NORGES HANDELSHØYSKOLE

Bergen, Spring 2012

The Feasibility and Challenges of Introducing Futures Exchange to the Shrimp Markets

Jie Zhang

Thesis Advisor: Petter Bjerksund

Master Thesis within the main profile of International Business

NORGES HANDELSHØYSKOLE

The Feasibility and Challenges of Introducing Futures Exchange to the Shrimp Markets

Abstract

This paper proposes a Key Success Factor Framework to evaluate the feasibility of introducing futures exchange to the shrimp markets through three perspectives – the market characteristics, the contract characteristics and the user (the owner managers) characteristics – based on both marketing and financial theories. The paper also provides information and analyses of the shrimp market characteristics including market size, segmentations, industry value chain and institutional factors. Empirical studies with econometric approach and discussion with the management of a Norwegian exchange are also conducted to understand the market integration and price volatility. The study shows that the two primary commercial shrimp species represent large and growing underlying markets, with some integration trend and a lack of price transparency due to a concentration of market power among the big importers and exporters. There are also trade barrier in the market. But the overall institutional factors including setting up safety and categorization standards are improving. The econometric analysis challenges the common presumption of high price uncertainty in the shrimp market. By drawing pricing models using simple regressions between the two major shrimp species the author concludes that the market integration and the causal relationship of prices between different species are relatively small. The overall evaluation of the key success factors are not in favor of introducing futures exchange in shrimp market under current market conditions. The author further provides discussions on managerial implications and alternative propositions to tap into the shrimp market for exchange houses.

Key words: shrimp exchange, success factors, shrimp market, shrimp pricing models

Acknowledgments

First and foremost, I would like to express my gratitude to my supervisor Petter Bjerksund for providing valuable feedbacks on the use of methodology and the creation of pricing models. I would also like to thank Søren Martens, Vibeke Juriks, Francois Perrone from Fish Pool for providing support during the whole process of the thesis and access to industry contacts, events, specialized news and related studies. Special thanks to Hank Hansen from Urner Barry Publishing, Inc. for providing the pricing information that makes it possible to conduct the financial modeling and analysis. Last but not least, I am grateful for the conversation with Jean-Louis Lepainteur from Labeyrie for giving me insights into the industry participants.

Foreword

Writing this thesis has been a great learning experience for me. Therefore I would like to dedicate a small chapter for the research process and a few unsuccessful attempts that are not included in the rest of the paper.

The difference between writing as an insightful journalist and writing as a researcher is perhaps most obvious in the process of collecting, analyzing and presenting information that is relevant to this topic. It has come a long way since I had the initial discussion with Fish Pool and Labeyrie to conceive the idea of this topic. The scope of the research has been revised a few times. It becomes clearer to me with every change of how to provide as much objective evidence and first-hand analysis as possible to support any arguments in this paper. One can say that the way of addressing to the problem at hand is very much evolved, rather than planned. I cannot say that I started off knowing exactly which research method is the best to use, or knowing any specific challenge that I would encounter. But in the process of writing the thesis, I learnt a lot about gathering data, reviewing relevant literatures, selecting research methods, and taking caution in performing scientific analysis, particularly in econometric analysis and interpreting the results.

Initially, I had the idea of conducting a well-designed, thorough, primary marketing research with the industry participants and draw conclusions from the market consensus. I created a survey in great details on the characteristics of the market, motivation and knowledge of the owner managers and obtained a list of contacts from 2011 European Seafood Exposition. After a few phone interviews and face-to-face conversations with the industry practitioners, I realized that this market is rather complex and the transparency is relatively low. Even for simple claims such as the dominant commercial shrimp species, the results coming back from the survey are confusing and conflicting. Therefore I decided to gather more secondary information from more objective and reliable resources such as the United

Nation Food and Agriculture Organization database and trade data from other governmental statistics bureau. I believe in this way, the creditability of the conclusions in this paper would be increased. More importantly, because there is a huge demand for education and information in the industry, the objective academic research can actually add value in the future in the conversations with the industry participants and provide evaluation tools for exchanges to select the strategies to enter the shrimp markets.

Second important learning point is when I start to perform the econometric analysis to establish price relationships between different shrimp species. Initially, this was a great challenge for me too, since I have never worked with real-life data, or study Times Series data, or tried to create a price models before. The process of collecting economic data, sorting them into a comparable format, and interpreting the regression results was a great opportunity for me to learn how to put the theories into practice and to fully appreciate the scope and challenges that one can encounter in solving economic questions in real life. As for processing the analysis, I started off by using Excel to perform statistics calculation and regressions. I attempted to create both simple regression and multiple regressions with economic data. But later I realized that most of the data I used could be non-stationary. Therefore I researched on time series lecture materials and switched to using Stata to perform more specific tests for time series data. Although maybe what I have created are still far from perfect models, they should be relatively scientific with cautions on the interpretation of the results. This exercise also makes it easy to understand the scope for future studies and possible hypothesis. I believe my analyses have both academic and practical meanings. By combining marketing and econometric analysis, the quantitative and qualitative results can confirm or challenge each other, making the conclusions much more comprehensive and objective. From a practical point of view, the exchange, the economists or the owner managers in the shrimp industry can use my study as an information source to understand the dynamics of the shrimp markets and a reference for creating pricing

models in the future.

