the less-known brands, the average recognition was 47% which means almost half the respondents were familiar with these brands. However, some of them are close to 80%, while others are just over 20%, so the difference are quite variable. For the unknown producers, a small number of them were recognized, but all were less than 20%, and most of them had no recognition. The relationship between recognition and net revenue per kilogram is shown in Figure 8. The average recognition of all three type of producers is shown in Table 2.

3.3. Cost Factors

Cost is divided into three different processes: production costs, retail sales costs and brand maintenance costs. Within each of the three processes there are more detailed cost factors. Averages for these cost factors among the three types of brands are shown in Table 3.

3.3.1. Production Costs

Mechanical Investment

The mechanical investment is a fixed cost which includes payments to principal or depreciation on machines and other fixed facilities. Examples include air conditioning for temperature control of the indoor environment, aeration to add oxygen to the water, and pumps for water circulation. The average mechanical investment of the well-known brands is 0.39RMB/KG which is close to that of the less-known brands and a little higher than the unknown producers at 0.35RMB/KG.

Rent

Producers doing outdoor cultivation usually rent space in the lake or pond. Factory and cage producers rent space to construct their factory or put in their cages. So the rent is a necessary fixed cost factor no matter what cultivation method the producers choose. The average rent of the well-known brands is 3.77 RMB/KG, 3.66 RMB/KG for the less-known, and 2.48 RMB/KG for the unknown. The local governments prefer to rent the lake to the well-known brands because they want to control the numbers of producers using the lake and protect the water quality, and since most well-known brands have a lower stocking density this is considered beneficial to the lake environment.

Tax

In this study, the tax is also taken as a fixed cost, which comes from the requirements of tax policy. When the producers operate their companies, build their factories, rent space, or buy machines, they are taxed some fixed fees every year. The main taxes that they need to pay in this process are the stamp tax, urban maintenance and construction tax, additional education tax, land use tax, vehicle purchase tax, and

building tax. In the per kilogram data, the tax of the less-known brands is higher than for the well-known brands. Most well-known brands have the qualifications and opportunity to apply for a tax subsidy, which is provided to the companies representing traditional cultural practices and characteristics.

Financial Expense

During the production process, some companies may not have enough working capital to ensure the production process runs smoothly and successfully, so they need to get loans from a bank or borrow money from other financial institutions. All these methods will produce interest and handling charges that should be accounted as financial expenses. Unknown producers do not have enough guarantees and qualifications to get loans from banks or other institutions, and they also have little financial activity, thus they have zero financial expenses. On the other hand, the well-known brands have numerous financial activities and are large-scale enterprises, so their average financial expense per kilogram is the highest at 2.58 RMB/KG. Less-known brands are in between at 1.81 RMB/KG.

Crab Seed

The unit price of crab seed reflect a difference in demand for male and female crabs. The price of the female is more expensive than the male since female crabs are more popular because of their eggs. Also high quality seed commands a higher price than low quality seed. Well-known brands prefer to buy high quality seed and much more female seed and this gives them the highest cost per kilogram at 10.84RMB/KG. The less-known brands may buy half male crab seed and half female crab seed. The

unknown producers buy the lower quality crab seed and more male crab seed since their prices are much lower, averaging 8.08 RMB/KG.

Feed

The difference in the unit price of feed between the three types of brands is not as large. The highest price feed reported was 3600RMB/TON while the lowest was 3300RMB/TON. The expensive feed has more animal feed and less plant feed while the cheap feed has more plant feed and less animal feed. The animal feed contains fresh fish, earthworm, apple snail and other meat products. The plant feed contains potato, soybean, pumpkin and other vegetables. Feed expenses for the well-known brands are higher than other two types of brands because lake cultivation may use more feed due to the presence of other aquatic animals that may also eat the feed, and thus their feed conversion ratio is poorer.

Utilities (Water and Power)

The utility expense includes supply of water and power used to operate machines and provide illumination for daily work. This factor is related to the cultivation method, so if the producers choose outdoor cultivation, they may check more often the health condition and escape crabs, and thus need more water and power support.

Labor

Labor is an important cost factor since the production process needs lots of workers to focus on cultivation, especially for feeding and monitoring. For outdoor cultivation, the producers need more people to do the feeding and need more patrols to prevent the escape of the crabs. More important, for the well-known brands, most

of them have some employees who focus on the advanced technology of cultivation that may improve the survival rate. These professional employees will earn much higher wages than other workers. It is not clear why the unknown producers spend more on labor than the less-known producers.

Others (Medicine)

The main items in this factor are medicine and chemicals used for disease prevention, consumable supplies used in patrolling and monitoring process, and miscellaneous expenses due to emergencies such as water quality deterioration.

3.3.2. Retail Sales Costs

Advertising Expense

Many producers place advertisements on TV, and in newspapers, internet and other media. Advertisements can inform the consumer and are an effective way to improve brand awareness. For the well-known brands, the producers put lots of money into this aspect since it can keep brand awareness at a high level. For the less-known brands, the producers need to make more people aware of their brands. For the unknown producers, most of them do not have brands to advertise so they spend very little on this aspect unless they are trying to develop a brand.

Packaging charge

Packaging refers to the use of a cooler, foam box or other materials to package the crabs for transport and storage. This cost per kilogram is related to the type of materials that are used during the process. For the unknown producers, they choose

the cheaper materials for crabs that are not transported far or stored. Thus their average cost per kilogram is much lower than well-known and less-known brands.

Transportation

The main modes of transportation are air transportation, railway transportation, and highway transportation. For the well-known brands, there are many seafood dealers who will come and pick up the crabs and some consumers will buy crabs from the direct-sale stores, thus the producers can save a part of transportation cost. And the lee-known brands offer some delivery services, which may explain why their transportation cost per kilogram is so much higher than the well-known brands. Unknown producers, usually sell crabs in close proximity to their production area and use cheaper modes of transportation.

Operating Expense

This aspect of cost contains the administration expense and fees to enter a supermarket or upscale seafood market, as well as other expenditures incurred during distribution. Notably, all of the well-known brands have their own direct-sales stores. The rent and daily expenditures of these stores are included in the operating expense category. Making it much higher than other two types of brands. For the unknown producers, most of them will not enter the supermarket or upscale seafood market, but rather enter small stores or markets that charge lower fees.

Tax

Here the tax is accounted as a variable cost and comes from the retail sales process. When producers sell their crabs, they are levied a business tax by the

government. The more revenue they make, the more tax they pay. Meanwhile, transportation and some other actions during retail process will also generate tax fee.

Labor

This factor concludes the wages of the salesforce and administrative staff. Since the well-known brands have their own direct-sales stores, they need more employees to do the sales and administrative work, thus they put more capital in the labor factor totaling 3.98RMB/KG. The less-known brands sell mostly through supermarkets and large seafood markets which may not need salesman all the time. And for the unknown producers, they enter the small market which really need salesman to do the sales work. Thus their labor cost per kilogram is 2.44RMB/KG which is higher than the less-known brands at 1.98 RMB/KG.

Others

This cost factor contains all the other expenses occurred in the sales process besides those factors mentioned already. The main components of this factor are consumable supplies and equipment used in the sales function, and expenses for special events such like sales promotions and miscellaneous expenses.

3.3.3. Brand Maintenance Costs

Materials Fee

Well-known brands use sophisticated techniques and expensive materials to prevent counterfeiting of their brands. The main technique is to use a security lock. The material fee for this technique is much higher than for other techniques.

Less-known brands need to maintain their brands identity too but their main purpose is to improve the ability of consumers to distinguish between different brands. So most of them will use the uniform store signs and distinctive packaging but will not use the security lock. For the unknown producers, they are not trying to differentiate their product or protect their identity so they do not spend anything on this aspect.

Labor

This factor includes the wages of security technicians and other fees incurred during the brand maintenance process. The well-known brands use more progressive techniques that must employ professional technicians and these employees require a higher salary. Since the unknown producers do not focus on the brand maintenance process, they do not incur this cost.

Others (Holding Events)

Organizing public events is also an efficient way to maintain brand image. For instance, the government will hold a competition to elect the ‘crab king’ and ‘crab queen’ by consumers every year, and this will attract many producers. During the competition, each producer can introduce the main characteristics of their crabs and teach consumers how to distinguish the counterfeits, all of which improves brand awareness. In addition, the well-known brands will organize some of their own activities, such as ‘who can eat the most crabs’, to attract consumers.

IV. Methods

Various economic methods were used to show the overall and detailed situations

of different types of mitten crab brands. Cost benefit analysis contains the basic economic index that shows the profitability of each brand. Risk analysis focuses on the net return to management under conditions of uncertainty. An important part of this thesis is to build an appropriate model to estimate the influence various factors have in determining brand equity.

4.1. Cost Benefit Analysis

Cost benefit analysis is a systematic process for calculating and comparing the benefits and costs of a project, decision or government policy. It is one process by which business decisions are analyzed. The benefits of a given situation or business-related action are summed and then the costs associated with taking that action are subtracted. Cost benefit analysis, a common economic analysis method, is used in many studies, including the area of aquacultural economics.

In this study, the Benefit Cost Ratio will be used to show the profitability of each brand. BCR represents the ratio of total benefits over total costs. The economic outlook for the enterprise is good when the BCR is larger than 1.0, and the larger the ratio is, the better the economic situation of the enterprise is.

Since Chinese mitten crabs are grown to different sizes and each size category has a different price, the ‘Gross Revenue’ can be shown as:

$$\textit{Gross Revenue} = \sum \textit{Gross Revenue in each size}$$

$$= \sum (\textit{Price of each size} \times \textit{Total weight in each size})$$

Where the total weight in each size category is calculated from the following:

$$Total\ weight_i = yield \times proportion\ of\ crabs\ in\ size\ category_i$$

$$i = <100g, 100\text{-}150g, 150\text{-}200g, 200\text{-}250g, >250g$$

Price, yield and proportion come from a survey of 10 well-known brands of Chinese mitten crab, 34 less-known brands and 20 producers of unbranded products. All these data have already been described in previous sections under ‘3.2.1.Market Price’, ‘3.1.4.Yield’, ‘3.1.6.Size Distribution’.

To distinguish production efficiency from brand equity, cost can be divided into different processes. Thus the data from each producer is divided into production costs, retail sales costs and brand maintenance costs, as described in the ‘3.3.Cost Factors’ section.

4.2. Risk Analysis

Risk analysis is a technique to quantify and assess variability in factors that may enhance or jeopardize the success of an enterprise. This technique also helps to identity preventive measures to reduce the probability of negative factors occurring and to identify countermeasures to mitigate these constraints. Risk analysis is used to evaluate the uncertainty of future cash flow streams, the variance of stock returns, the probability of a project's success or failure, and the likelihood of future economic states, all of which can and have been used in the evaluating aquaculture enterprises.

In this study, a risk modeling and analysis procedure will be used to examine the distribution of net returns to management among different types of Chinese mitten crab brands. Risk analysis can show an entire probability distribution of net returns to

management by using simulation software that allows the user to express the many possible outcomes of a simulated decision situation as a probability distribution.

Here the risk model is based on the same enterprise budgets that were used to assess the costs and returns among different types of brands. The budgets are presented on a per kilogram basis. They each contains six main items: gross receipts, production cost, sales cost, maintenance cost, total costs and net return to management.

After developing the risk model, the simulation process was done using @RISK software. Firstly, the values for stochastic variables are chosen. In the current situation, since the survey datasets have considerable detail, it is simple to complete this step by assuming normal distributions for all variables. Secondly, recalculate 1,000 times using the @RISK software. Each recalculation is called an ‘iteration’ and the 1,000 outcomes of net returns to management are stored in a file for later use in describing the distribution.

4.3. Brand Equity

Brand equity is a core concept concerning brand management and it is viewed from different perspectives. Brand equity is accepted as the overall utility that customers place in a brand compared to its competitors. Generally, measures of brand equity can be divided into three main categories or levels (Ailawadi, 2003). The first one is the consumer-based level. It is the most popular one which contains factors that elicited from consumers, such as brand awareness, attitudes, associations, attachments

and loyalties. This method uses the survey data from a large number of consumers.

The second category is the product-based level. It is focused on the product-market which means the value of brand equity should be reflected in the performance of the product in the market place. The most common method of measurement is the revenue premium which primarily reflects the ability of a branded product to charge a higher price than an unbranded one. Other measures in this level include market share, relative price, demand models, and residual in hedonic regression (Ailawadi, 2003). At this level, most of the data are obtained from surveys of enterprises while some data comes from consumers.

The third category is the firm-based level. It uses information about the whole financial situation of the enterprise, such as purchase price at the time a brand is sold or acquired, discounted cash flow valuation of licensing fees and royalties, stock market value, market capitalization, etc. This method needs data from both the firm and the financial market.

The measurement method used in this study was the product-based level. Furthermore, after considering various alternatives, the revenue premium was used during the detailed evaluation process.

4.3.1. Revenue Premium

In this study, the revenue premium is defined as the difference in revenue between branded producers and unbranded producers for the same product (Ailawadi, 2003). This measure combines high external validity, strong conceptual grounding,

completeness and ease of calculation. The Revenue premium is calculated as：

$$Revenue\ Premium = Sales\ Volume_{\ branded} \times Price_{\ branded} - Sales\ Volume_{\ unbranded} \times Price_{\ unbranded}$$

In the market, there are four main aspects that influence the brand equity. The first one is the producer's price and marketing mix; this will influence consumer choice directly since they are the most sensitive factors in the consumption process. The second one is competitor's price and marketing mix, since this affects consumer choice indirectly, because the competitor's strategy and activity will influence purchasing intentions as well. The third one is firm strength, which comes from brand image, product quality, research and development and so on. The fourth one is category characteristics. This is an exogenous factor including market size, and perceived risk.

Thus for Chinese mitten crab producers, the firm's current revenue with a brand (no matter whether it is a well-known one or less-known one) is R_{brand}, while the revenue without a brand (i.e. an unknown one) is $R_{unbrand}$. The brand equity can be shown as:

$$E_{brand} = R_{brand} - R_{unbrand} = S_{brand} \times P_{brand} - S_{unbrand} \times P_{unbrand}$$

Here the revenue premium is a better measure than others since it includes sales volume premium as well as price premium. Both sales volume premium and price premium can represent the brand equity from different perspectives since they are all relevant to consumer choice. Furthermore, considering the cost factors, the brand equity can be adjusted to this form:

$$E_{brand} = NRP = NR_{brand} - NR_{unbrand}$$

$$= (S_{brand} \times P_{brand} - C_{brand}) - (S_{unbrand} \times P_{unbrand} - C_{unbrand})$$

In this study, NRP means the net revenue premium, NR_{brand} will be the net revenue of each branded producer while $NR_{unbrand}$ will be the average net revenue of unknown producers.

4.3.2. Estimated Model

4.3.2.1. Correlations with Other Measures

Ailawadi et al. (2003) argued that the validity of a brand equity measure can be assessed by examining whether it is stable over the short and medium runs and correlates with other measures of brand equity consistent with the brand's marketing efforts, and with other variables, such as the characteristics of the product category, as well as with price sensitivity (p. 6). In this study we do not have time series data, and the relationship between marketing actions and brand equity occurs through a complex chain of simultaneous relations that are not easy to model. Meanwhile, there is only one product -- the Chinese mitten crab -- and we do not have data on consumer sensitivity to price.

In theory, various measures of brand equity reflect the same underlying construct. However, brand equity is a multidimensional construct (Aaker 1996), and each measure may reflect somewhat different dimensions. What is more important, any proposed measure should correlate well with other conceptually similar measures, but it should not correlate so highly as to be redundant. Thus if there are many feasible

methods to measure brand equity, the estimated process should only use one of them, in order to avoid the problem of multicollinearity.

Therefore, although ‘net revenue premium’ (NRP) is chosen as the appropriate measure in this case, it still needs to be justified why NRP should be the one measure to represent brand equity in the estimation process.

Generally, price, volume, market share, revenue, recognition and their premiums are all measures that can reflect some characteristics of brand equity. Thus we conduct correlations of all these measures, along with NRP.

In our study, there are eleven variables. The variables ‘aveprice’ and ‘avepricep’ represent each firm’s average price of all sizes of crabs and its premium above the average price of unbranded products, in units of RMB per kilogram. The variables ‘volume’ and ‘volumep’ are nominal sales and sales premium, in metric tonnes. The variables ‘gr’ and ‘grp’ are gross revenue and its premium, in units of RMB/kg. The variables ‘nr’ and ‘nrp’ are net revenue its premium, again in units of RMB/kg. The variables ‘marshare’ and ‘marsharep’ are market share its premium, with units in percentages. The variable ‘recognition’ represents brand awareness (mentioned earlier), also in percentages.

4.3.2.2. Structural Models

Since the many variables representing brand equity are expected to be highly correlated the regression model will need to be specified carefully to avoid problems with multicollinearity. Therefore, a structural model is an appropriate method for the

estimation because it will avoid some of those problems and show the results clearly and directly.

Net revenue premium is used as a preferred measure to estimate brand equity in this study. The factors that influence it are sales volume, price, and costs. Here the sales volume is represented by yield, so we can use the per kilogram net revenue premium data to eliminate sales volume as a variable. Then the most important factors in determining net revenue premium are just prices and costs.

The costs here should be the 'total costs' which include product costs, retail costs, and maintenance costs. All the detailed cost factors are directly and deterministically related to total cost so they cannot be used in the regression. However, some of the detailed cost factors can indirectly exert their influence on net revenue premium through the recognition variable.