Of course, in this thesis, it is impossible to answer all the questions about creating a successful shrimp futures exchange. For example, to understand the motivation of the owner managers could become a topic or project for future Master or PHD dissertation by itself. It needs to be carefully designed to screen out the noises from biases of each individual participant. Another research angle that is relevant to the topic is to combine the study of biological features, grading systems, and new regulations of shrimp market to establish more advanced models that help exchange or companies to quantify premiums and discounts which can be changed on a timely basis for cross-hedging between different shrimp species. In addition, better sources of economic data can also be researched to improve the pricing models with multiple regressions. Therefore, I hope this paper could provide a lot of ground work and sources for information for future researchers.

Last but not least, the process of writing this thesis helps me to think from the perspective of scientific research and construction of theories. I constantly find myself with the challenge of externalize my knowledge and understanding, looking for better and clearer reasoning and illustrations. I believe after writing this paper, I am better prepared to be a good researcher in the future.

Table of Content

1. Introduction

Commodities exchanges have existed since the 19th century. Seafood, as an important high-value commodity sector, however, has only been recently successful in creating a futures exchange. In the US, Both Chicago Mercantile Exchange (CME) and Minneapolis Grain Exchange (MGE) have attempted to establish a sophisticated shrimp exchanges with multiple physical delivery options. In Japan, Kansai Commodity Exchange introduced black tiger shrimp contracts. These attempts haven't gone very far and did not reach a successful global shrimp derivative market. In Europe, Fish Pool has attempted a completely different approach in establishing a salmon futures exchange with only cash settlement and they have succeeded in creating a working price index that have been well accepted by farming communities and mid-sized companies. They believe that this is also going to be a good model for other fresh commodities such as shrimps as it can avoid certain limitations in physical delivery.

As an endeavor to fully understand the complexity and dynamics of the shrimp markets, as well as the success factors that exchanges need to consider in order to introduce futures contracts into the market, Fish Pool commissioned this thesis project with Norwegian School of Economics (NHH). The paper takes a cross-disciplinary approach to evaluate the feasibility and challenges to introduce futures exchange in shrimp market.

The **key research questions** are 1) whether it is feasible to introduce futures exchange to shrimp market, and 2) what the challenges are in the process of establishing such an exchange.

In order to tackle these questions, the paper presents a key success factor framework as a tool to evaluate the development of the market over time, which takes into account the most relevant factors identified by various researchers as the main contributors to the success of establishment and survival of a futures market.

There are a number of studies related to the possibility to success for futures contracts in various commodity markets from a financial perspective. These studies take into account the factors that are related to the underlying market such as the size and liquidity of the market as well as the design of the contracts itself. A few researchers also begin to look at commodities exchange from a marketing perspective. In these studies, the sense of "market" is different from the "market" referred in financial world. It refers to the people, the target group who are the potential users of these financial products. Therefore the marketing approach studies the industry environment of the companies that produce or trade the commodities, the users who deal with the commodities derivatives such as futures and options, as well as the knowledge, motivation and demand of these groups of users. The author takes a holistic view on these approaches and puts forward a key success framework to establish connections between these approaches and suggests a method to assign weights to the success factors.

The second objective is by using cross-disciplinary approach, the paper provides a better understanding to the dynamics of shrimp market including its industry structure, pricing relationships and institutional factors. The marketing approach studies the market potential from market size, segmentation, industry value chain, industry powers, cost structures and institutional factors. The econometric approach offers analysis on the correlation and causal relationship between price changes of the two major shrimp species in cash market and provides alternatives to build pricing models. A comparative study with the salmon market is provided to illustrate the similarities or differences in volatility and some other market characteristics. Both quantitative and qualitative methods will be used in the marketing analysis and financial analysis.

The paper confirms some good attributes of the underlying market for a potential futures exchange such as large market size and large number of (downstream) participants. However, the cash market seems to present a lack of

volatility, which could contribute to a lack of motivation to reduce market risk. To understand this challenge, extensive discussion with industry practitioners regarding alternative data sources and evaluations of market uncertainties are presented. The paper also identifies challenges in price transparency and motivation and knowledge of industry participants in the use of futures contracts. After discussing in the framework of key success factors, the paper makes reference to the studies on the possible reasons why previous shrimp exchanges have failed and discusses the possible solutions and futures search areas.

The organization of the thesis

The main research question of this paper is whether it is feasible to start a futures exchange in shrimp market. It is a rather complex question and involves both theories and practical aspects. Therefore the master thesis covers a wide selection of topics, theories, previous researches and empirical studies. Before proceeding, I will briefly explain the organization of the paper.

There are two major parts of theories involved. In chapter 3, I focus on the theories that explain in general why futures exchange could succeed in some markets and fail in others. In this part, I also formulate the evaluation framework for the shrimp market. In chapter 4 and 5 I turn the focus to the shrimp market to discuss extensively the different aspects of the industry. Another theoretical review is then introduced in chapter 5 when econometrics methods are used in quantify some characteristics of the shrimp market. Chapter 6 summarizes the findings of the shrimp market and applies the theoretical evaluation framework – the key success factors framework on shrimp market. The researches on the previous failed shrimp exchange are summarized here to provide an understanding of the development of the market characteristics over time. In the end, I further discuss the challenges in practical sense in chapter 7 and propose a few possible actions and future research directions based on the findings in this paper.

2. Research Methodology

2.1 Research methodology

The paper starts off by reviewing and integrating different literatures on the success factors of a commodity exchange, including studies in shrimp markets and other commodities markets. Then the author identifies and summarizes the key success factors presented in these literatures. A new way to assign weights based on causal relationships of the factors are proposed to connect the three schools of thoughts and to identify the most important or fundamental factors. The key success factors are then simplified in a framework which allows the users to create different scenario based on objective research or subjective judgment.