In this market, although different sizes of crabs receive different prices per kilogram, we use the yield-weighted 'average price' to represent the price variable. On the other hand, larger crabs are harder to produce, are more highly prized, and are associated with the premium brands. Also, if the brand has a better awareness among consumers, the price will be higher. Thus the proportion of the two largest size classes of crabs (>200g) and brand recognition have the most influence on average price.

Then the next question is which factors will have an impact on the proportion of big crabs. Certain factors in the production process may influence the crab size a lot. Mechanical investment, rent, tax, and financial expenses in production chain are all fixed or difficult to change and have little direct connection with crab size. Thus we

can delete all these factors during the estimation process and just consider expenditures for crab seed (juveniles), feed, utilities, production labor, and other production expenses such as water quality treatments. Cultivation methods (lake, pond, cage, and recirculating) are categorical variables that also should be taken into account. These are grouped into “outdoor” (lake and pond) and “indoor” (cage and recirculating) dummy variables.

Lastly, uncovering which factors influence recognition is another important task. In general, investment in retail establishments and brand maintenance processes could increase recognition of a brand among consumer groups. Therefore, the sub-categories of operating expenses, advertising expenses, retail labor, others retail expenses, branding materials, brand maintenance labor, and others maintenance expenses (such as public events) are necessary independent variables. Packaging expenses, transportation, and sales tax will not be included in estimating brand recognition.

In conclusion, we can do a series of regressions to complete the structural model estimation. In the first step, the dependent variable is ‘NRP’ while the independent variables are ‘average price’ and ‘total costs’. In second step, the dependent variable is ‘average price’ while the independent variables are ‘proportion > 200g’ and ‘recognition’. In third step, the dependent variable is ‘proportion >200g’ while the independent variables are ‘cultivation method’, ‘seed’, ‘feed’, ‘utilities’, ‘labor in product’, and ‘others’. In fourth step, the dependent variable is ‘recognition’ while the independent variables are ‘operating expenses’, ‘advertising expenses’, ‘labor in

retail', 'others in retail', 'materials', 'labor in maintenance', and 'others'.

The whole structural model is shown in Figure 9

V. Results

The objective of this study was to show the overall and detailed economic situations of different types of Chinese mitten crab brands, and attempt to estimate the influence various factors have in determining brand equity.

Cost benefit analysis shows the profitability of each brand. Risk analysis shows the distribution of net returns to management by brand type. Brand equity modeling uses linear regression to show how various factors influence brand equity.

5.1. Benefit Cost Ratio in Cost-Benefit Analysis

Since BCR = $PV_{benefits}$ / PV_{costs} and all needed values can be taken from the survey mentioned above, the ratios of the three different types of brands can be shown in Table 4. There are three categories named well-known brands, less-known brands and unknown producers which are distinguished by their recognition percentage. All the results in this table are mean values of all producers in each category and the units are in RMB/KG.

The gross revenues have major differences among different size and different types of brands. For the producers who have a well-known brand, their gross revenues are more than two times the less-known brands, and more than four times the unknown producers. For the producers who have a less-known brand, their gross

revenues are more than two times the unknown producers.

The total costs also have differences among different types of brands. For the well-known brands, the total costs are about 1.7 times the less-known brands, and about 3.8 times the unknown producers. For the less-known brands, the total costs are about 2.2 times the unknown producers.

The benefits of well-known brands are about 2.5 times those of the less-known brands, and about 5.6 times the unknown producers. The benefits of the less-known brands are about 2.2 times the unknown producers.

Finally, when it comes to BCR, it is obviously that all Chinese mitten crab producers no matter which category they belong to, are operating under good economic condition since their BCRs are much larger than one. And the BCR of well-known brands is 3.62 which is the largest among the three categories, showing that this kind of firm has strong profitability and can generate more benefits when investing a certain amount of capital since the larger the BCR, the better the economic situation of enterprise. However, less-known and unknown producers also have earning potential because their BCRs are 2.46 and 2.42.

In addition, improving benefits by acquiring more brand equity is one of the methods to become more profitable for all producers, which should be interested in the results from brand equity analysis since that is an important factor for obtaining higher prices, sales and revenue premium.

5.2. Net Returns to Management in Risk Analysis

Table 5 shows the budget used in the risk analysis procedure after one random simulation of the stochastic variables under lying each cell. The three categories distinguished by the percentage recognition by consumers are well-known brands (recognition ≥ 80%), less-known brands (20% ≤ recognition ≤ 80%), and unknown producers (recognition ≤ 20%). The budget is presented on a per kilogram basis and contains six main items which are gross receipts, production cost, sales cost, maintenance cost, total costs and net return to management.

Since there are 64 producers who provided the necessary data, each variable can be described in the budget by using the distribution @RISKNORMAL (mean value, standard deviation) for the average values in that brand catogory. The mean values and standard deviations of each variable are calculated from the dataset.

Using @RISK, after saving to the output field the ‘net return to management’ (NRM) after iterating 1000 times, the regression and rank information of each variable for ‘net return to management’ is shown in Figure 10 (well-known brands), Figure 11 (less-known brands), and Figure 12 (unknown producers).

The coefficients for each variable show their properties of them. For all types of brands, gross revenues have a positive impact on ‘net return to management’ while cost factors have a negative impact. The variables showing the larger absolute value of their coefficients, have the greater influence on the net return to management.

The ranks of each variable show the sensitivity of NRM to them from highest to lowest. For all of the producers, the gross revenues from the different sizes are the

most influential variables.

For all producers, the labor used during the production process is influential. For well-known and less-known brands, the operating expenses are influential, however, the material fee is more influential for well-known brands while the feed cost is more influential for less-known brands and the unknown producers.

The simulation outcome of net returns to management among the three categories is shown in Figure 13. This figure contains information about the maximum, minimum, mean, and standard deviation of each type of brand. The highest net return to management of less-known brands is much less than the lowest net return to management of well-known brands and there is no overlap between these two areas. However, the highest one of unknown producers is close to the lowest one of less-known brands but there is little to no overlap between less-known and unknown producers.

5.3. Modeling Brand Equity

5.3.1. Summary of Correlations

Table 6 shows the results of the correlation analysis. We see that all the correlations are higher than 0.9, so we could just choose any one of them to measure brand equity. And since all of the variables have perfect correlations with their premiums, we can pick any one of them in either their nominal or premium forms. Comparing these variables, recognition only represents the consumer market situation but does not include any production information, thus it may not be the best measure.

Also, although the gross revenue captures the market price differential, it dose not include cost factors, where net revenue does include those factors. Thus the net revenue should be considered as the best measure.

When it comes to choosing ‘net revenue’ or ‘net revenue premium’, we should consider which one represents brand equity better. The net revenue premium can be defined as the difference in net revenue between branded producers and corresponding unbranded producers, which means that after adjusting for scale by converting all variables to a per kilogram basis, the remaining stochastic differential or premium may then be attributable to brand equity. Thus the ‘net revenue premium’ is the measure used for most of the following estimation processes.

Figure 14 summarizes the correlations of ‘net revenue premium’ with other measures.

5.3.2. Structural Models

Following the steps mentioned in ‘4.3.2.2. Structural Model’ and using SAS software, we get the results below.

Firstly, after doing the regression ‘NRP = f (average price, total costs)’, we get some interesting information. The regression results are shown in Figure 15. ‘Average Price’ is significant while ‘Total Costs’ is non-significant. Thus we should focus on factors that influence the average price such as size of crabs and recognition. The adjusted R-square is 0.974.

Secondly, after doing the regression ‘Average price = f (proportion of large crab,

recognition)', the results are shown in Figure 16. Here we find that 'prolarge200g' variable is only marginally significant (P = 0.13) while 'recognition' is highly significant (P < 0.0001) suggesting that the relation between the latent variable of 'quality' and the observed proportion of large size is less influential than the relation between the latent variable brand awareness/image and the observed recognition variable. The adjusted R-square is 0.863.

Thirdly, after doing the regression 'Proportion of large crab = f (outdoor cultivation method, seed, feed, utilities, production labor, other production expenses)', the results are shown in Figure 17-1. And if we use stepwise regression to choose a minimal set of influential variables, the results are shown in Figure 17-2. In Figure 17-1, the P-values of 'cultivation method', 'seed', 'laborprod', and 'otherprod' are significant. These are also the only variables to enter solution in the stepwise model in Figure 17-2. The parameters of three of these variables are positive which means increasing these factors will produce a higher proportion of large crabs. The parameter of 'laborprod' is negative which means that increasing this factor will bring a lower proportion of large crabs. The reason for this negative relation is not readily apparent. The adjusted R-square for the full model is 0.830.

Fourthly, after doing the regression 'Recognition = f (operating expense, advertising expense, labor in retail, other expenses in retail, materials, labor in maintenance, other expenses in maintenance)', the results are shown in Figure 18-1. And if we use stepwise regression to limit the set of significant variables, the results are shown in Figure 18-2. In Figure 18-1, the variables of 'advertising expense' and

‘materials’ are large, significant and positive, which means inputting more dollars into these factors may increase recognition. ‘Labor in retail’ is also significant but negative, which would tend to suggest that moving dollars out of this factor and into the other two would bring more recognition. The adjusted R-square for the full model is 0.840.

Finally, the overall, conceptual structural model is shown in Figure 19. The solid line indicates positive impact while the dotted line means negative impact.

VI. Conclusions

For every Chinese mitten crab producer, the objective function, net revenue maximization, is presumed to be identical, but their observed profitability is totally different, even on a per kilogram basis. Thus the central issues that need to be resolved in this thesis are uncovering the overall economic situation of each brand (or brand category), then estimating the influence various factors have in determining brand equity and suggesting ways to improve brand equity. To uncover the overall economic situation, cost benefit analysis and risk analysis were both used here. To estimate the influence various factors have in determining brand equity, net revenue premium was chosen as the appropriate measure method to complete the structural model.

The cost benefit analysis results showed that all Chinese mitten crab producers, no matter which category their brand belongs to, are operating under favorable economic conditions, since their Benefit Cost Ratios (BCRs) are much larger than one. The BCR of well-known brands is 3.62, which is the largest one among the three

categories, meaning that this kind of firm exhibits strong profitability and can make more benefits from investing their capital. Similarly, less-known and unknown brands also have good earning potential because their BCRs are 2.46 and 2.42. Therefore, the producers of less-known and unknown need to improve some processes based on further analysis of which factors are more worth to invest in for obtaining more profits.

The risk analysis results showed that, after running the simulation process with 1000 iterations, the highest net return to management of less-known brands is lower than the lowest net return to management of well-known brands and there is no overlap between these two types of brands. This means that if the producers have a choice to make a change in brand type, all producers would like to be a member of the well-known brands since the net returns to management of this type will be much higher. On the other hand, although unknown producers have lower mean returns they are also less variable than less-known brands.

The appropriate measure chosen for the estimate of which factors have an impact on determining brand equity was net revenue premium. The correlation results showed that all the measures were correlated at higher than 0.9, thus only one of them can be chosen to measure brand equity. While recognition represents the consumer market situation, it does not include any production information. The gross revenue variable contains market price but still does not include cost factors. However, the net revenue variable includes all those factors and is thus the best measure of brand equity for the estimation process. With brand equity represented by the net revenue premium,

the structural model was set up using a series of regressions as detailed previously. Thus the final structural model was composed of four separate regression models showing which factors have a positive or negative impact on brand equity.

For the Chinese mitten crab producers, the results above will provide some suggestions for improving profitability and brand equity. This is valuable for protecting the whole Chinese mitten crab industry, and for consumers it will also bring long-term benefits in the form of higher quality and more reliable supplies.