The author then tries to adopt marketing analysis and econometric analysis to provide evidence to objectively assess some key success factors. Quantitative methods are used to study the market size, segmentation and key commercial shrimp products. Qualitative methods are used to analyze the industry value chain, industry forces, regulations and other institutional factors. In the econometric analysis, simple regression is used to study the possible relationships in price changes between the two major shrimp types. These analyses are used to understand the integration of different market, the possibilities for cross-hedging opportunity and market uncertainties.

The paper relies on secondary resources to a great extent, both from previous researches or other governmental and industrial statistics. Primary research is limited to the information and review from a small group of industry participants.

2.2 Data sources and data collection

Scientific articles

There are many researches in shrimp industry. Most of them focus on the technical and environmental aspects of shrimp farming. These articles are relevant to the market and institutional analysis in this paper. A number of researches are also conducted in the success and failure of commodity exchanges, cash and financial settlement and previous shrimp exchange in Minneapolis Grain Exchange. A literature review using key words "shrimp", "shrimp market", "shrimp price", "shrimp exchange", "success factors of commodity exchange", etc are conducted in public sources such as Google Scholar and specialized database including Bora (NHH), Science Direct, EBSCO Publishing, Gale Database, etc.

Economic data

Food and Agriculture Organization of the United Nations (FAO) is the primary source for economic and market data such as shrimp production (by species) and consumption. FAO ad hoc projects and related presentations is also a portal for institutional factors regarding environment and regulation. Other governmental sources include FDA and OECD websites. Specialized seafood websites including IntraFish and the foodmarketexchange.com are used for news and industry report.

Price information

In order to perform financial analysis, the author scanned a list of seafood exchanges including physical, auction and derivatives. Full list is available in Appendix C. There are not many exchanges that report shrimp prices. Much price information is communicated through auction, seafood expo and other traditional medium. A few exchanges provide public price information but the quality varies to different standards.

Kansai Commodity Exchange is the only futures exchange in shrimp that the author has come across. The contracts are still active, but the historical prices are

only available from 1999 to 2008.

The main historical prices used in this thesis are kindly provided by Urner Barry Survey[1] through personal request.

Another widely referred price sources is published by NOAA National Marine Fishery Service in United States on Tokyo wholesale prices[2]. The office publish information on Fulton Fish Market, New England Auction Prices, West Coast Shellfish, Boston Frozen Market, Fish Meal & Fish Oil Prices, New York Frozen Market (no price history), Gulf Coast, Southeast landing report for average Weekly Ex-Vessel Gulf Fresh Shrimp price for all species[3]. The prices will be analyzed in later chapter to compare with the Urner Barry Survey. From the author's point of view, UB prices are more up-to-date and better reflect the market dynamics, hence are used in the regression analysis.

Other sources provide OTC market to shrimp trading such as Alibaba.com and Göteborgs Fiskauktion[4] and reference price such as IMF US Shrimp Export Price (quarterly, aggregate) on Bloomberg http://www.bloomberg.com/quote/1117868:IND and http://www.21food.cn/.

[1] http://urnerbarry.com/

[2] http://swr.ucsd.edu/fmd/sunee/twshrimp/tokyo.htm

[3] http://www.st.nmfs.gov/st1/market_news/doc42.txt

[4] http://www.gfa.se/

3. Theoretical Perspective

3.1 Financial theory perspective

3.1.1 Development and application of derivatives in commodities market

Hull defines a *derivative* as "a financial instrument whose value depends on (or derives from) the values of others, more basic, underlying variables. "[5] A derivatives exchange is a market where standardized contracts that have been defined by the exchange can be traded.

The Market Place

Derivatives exchanges have existed for a long time. The first commodity exchange Chicago Board of Trade (CBOT) was established in 1848 to bring farmers and merchants together. Initially its main task was to standardize the quantities and qualities of the grains that were traded. Within a few years, the first futures-type contract was developed. It was known as a *"to-arrive"* contract[5]. Speculators soon became interested in the contract and found that trading the contract to be an attractive alternative than trading the grain itself. A rival futures exchange, the Chicago Mercantile Exchange (CME), was established in 1919. Now futures exchanges exist all over the world. CME and CBOT have merged to form the CME Group, which also includes the New York Mercantile Exchange. The commodities traded on CME include pork bellies, live cattle, sugar, wool, lumber, copper, aluminum, gold and tin, while financial assets include stock indices, currencies, and Treasury bonds are also traded on CME.

Traditionally, derivatives exchanges have used what is known as the *open outcry system*[5]. This involves traders physically meeting on the floor of the exchange,

[5] John C. Hull, (2011) *Option, Futures and Other Derivatives*, Global Edition, 8th Edition, Pearson, ISBN 13: 978-0-273-75907-2, ISBN 10: 0-273-75907-8

shouting, and using a complicated set of hand signals to indicate the trades they would like to carry out. Exchanges are increasingly replacing the open outcry system with *electronic trading*[5]. This involves traders entering their desired trades with a keyboard and computer systems are used to match buyers and sellers.

Not all trading of derivatives is done via exchanges. The *over-the-counter*[5] *(OTC)* market is an important alternative to exchanges and, measured in terms of the total volume of trading, has become much larger than the exchange-traded market. It is a telephone- and computer-linked network of dealers. Trades are done over the phone and are usually between two financial institutions or between a financial institution and one of its clients.