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Figures and Tables

Figure 1: Sales Trend of Chinese Mitten Crab

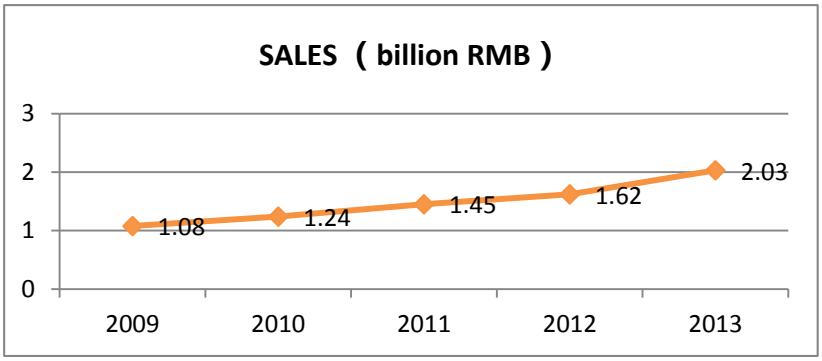

Figure 2: Outdoor Cultivation Methods

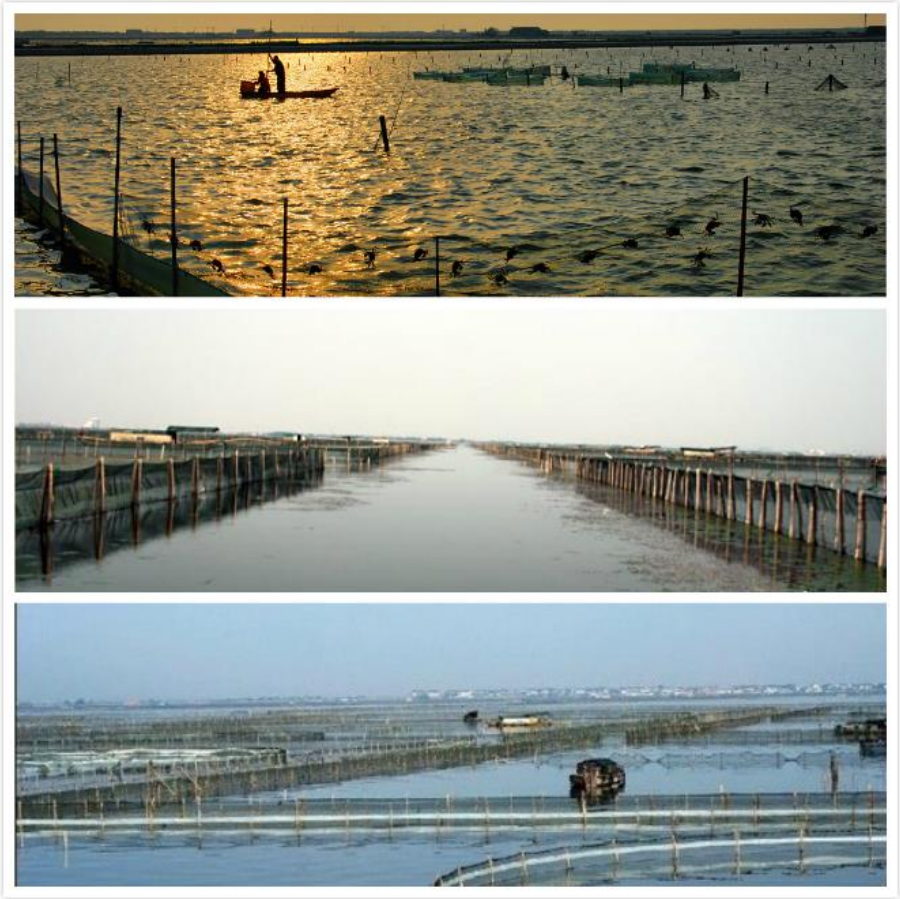

Figure 3: Indoor Cultivation Methods

Figure 4: Security Lock

Figure 5: Size Distribution

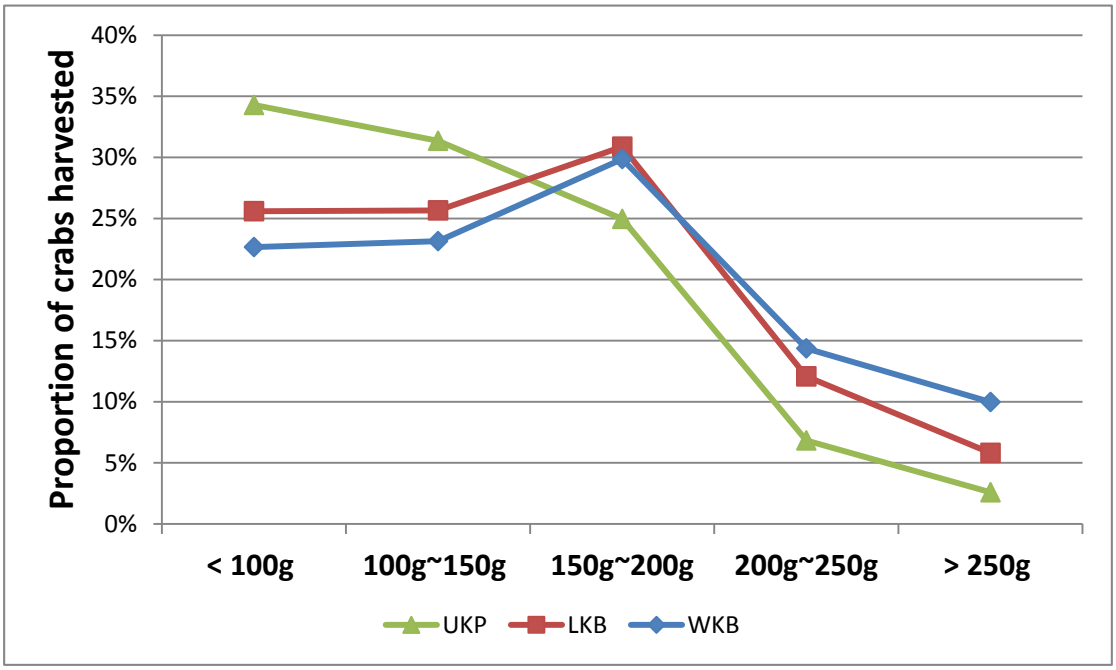

Figure 6: Differences in Market Price

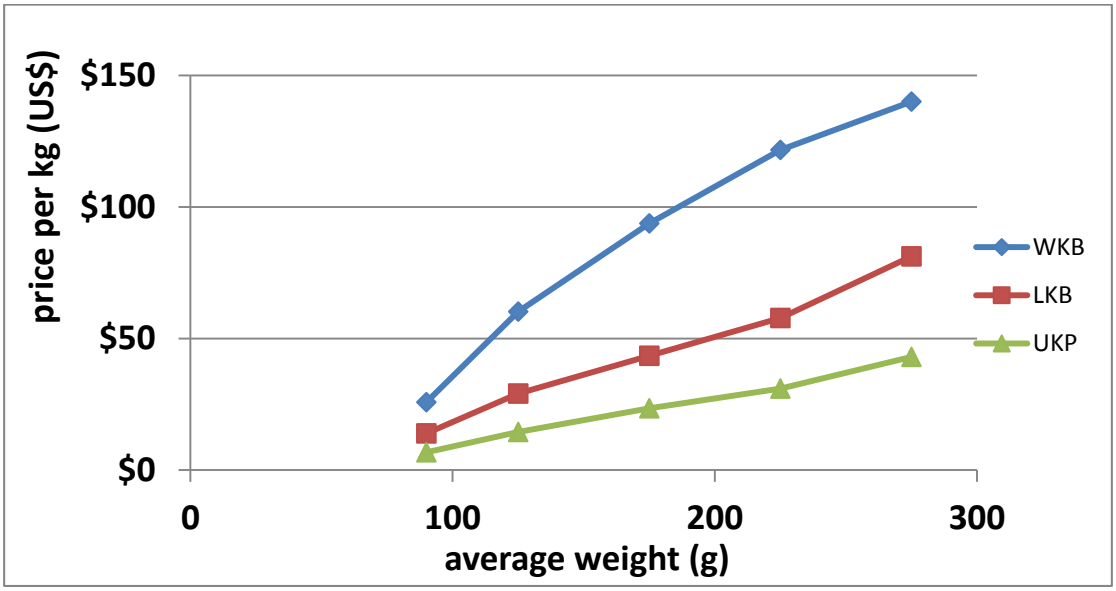

Figure 7: Differences in Gross Revenue

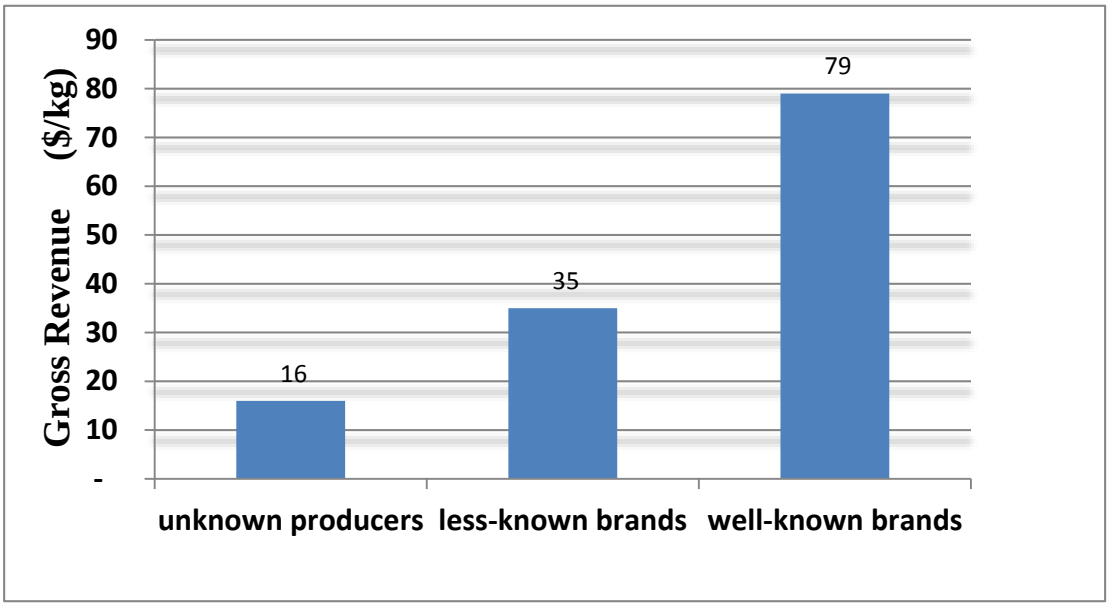

Figure 8: Relationship between Recognition and Net Revenue

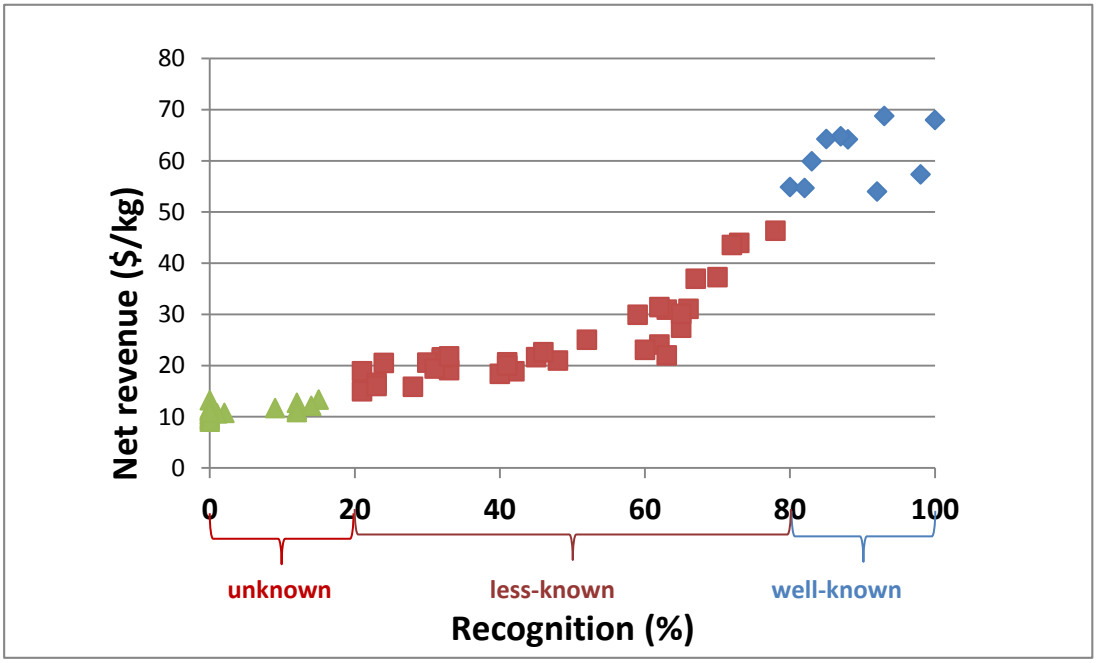

Figure 9: Structural Model

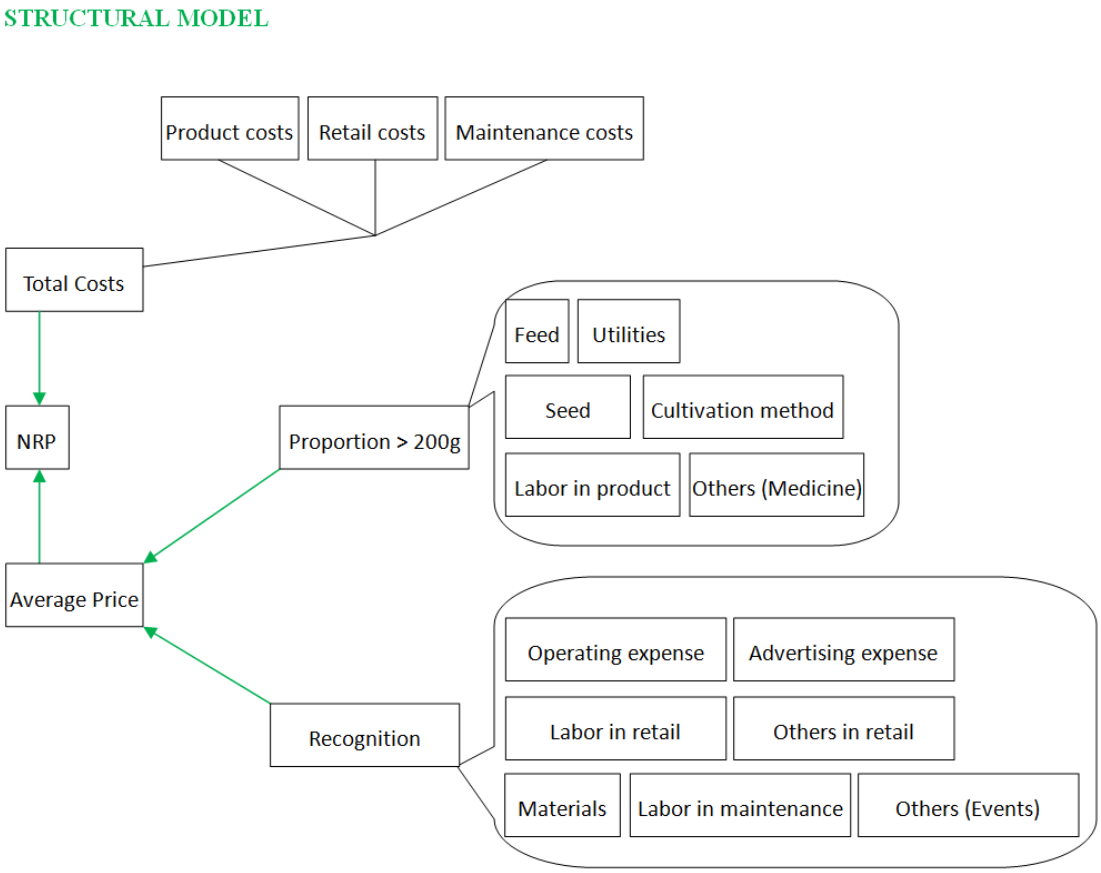

Figure 10: Regression Coefficients of Well-known Brands

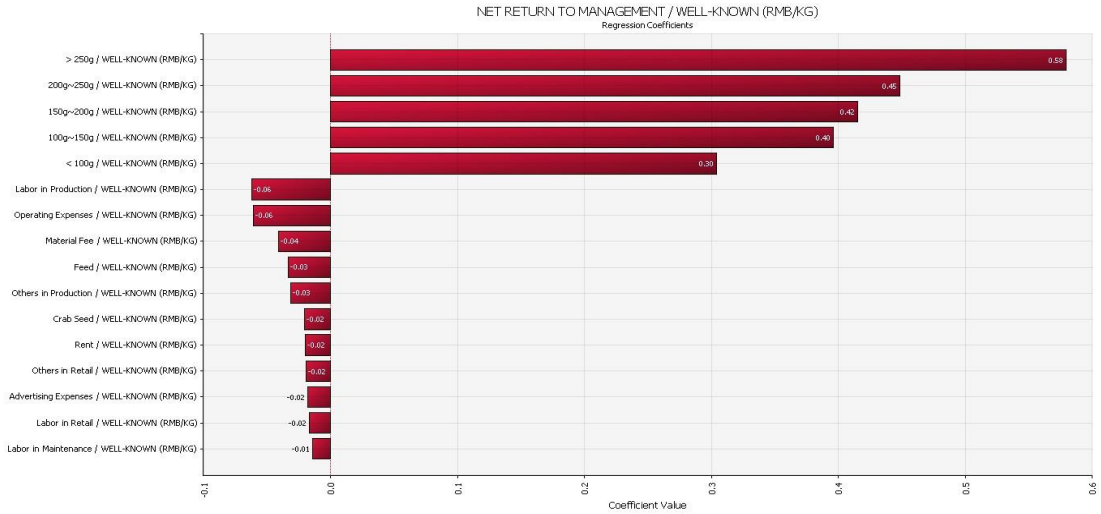

Figure 11: Regression Coefficients of Less-known Brands

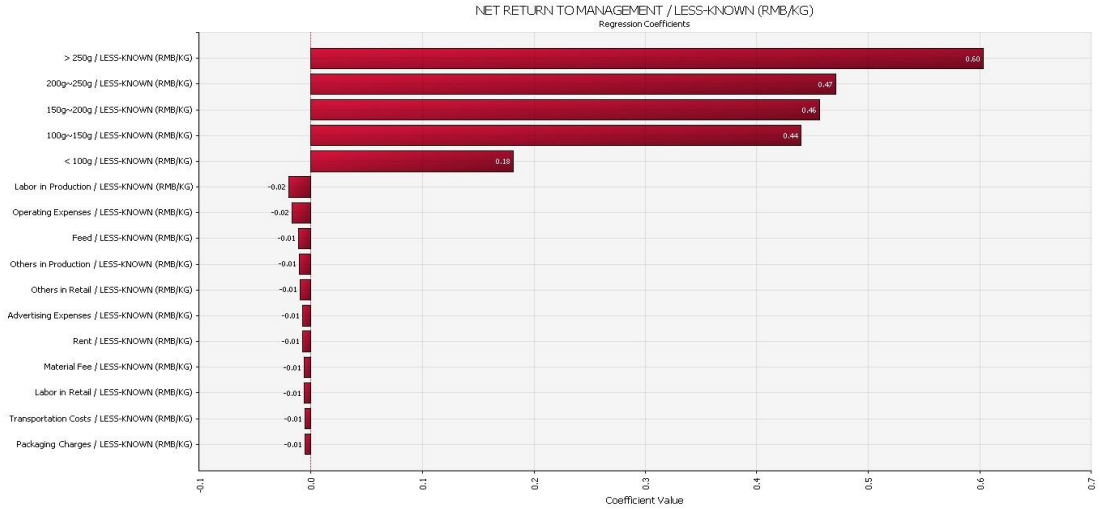

Figure 12: Regression Coefficients of Unknown Producers

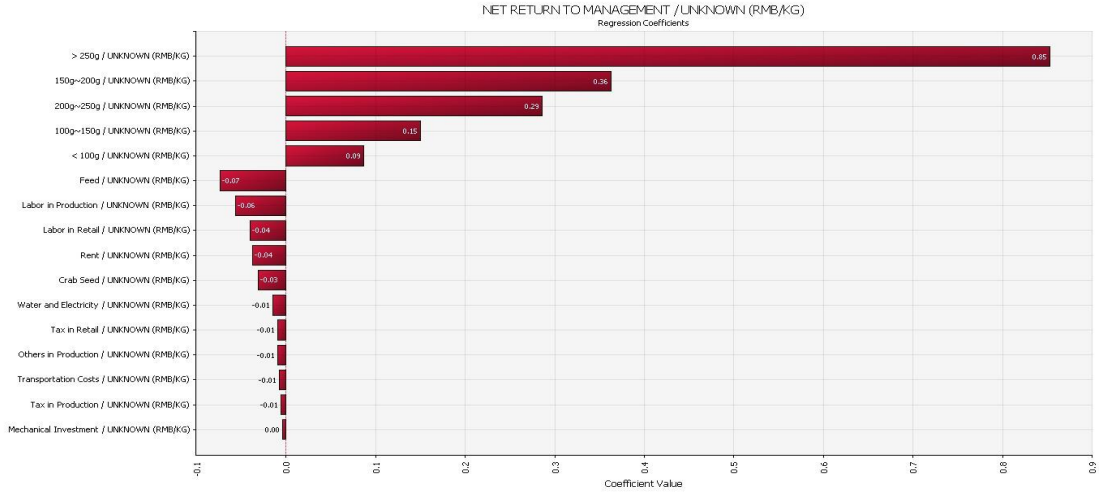

Figure 13: Net Return to Management of Three Types of Producers

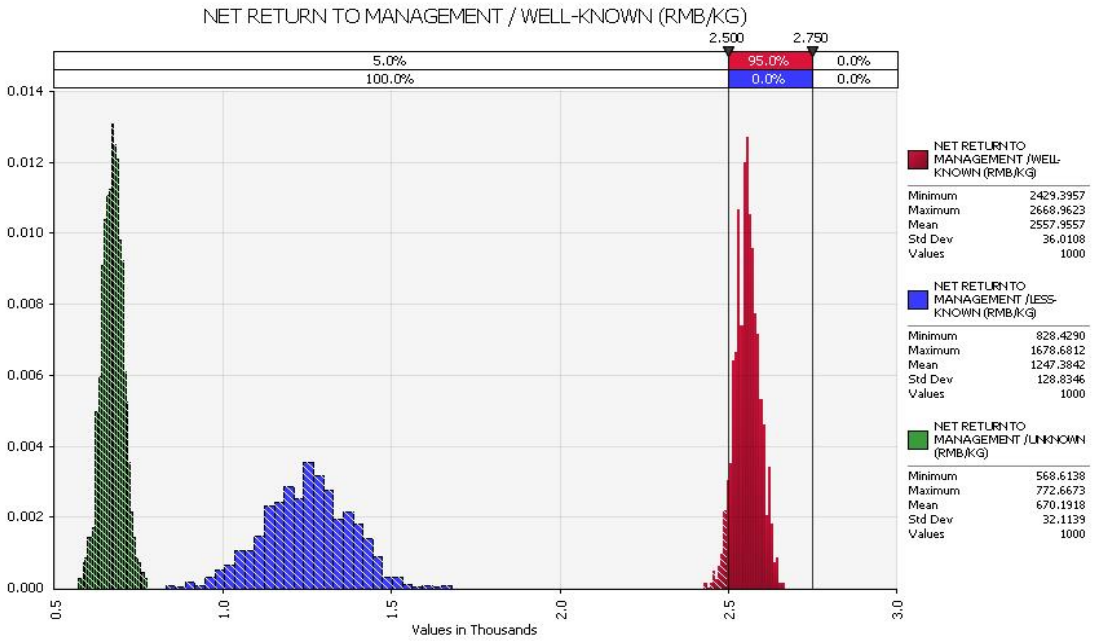

Figure 14: Correlations between Net Revenue Premium and Other Measures

Product-Market Measure	**Correlation with NRP**
Average price	0.9913
Average price premium	0.9913
Volume	0.9445
Volume premium	0.9445
Gross revenue	0.9947
Gross revenue premium	0.9711
Net revenue	1.0000
Market share	0.9584
Market share premium	0.9584
Recognition	0.9163