OTC trading and exchange trading has their own distinct advantages. A key advantage of the OTC market is that the terms of a contract do not have to be those specified by an exchange. Market participants are free to negotiate any mutually attractive deal. A disadvantage is that there is usually some credit risk in an over-the-counter trade (i.e., there is a small risk that the contract will not be honored). Exchanges have organized themselves to eliminate virtually all credit risks[5].

Forward and futures contracts

A *forward contract* is an agreement to buy or sell an asset at a certain future time for a certain price. It can be contrasted with a *spot contract*, which is an agreement to buy or sell an asset today. A forward contract is traded in the over-the-counter market.

Like a forward contract, a *futures contract* is an agreement between two parties to buy or sell an asset at a certain time in the future for a certain price. Unlike forward contracts, futures contracts are normally traded on an exchange. To make trading possible, the exchange specifies certain standardized features of the contract. As the two parties to the contract do not necessarily know each other,

the exchange also provides a mechanism that gives the two parties a guarantee that the contract will be honored.

3.1.2 Three school of thoughts on success factors of futures contracts in commodities markets

A number of studies have been carried out in order to explain why futures contracts succeed or fail in various commodities markets. They can be summarized into three schools of thoughts.

I. Commodity Attributes

First school of thoughts emphasize the importance of the technical aspects of the underlying commodity. This is well-described by Deborah G. Black as the ***commodity attributes*** (Black et al., 1986), namely durability, homogeneity, frequent price fluctuation, large supply and demand (active cash market activity), free flow of goods and existing pattern of forward contracting.

The durability makes the commodity storable, hence, makes it possible to be transported and delivered at a desired time, which facilitates the use of forward and futures contracts.

The homogeneity makes it possible to find a simple underlying product for the futures contract; on the other hand, if the underlying product is extremely heterogeneous, it is difficult to combine the various sub-markets into a big market, unless the prices of these products have high correlations. Therefore, the more homogeneous the underlying commodity is, the more favourable it is to the success of a futures market.

Volatile price movements indicate higher market uncertainties and higher risks; hence can be seen as a pre-requisite for the success of a futures contract based on the assumption that risk management is a primary motivation for fund managers or

purchasing managers to use the futures market. Another expression used in describing price uncertainties is price variation. The definition and implications of the two measurements will be discussed in later chapters.

Large cash market activity both in terms of volume and trading frequency (**velocity** by Black) are favourable to the success of futures markets, as they indicate a large futures market which potentially has a lot of interested parties.

Free flow of goods can facilitate the market integration between different geographies, constituting a bigger market and increasing price correlations between different markets. In addition, **free flow of information** is also vital for an efficient market. It means that cash prices should be public knowledge. A few institutional factors can influence this, such as market power. **Little vertical integration** is in favour of free flow of information. (Bergfjord, 2007)

Last but not least, since the major difference between futures and forwards is that futures are standardized contracts that are organized and cleared by exchanges, an **existing forward market** indicate a visible demand for futures contracts. Moreover, the psychological association of forward and futures are much easier compared to creating a demand for futures from scratch.

II. Contract design

A second viewpoint is based on the technical attributes of the contract that are introduced to the markets – ***contract design*** (Black, 1986).

Researchers studied a well-designed contract from its **attractiveness to hedgers** and **attractiveness to speculators**. (Bergfjord, 2007) While attractiveness to speculators is easier to measure through **liquidity** and **volatility,** attractiveness to hedgers typically means that a contract has high **hedging effectiveness**. An effective futures contract should first reflect the market dynamics and available information, i.e. its relationship with cash market prices should be predictable – in the long term the futures prices and spot prices in the future should converge, and

any arbitrage in the market will be quickly captured. (Geman, 2005) In addition, as a hedging instrument, the use of futures contract should provide protections against risk exposure – an effective hedging.

Many researchers such as Ederington (1979), Gjerde (1987), Hill and Schneeweis (1982), Chang and Fang (1990) have explored various approaches to measure the hedging effectiveness of futures contracts. There are models from as simple as measuring hedging effectiveness as the percentage reduction in the variance of returns achieved by an optimally hedged position as opposed to an un-hedged position (Ederington, 1979, Hill and Schneeweis, 1982) to complex models that take into account minimum variance hedge, risk-return, cost involved in futures trading and liquidity risk. (Pennings and Meulenberg, 1997) It is difficult to tell how a futures contract will work *ex-ante* in terms of hedging effectiveness, but it could be included as a measure for performance evaluation. In later section, an evaluation of hedging effectiveness of the previous attempt to establish pacific white shrimp contract in Minneapolis Grain Exchange will be presented.

Another principle of an attractive contract is to be **unbiased** to *longs* or *shorts*. One example that can influence the fairness of the contract design is the contract specification. Although flexible contract terms could be attractive to some physical buyers and sellers, it could also be used as a way to manipulate the gains and losses on futures transaction and affect the real hedging effectiveness. For example, if there are premiums/discounts associated with non-par deliveries, in a well-designed contract, they should cancel out the value of the option to exchange par and non-par categories provided the price differential is relatively constant. Otherwise, the short hedger will always choose to deliver the cheapest of the allowed assets. (Martínez-Garmendia and Anderson, 1999)