Figure 15: Regression of Net Revenue Premium

Number of Observations Used 64

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	908795	454397	1184.26	<.0001
Error	61	23406	383.69723		
Corrected Total	63	932200			

Root MSE	19.58819	R-Square	0.9749
Dependent Mean	138.85049	Adj R-Sq	0.9741
Coeff Var	14.10740		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	-99.92073	5.82827	-17.14	<.0001
aveprice	aveprice	1	0.88795	0.04495	19.75	<.0001
totalcost	totalcost	1	0.05093	0.22844	0.22	0.8243

Figure 16: Regression of Market Price

Number of Observations Used 64

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	979291	489645	199.19	<.0001
Error	61	149947	2458.14110		
Corrected Total	63	1129237			

Root MSE	49.57964	R-Square	0.8672
Dependent Mean	265.66563	Adj R-Sq	0.8629
Coeff Var	18.66242		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	68.63184	27.61154	2.49	0.0157
prolarge200g	prolarge200g	1	4.25541	2.79386	1.52	0.1329
recognition	recognition	1	3.22695	0.49725	6.49	<.0001

Figure 17-1: Regression of Proportion of Large Crab

Dependent Variable: prolarge200g prolarge200g

Number of Observations Read	64
Number of Observations Used	64

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	1695.38294	282.56382	52.08	<.0001
Error	57	309.26065	5.42563		
Corrected Total	63	2004.64359			

Root MSE	2.32930	R-Square	0.8457
Dependent Mean	15.77969	Adj R-Sq	0.8295
Coeff Var	14.76136		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	-2.49040	3.42315	-0.73	0.4699
cultivation	cultivation	1	2.39290	0.74636	3.21	0.0022
seed	seed	1	1.18737	0.52629	2.26	0.0279
feed	feed	1	0.27052	0.28052	0.96	0.3389
utilities	utilities	1	0.77514	0.85261	0.91	0.3671
laborprod	laborprod	1	-0.45111	0.15609	-2.89	0.0054
otherprod	otherprod	1	1.53806	0.37370	4.12	0.0001

Figure 17-2: Stepwise Regression of Proportion of Large Crab

Variable laborprod Entered: R-Square = 0.8382 and C(p) = 5.7661

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	1680.37511	420.09378	76.44	<.0001
Error	59	324.26849	5.49608		
Corrected Total	63	2004.64359			

Variable	Parameter Estimate	Standard Error	Type II SS	F Value	Pr > F
Intercept	-5.00630	2.89297	16.45886	2.99	0.0888
cultivation	2.37331	0.75040	54.97666	10.00	0.0025
seed	1.76192	0.33995	147.63547	26.86	<.0001
laborprod	-0.34943	0.13437	37.16978	6.76	0.0117
otherprod	1.59886	0.28307	175.34791	31.90	<.0001

Summary of Stepwise Selection

Step	Variable Entered	Variable Removed	Label	Number Vars In	Partial R-Square	Model R-Square	C(p)	F Value	Pr > F
1	seed		seed	1	0.6717	0.6717	61.3022	126.85	<.0001
2	otherprod		otherprod	2	0.1224	0.7941	18.0910	36.24	<.0001
3	cultivation		cultivation	3	0.0256	0.8197	10.6169	8.53	0.0049
4	laborprod		laborprod	4	0.0185	0.8382	5.7661	6.76	0.0117

Figure 18-1: Regression of Recognition

Number of Observations Used 64

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	7	54244	7749.09076	48.00	<.0001
Error	56	9040.36471	161.43508		
Corrected Total	63	63284			

Root MSE	12.70571	R-Square	0.8571
Dependent Mean	40.25000	Adj R-Sq	0.8393
Coeff Var	31.56698		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	22.12231	4.93508	4.48	<.0001
operexp	operexp	1	1.09511	1.85081	0.59	0.5564
advertexp	advertexp	1	6.14867	1.96316	3.13	0.0028
laborretail	laborretail	1	-7.57551	1.74450	-4.34	<.0001
otherretail	otherretail	1	-1.76180	3.51526	-0.50	0.6182
materials	materials	1	11.09266	3.01362	3.68	0.0005
labormaint	labormaint	1	0.14305	9.40253	0.02	0.9879
othermaint	othermaint	1	-13.15045	9.02232	-1.46	0.1506

Figure 18-2: Stepwise Regression of Recognition

Variable operexp Removed: R-Square = 0.8507 and C(p) = 2.5153

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	53838	17946	113.99	<.0001
Error	60	9446.42469	157.44041		
Corrected Total	63	63284			

Variable	Parameter Estimate	Standard Error	Type II SS	F Value	Pr > F
Intercept	22.14477	4.59969	3649.23300	23.18	<.0001
advertexp	5.42962	0.97304	4902.27380	31.14	<.0001
laborretail	-7.56395	1.64727	3319.59168	21.08	<.0001
materials	9.35619	0.90446	16847	107.01	<.0001

Summary of Stepwise Selection

Step	Variable Entered	Variable Removed	Label	Number Vars In	Partial R-Square	Model R-Square	C(p)	F Value	Pr > F
1	operexp		operexp	1	0.6886	0.6886	62.0564	137.13	<.0001
2	laborretail		laborretail	2	0.0584	0.7470	41.1695	14.08	0.0004
3	materials		materials	3	0.0699	0.8169	15.7762	22.90	<.0001
4	advertexp		advertexp	4	0.0338	0.8507	4.5094	13.38	0.0005
5		operexp	operexp	3	0.0000	0.8507	2.5153	0.01	0.9386