Last but not least, **flexibility** such as small contract size can be an advantage to attract smaller trading partners and increase liquidity in the market. The **settlement method** can also become a point of differentiation in flexibility for

contract design. In most exchange, products are required to be storable. However, in the case of Fish Pool, a new way to trade fresh commodities on exchange is explored by using cash-only settlement. In this way the problems such as durability, restrictions on trade, high transportation costs and unfair delivery as described before can be reduced or eliminated. At the same time, it could also raise question on the effectiveness of **price convergence** between spot and futures market with the removal of the direct physical requirement to deliver the product. (Lien & Tse, 2003; Bergfjord, 2007)

III. Firms and owner-managers

The third perspective presented by various literatures focuses on analyzing the attributes of the market in the sense of *firms and owner-managers*. Several authors such as Smith and Stulz (1985), Nance, Smith, and Smithson (1993), Mian, (1996), Tufano (1996), Lee and Hoyt (1997), Géczy, Minton and Schrand (1997), Carter and Sinkey (1998), Howton and Perfect (1998), Schrand and Unal (1998), Visvanathan (1998), Koski and Pontiff (1999) studied **micro-economic factors**, such as the *firm's risk exposure, its growth opportunity, the level of wealth, managerial risk aversion, financial distress costs, and the accessibility to financing* that appear to influence the decision of a corporation to adapt derivatives to their risk management toolbox. Other researchers such as Holthausen (1979), Shapiro and Brorsen (1988), Hirshleifer (1988), Asplund, Foster and Stout (1989), Makus et al. (1990), Paroush and Wolf (1992), Goodwin and Schroeder (1994), Musser, Patrick and Eckman (1996), Patrick, Musser and Eckman (1998) addressed the factors influencing how the **owner-managers** perceive the benefits of using derivative markets such as *experience, education, enterprise size, expected income change, age, leverage, risk management and marketing seminar participation*.

Pennings and Leuthold (1999), who have extensively studied futures contract design in a few commodities markets, notably in Dutch hogs market, have further developed these studies and presented a *behavioural theory* based on

problem-solving needs to illustrate the *decision process* of the owner manager. They segmented the owner-managers into **economic-driven** and **market-driven**. In the first segment, the factors that influence the owner managers' probability of using futures are *perceived performance, risk attitude, perceived risk exposure, debt-to-asset ratio and the decision unit.* For the second segment, in addition to the perceived performance and decision unit, the owner managers also appeared to be motivated by the possibility to exercise *entrepreneurial freedom* and *market orientation*.

The different motivations of owner managers also result in their differences in the *information required* – eg. the latter is motivated by accurate real-time info to keep up with the market – and their way of comparing alternative risk management instruments.

Pennings and Leuthold's framework provides a good example of reconciling the financial and marketing perspectives.

The three schools of theories are tightly knitted with each other, especially the first two perspectives. In the rest of this paper, the author tries to bring these different perspectives into one evaluation framework that can be applied in practice. Both financial analytics and marketing analysis will be used to illustrate some key success factors such as market size and volatility.

3.1.3 Application of financial theories on seafood futures market – Case study of salmon exchange

Much of the studies on success factors of futures exchange are inspired by the failure of numerous attempts to introduce futures exchange into commodities markets. The usage of futures exchange in seafood industry is relatively new. But at least it has been successfully launched in one seafood sector – salmon. Hence, the characteristics of salmon market and salmon contracts could be used as one

benchmark to shed lights on the feasibility of a shrimp exchange.

Bergfjord (2007) has applied all three perspectives in analyzing the salmon market. He suggested that market size is not the most important success factor for salmon contracts, as it is only medium: much smaller compared to wheat, soybean, etc, but twice as big as the cocoa market. Volatility of salmon, which he represented by **coefficient of variation** $\left(\frac{\sigma}{\mu}\right)$, is also significantly lower than cocoa and pork. There is not a tradition to use OTC forward contract in salmon trading, and the production of salmon has been vertically-integrated and has been concentrated in fewer, larger companies. In some ways, salmon futures seem to be working against the odds. But on the other hand, there are existing grading systems which make it easy to establish standard salmon futures contracts. Trustworthy price series are also available to reflect spot prices and create settlement prices. These factors give birth to a few successful salmon exchanges based on cash settlement such as Fishpool in Bergen, Norway and FishEX in Tromsø, Norway. From a motivation point of view, Bergfjord pointed out that the salmon farmers in Norway had only moderate level of risk aversion. The strengthening power of the upper stream of the industry has also made the producers less vulnerable towards price changes which could reduce the demand for futures exchange. But according to Søren Martens, CEO of Fishpool, he sees the real value and motivation of having his salmon exchange is in bringing price transparency to the farming community. As much as he experienced some push-back from the biggest industry giants at initial stage, the salmon exchange received lots of interests from mid-sized companies and then cascaded into the rest of the industry.

In this sense, salmon exchange is a good example of creatively managing the advantages and disadvantages from all these three perspectives and a proof for comprehensive approach towards establishing a commodity's futures market.

3.2 Marketing and Behaviour Theories

Like all the other services and tools, futures and futures exchanges are created and used to fulfil certain needs from various professional customer groups. For any successful business case, it is crucial to understand the market both from a macro level: market size, segments, industry value chain and institutional factors, and from a micro perspective: the end users and their unfulfilled needs. The next chapter (chapter 4) elaborates the shrimp markets in details from the macro perspective. In this section, a few important concepts from consumer behaviour theories are reviewed, in order to provide a comprehensive perspective to Pennings and Leuthold's behavioural research.

3.2.1 A model of Consumer Behaviour

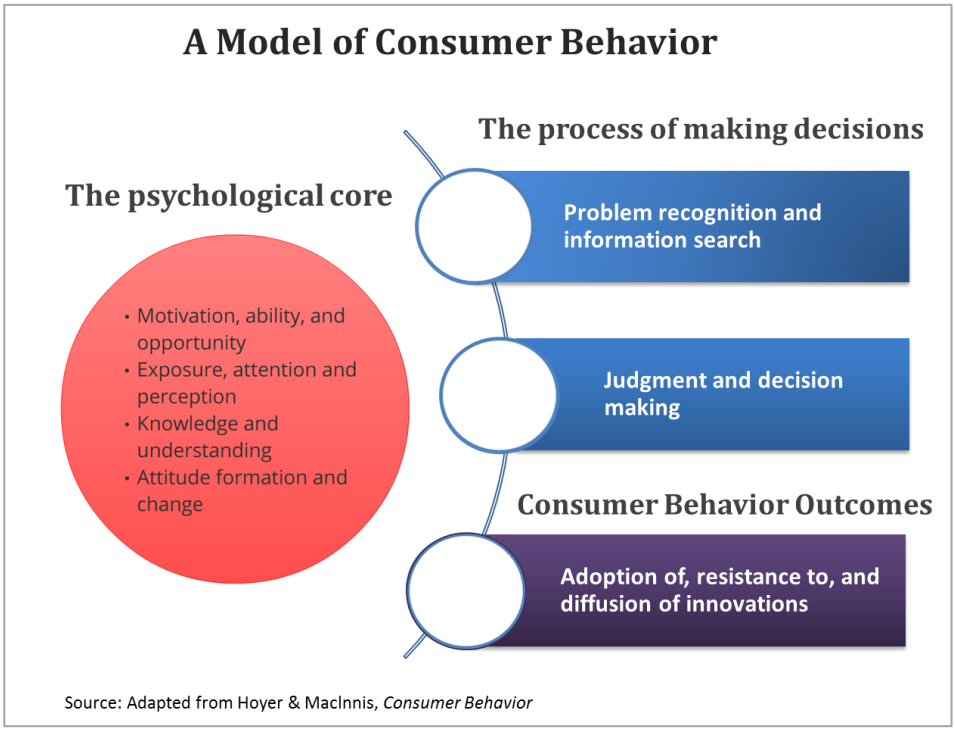
Consumer behaviour theories study the internal and external factors that could influence the behaviour of a target customer group. Jacoby (1976) defined consumer behaviour as "a reflection of the totality of consumer's decisions with respect to the acquisition, consumption, and disposition of goods, services, activities, experiences, people, and ideas by (human) decision-making units [over time]. "[6] Hoyer and MacInnis described four components of this definition and proposed a model of consumer behaviour which encompasses: (1) the consumer's culture (2) the psychological core, (3) the process of making decisions, and (4) consumer behaviour outcomes and issues.[6] In this section, the author will apply this framework to explain the factors in shrimp market that can have an impact on the decision of whether or not to use the futures exchange.

[6] Wayne D. Hoyer & Deborah J. Maclnnis, (2009) *Consumer Behavior*, University of Texas at Austin, University of Southern California, South-Western Cengage Learning. 5th Edition, ISBN-13: 978-0-324-83427-7, ISBN-10: 0-324-83427-6

In this paper, **the consumer** refers to the people that are involved in shrimp trading, primarily in cash market now and potentially in the futures market, or the **owner managers** in Pennings and Leuthold's words. To take a consumer behaviour perspective to study this consumer group means that we are interested in how the owner managers make decision of whether or not to use a derivative instrument; if they do, what the motivations are; how they use it; what the experiences are; and how the experience of using such instruments is going to affect their evaluation and future actions of the such **product** (the futures contract).

Adapted from Hoyer & MacInnis' framework, figure 3.1 illustrates the components that we should take into account when we study the owner managers using a behavioural approach. Perhaps the easiest way to understand this approach is to start from the end result – the consumer behaviour outcomes, walk back the process of decision making and then understand the psychological core behind it.

Figure 3.1. A Model of Consumer Behavior



In this case, the **behaviour outcome** we try to understand is whether the

consumer – the owner managers – would *adopt or resist* to the introduction of futures concept in shrimp trading. A further interest of the outcome beyond the simple adoption and resistance of a product is the involvement of the consumer in the *future innovation* of this product or service; or if by using such product or service, the user would develop *intangible association* with it, for example: a symbolic meaning, a brand association or a sub-culture. This is the unknown part of the puzzle, and is what researchers try to predict, or what the exchanges try to achieve.

In order to predict whether or not the owner managers would adopt shrimp futures exchange, we need to understand their **process of making decisions.**

First of all, to make the decision of whether or not to use futures exchange, the owner managers must *recognize that there is a problem* that they need to solve, and potentially the future exchange could be an optional resolution. Then to help them know and assess the options, there is an *information search process*. From the service provider, in this case, the exchange's point of view, it is important to know the type of information that is needed, the extent, the place where the search occurs, and how the information is searched. In order to discover unfulfilled needs, it is also essential to understand the *ideal state and actual state* of the problem defined.

When it comes to actually making the decision, Hoyer & MacInnis suggested that there are big differences in the ways and the levels of involvement from the users (the owner managers). Some make the judgment based on *cognitive reasons* and some based on *affective reasons*. Some exhibit *high-effort* judgement process, for example: proactively search for information, involve high-level management and adopt more rational assessment methods; and some exhibit *low-effort* judgement process, for example, being more reflective and making decisions based availability.