Figure 19: Overall Structural Model

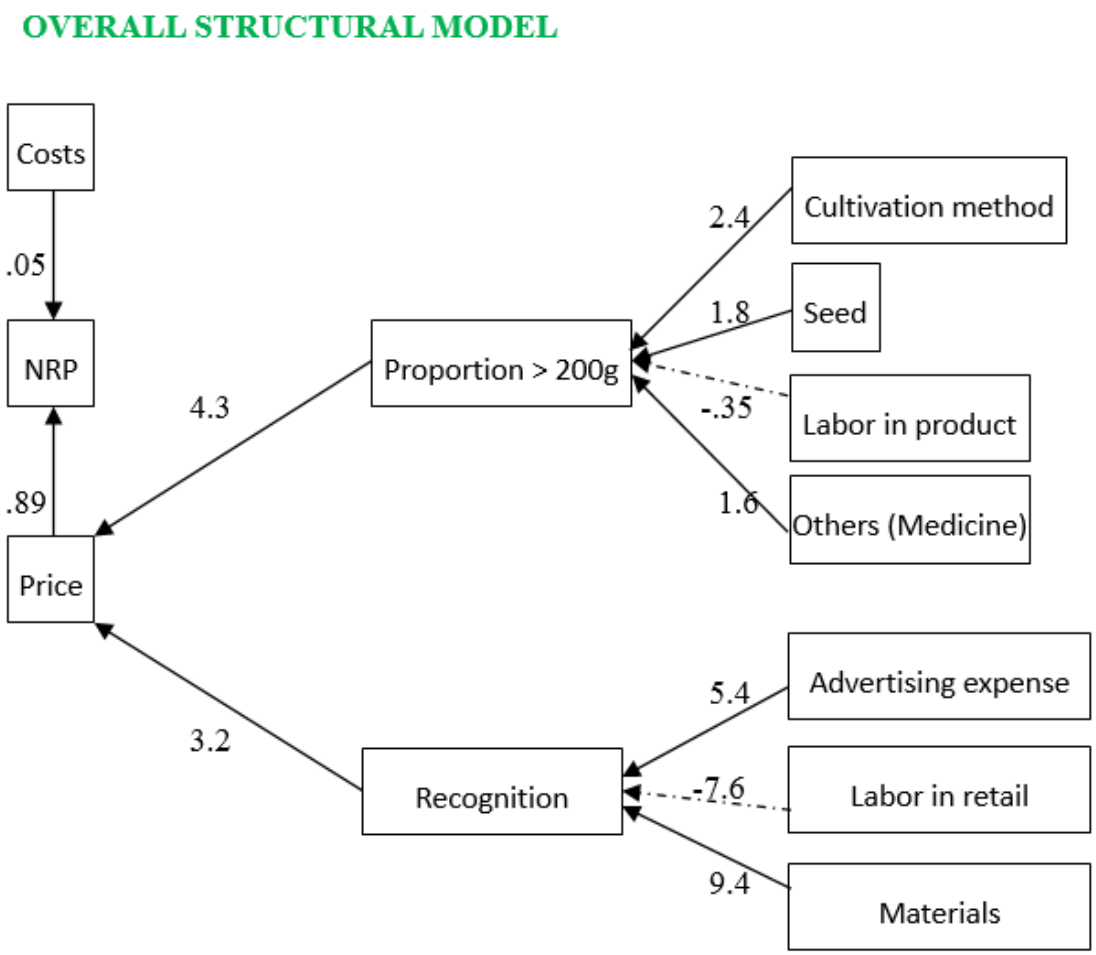

Table 1: Key Production Factors

	Well-known	Less-known	Unknown
Scale (acre)	**351**	**139**	**11.6**
Stocking Density (amount/acre)	**5287**	**6516**	**10458**
Harvest Density (amount/acre)	**4265**	**4590**	**5450**
Yield (kg/acre)	**682**	**705**	**893**
Survival Rate	**80.5%**	**70.5%**	**63.7%**
< 100g (size distribution)	**23.3%**	**25.8%**	**35.4%**
100g~150g (size distribution)	**23.4%**	**25.9%**	**31.4%**
150g~200g (size distribution)	**29.4%**	**30.7%**	**24.6%**
200g~250g (size distribution)	**14.1%**	**11.9%**	**6.4%**
> 250g (size distribution)	**9.8%**	**5.7%**	**2.3%**

Table 2: Key Market Factors

	Well-known	Less-known	Unknown
Recognition	**88%**	**47%**	**4%**
Market Price (RMB/KG)			
< 100g	**156**	**82**	**40**
100g~150g	**363**	**168**	**86**
150g~200g	**565**	**251**	**140**
200g~250g	**734**	**336**	**185**
> 250g	**843**	**470**	**246**
Gross Revenue (thousand RMB)			
< 100g	**8495**	**4404**	**123**
100g~150g	**20266**	**7909**	**241**
150g~200g	**40721**	**4115**	**312**
200g~250g	**25434**	**2785**	**113**
> 250g	**20325**	**21318**	**59**
total	**115240**	**40532**	**847**

Table 3: All Cost Factors

RMB/KG	Well-known	Less-known	Unknown
Production Costs			
Mechanical	0.39	0.40	0.35
Pond Rent	3.77	3.66	2.47
Taxes	0.93	1.32	0.35
Financial	2.58	1.81	0.00
Crab Seed	10.84	10.00	8.08
Feed	11.47	8.03	6.35
Utilities	3.22	1.89	1.03
Labor	12.53	3.40	3.18
Medicine	6.57	2.82	0.43
Total	52.30	33.32	21.90
Retail Sales Costs			
Advertising	4.63	4.23	0.19
Packaging	2.10	2.71	0.25
Transportation	1.81	3.09	1.14
Labor	3.98	1.98	2.44
Taxes	2.14	1.64	0.59
Operating	17.63	6.82	0.17
Others	4.87	3.03	0.21
Total	37.15	23.49	5.00
Brand Maintenance Costs			
Material Fee	7.40	1.86	0.00
Labor	3.62	0.90	0.00
Events	2.07	0.64	0.00
Total	13.10	3.41	0.00
TOTAL	102.55	60.23	26.89

Table 4: BCR of Three Types of Producers

GROSS REVENUES	WELL-KNOWN (RMB/KG)	LESS-KNOWN (RMB/KG)	UNKNOWN (RMB/KG)
< 100g	156	82	40
100g~150g	363	168	86
150g~200g	565	251	140
200g~250g	734	336	185
> 250g	843	470	246
SIZE DISTRIBUTION			
< 100g	23%	26%	35%
100g~150g	23%	26%	31%
150g~200g	29%	31%	25%
200g~250g	14%	12%	6%
> 250g	10%	6%	2%
Average Gross Revenue	473	209	93
PRODUCTION COST			
Mechanical Investment	0.39	0.40	0.35
Rent	3.77	3.66	2.47
Tax	0.93	1.32	0.35
Financial Expenses	2.58	1.81	0.00
Crab Seed	10.84	10.00	8.08
Feed	11.47	8.03	6.35
Water and Electricity	3.22	1.89	1.03
Labor	12.53	3.40	3.18
Others	6.57	2.82	0.43
Total	52.30	33.32	22.25
RETAIL COST			
Advertising Expenses	4.63	4.23	0.19
Packaging Charges	2.10	2.71	0.25
Transportation Costs	1.81	3.09	1.14
Labor	3.98	1.98	2.44
Tax	2.14	1.64	0.59
Operating Expenses	17.63	6.82	0.17
Others	4.87	3.03	0.21
Total	37.15	23.49	5.00
MAINTENANCE COST			
Material Fee	7.40	1.86	
Labor	3.62	0.90	
Others	2.07	0.64	
Total	13.10	3.41	
TOTAL COST	103	60	27
BENEFITS	371	148	66
BCR (Benefit Cost Ratio)	3.62	2.46	2.42

Table 5: Net Return to Management of Producers Based on Enterprise Budget

GROSS REVENUES	WELL-KNOWN (RMB/KG)	LESS-KNOWN (RMB/KG)	UNKNOWN (RMB/KG)
< 100g	179	55	39
100g~150g	386	223	98
150g~200g	542	245	142
200g~250g	735	302	199
> 250g	893	545	238
Total	2736	1371	716
PRODUCTION COST			
Mechanical Investment	0.43	0.33	0.46
Rent	3.38	1.61	4.47
Tax	1.06	1.73	0.46
Financial Expenses	2.85	1.82	0.00
Crab Seed	10.31	9.93	8.52
Feed	10.33	8.48	6.90
Utilities	3.53	2.12	1.23
Labor	13.48	4.84	0.53
Others	9.16	2.28	0.28
Total	54.54	33.14	22.84
RETAIL SALES COST			
Advertising Expense	5.60	2.27	0.23
Packaging Charge	2.23	3.07	0.11
Transportation	1.66	3.01	1.13
Labor	4.17	1.76	5.56
Tax	2.19	1.39	1.06
Operating Expense	23.44	5.84	0.10
Others	4.52	3.95	0.10
Total	43.82	21.28	8.29
BRAND MAINTENANCE COST			
Materials Fee	6.35	1.74	0.00
Labor	3.59	0.50	0.00
Others	1.76	0.64	0.00
Total	11.70	2.88	0.00
TOTAL COST	110	57	31
NET RETURN TO MANAGEMENT	2626	1313	685

Table 6: Correlations of Various Measurements

	aveprice	avepricep	volume	volumep	gr	grp	nr	nrp	marshare	marsharep	recognition
aveprice	1.0000	1.0000	0.9438	0.9438	0.9969	0.9969	0.9913	0.9913	0.9438	0.9438	0.9285
avepricep	1.0000	1.0000	0.9438	0.9438	0.9969	0.9969	0.9913	0.9913	0.9438	0.9438	0.9285
volume	0.9438	0.9438	1.0000	1.0000	0.9521	0.9521	0.9445	0.9445	1.0000	1.0000	0.9088
volumep	0.9438	0.9438	1.0000	1.0000	0.9521	0.9521	0.9445	0.9445	1.0000	1.0000	0.9088
gr	0.9969	0.9969	0.9521	0.9521	1.0000	1.0000	0.9947	0.9947	0.9521	0.9521	0.9219
grp	0.9969	0.9969	0.9521	0.9521	1.0000	1.0000	0.9711	0.9711	0.9581	0.9581	0.9219
nr	0.9913	0.9913	0.9445	0.9445	0.9947	0.9711	1.0000	1.0000	0.9445	0.9445	0.9163
nrp	0.9913	0.9913	0.9445	0.9445	0.9947	0.9711	1.0000	1.0000	0.9584	0.9584	0.9163
marshare	0.9438	0.9438	1.0000	1.0000	0.9521	0.9581	0.9445	0.9584	1.0000	1.0000	0.9088
marsharep	0.9438	0.9438	1.0000	1.0000	0.9521	0.9581	0.9445	0.9584	1.0000	1.0000	0.9088
recognition	0.9285	0.9285	0.9088	0.9088	0.9219	0.9219	0.9163	0.9163	0.9088	0.9088	1.0000