After the completion of acquisition of the product or service, there is also a *process of learning* depending on whether or not they are satisfied with the product. As mentioned in the financial theory, in this process, the hedging effectiveness could

be an important measurement. For owner managers with high-effort, it might become a formal measurement method; for low-effort users, they might simply judge the effectiveness by experience or gut feeling. In any case, it is important for researchers and practitioners to understand the level of involvement from the owner managers nowadays, as well as to understand whether they recognize a problem, more importantly, what problem, to be solved.

The answer to this question might not be as simple as it looks like, because the decision process is closely related to the psychological process of the owner managers. Therefore the most important component of the model is the **psychological core.**

First of all, we need to consider the *motivation* of the owner managers, which determines the level of involvement in the decision process. Motivation can come from personal relevance, perceived risk, etc; and can exhibit moderate inconsistency with attitudes. Therefore caution needs to be taken so that we do not overlook the *inexplicit motivation*. In addition to the market risk that is primarily concerned of a financial instrument, owner managers might need to take into account many other types of risks: functional, financial, temporal, physical, psychological, social, and sensory. Lovelock & Wirtz mentioned in *Service Marketing – People, Technology, Strategy* that "perceived risk is especially relevant for services that are difficult to evaluate before purchase and consumption, and first-time users are likely to face greater uncertainty."[7] Therefore the true motivation of the owner managers could be different from managing market risk. For example, it could be personally related such as to minimize risk or uncertainty of change (eg: adopting new strategies). Moreover, recall from Pennings and Leuthold's research, the motivation for owner managers to use futures exchange might not be merely to hedge price risks. Some

[7] Lovelock, C. and Wirtz, J. (2010) *Service Marketing – People, Technology, Strategy*, Global Edition, Yale University, National University of Singapore, Pearson, ISBN 13: 978-0-13-611874-9, ISBN 10: 0-13-611874-7

do so to make profits, to explore their entrepreneurship freedom (taking controls), and to use it as a relationship management tool. The differences in the motivation would result in difference in defining the problem to solve. For one owner manager, the problem could be to minimize price risk, while for another it could be to access different trading counterparties.

Other important psychological components that both affects the motivation and the decision making process includes the *knowledge and experience* which affects the owner managers' ability to process information with different complexity. They could be influenced by internal factors such *intelligence, education* and *age*, or by external factors (opportunity) such as *exposure, monetary resources, time*, and *control of information*. *Perception* is an interesting constitute because it can be both a result of internal factors such as knowledge and of external factors such as exposure. In service marketing, it is more difficult to assess customer's exposure, attention and perception, due to the fact that service is often intangible (Alam, 2002); the end result cannot be known until the service is consumed and it often involves the participation from the customers. (Hilton, 2008) Nevertheless, these factors should be taken into account when creating a key success factor matrix. Although it is difficult to observe the perception of the use of futures contract in this market, it is possible to use some indicator such as the knowledge of futures trading concept and the existence of a forward market.

The last psychological aspect describes the *attitude formation and its change over time*. As discussed before, there are high-effort and low-effort attitudes, depending on its cognitive or affective foundations. High-effort attitudes are often generated from direct or imagined experience, reasoning by analogy or category, proven values, social identify-based attitude and analytical process. Low-effort attitudes are based on simple beliefs and unconscious. Different attitudes lead to different intentions.

In the original model, there's also a *cultural* component that influences the

behaviour of consumers. In the context of the owner managers, cultural aspect can also be interpreted as the firm-level environment that was mentioned in previous section, such as the risk exposure, growth opportunity, financial distress costs, etc. From the perspective of the key success factor framework, the author decides not to include a section for the firm characteristics. This is because, first, the evaluation on a micro-economic level for individual firms is not really practical or useful for the exchange that wants to establish the futures market; second, the influence of the firm characteristics should be reflected in the behaviour of the owner managers eventually, such as *knowledge* and *exposure*, according to Hoyer and MacInnis' framework. Therefore, there is no need to repeatedly reflect these factors in the key success factor framework. However, it is still important to understand the cultural influence from an aggregated level. Therefore, in the analysis of the shrimp market characteristics, the industry value chain, the industry power, the institutional factors, etc, are also studied. The ultimate purpose is to provide the background for the designer of the futures market to understand the environment that the owner managers are working in and further understand their decision-making behaviour. Of course, when it comes to discuss the establishment of a futures exchange in a particular country, then the cultural background such as region, ethnic would also become very important.

3.2.2 Implications on the design of a Key Success Factor Framework

In this section, the author tries to put the behavioural studies into perspective and introduce the linkage between the psychological components to the end result of this study. The most important implication is that the result of whether or not a futures exchange would succeed in a particular market cannot be separated from the people that actually use it. The development of a fantastic hedging product alone cannot promise success even with the best market conditions, if the consumers are not ready for such a product. Therefore in the key success factor framework, we

must consider the market characteristics, the product characteristics (the design of the contract) and the user characteristics.

The analysis of the consumer behaviour model shows that the most important psychological components that have an influence on the whole decision process are the ***motivation*** and the ***knowledge*** of the users.

On one hand, the motivation directs the level of involvement of the owner managers. On the other hand, it has a crucial influence on the design of a successful futures contract. The assumption of risk management being the only motivation of using a futures exchange can be misleading. Only by understanding the true motivation of the owner managers can the exchange develop tools to fulfil their needs, whether it is to manage risks, to take entrepreneurship initiative or to manage relationships.

The knowledge of the owner managers determines their ability to comprehend, to understand and to accept futures contracts. Due to the complex nature of the futures products, the current knowledge and exposure of the owner managers need to be studied. For an exchange who wants to create a futures market for shrimp, this means that certain education needs to be introduced before the market could accept it, and the development of the users needs to be continuously studied.

3.3 Key Success Factors Framework

The Key Success Factor Framework proposed in this paper started by integrating the preliminary studies from literature reviews. The aim is to provide a dynamic, up-to-date decision-making tool to determine whether it is feasible to establish a futures market in shrimp now or at future stage. It can also be used to evaluate the influence on the success of shrimp futures exchange if change occurs to one or more of the components.

3.3.1 The factors

The first step of establishing such an evaluation framework is to list a number of factors that are discussed from the three schools of thoughts. The list is not exhaustive but comprehensive. As discussed before, the firm-level characteristics should be either reflected in the characteristics of the owner managers (behavioural view) or the characteristics of the market (aggregated/industry level).

Table 3.1 illustrates the factors from the market, contract and users' perspectives. The relevant theories are mentioned in previous sections. The author removed durability or storability as a requirement, considering the option of establishing a cash-settlement exchange. We can see that the factors are not mutually exclusive across the three perspectives. Therefore in the next section, the author will discuss their relationships and propose a method to eliminate duplicate factors and assign proper weights among them.

According to Martens, Fish Pool has created a similar evaluation matrix for the salmon markets with a few external consultants. They have given salmon market a score of 5.54 out of 10 using similar factors. But the weighting of different factors and the final evaluation were quite subjective. Therefore a systematic review of the factors needs to be performed so that such matrix can be applied to other new markets.

3.3.2 Dependencies of the factors and weights assignments

The second step is to eliminate repetitive elements and determine the respective weights of these factors. The three schools of thoughts are not mutually exclusive. On the contrary, they reflect each other's point of view from different perspectives. For example, large cash market trading volume in column A could leads to (but not equal to) liquidity in column B. Price volatility in cash market in column A means that there are possibilities to reduce volatility (good hedging effectiveness) which can increase the attractiveness to hedgers in column B, which also fulfil the requirement of a motivation to risk management in column C.

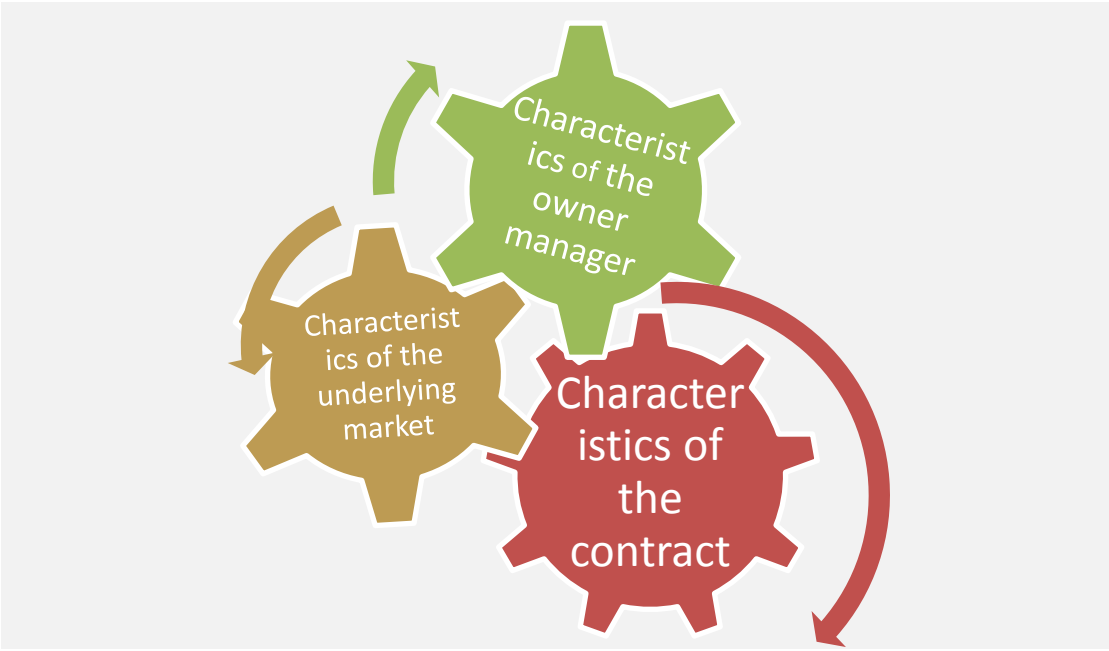
Table 3.1. Factors from three schools of thoughts

A. Characteristics of the underlying market	B. Characteristics of the contract	C. Characteristics of the owner manager
• Size of the market/ trading volume of the cash market [1]	• Reliable price source [2]	• Motivation of hedging price [6,7]
• Price Volatility [1]	• Possibility to construct a reliable price index [2]	• Motivation of entrepreneurship (making profits) [6,7]
• Low / moderate market concentration [1]	• Price convergence to cash market [1,8]	• Motivation of contractual relationship management [6,7]
• Homogeneity of the underlying product [1]	• Attractiveness to the physical users (hedgers): [3]	• Knowledge of futures market [6,7]
• Existing forward market [3]	- Good hedging effectiveness (Reduced volatility) [3,4]	
• Large number of market players [1]	- Liquidity [3]	
• Price transparency [1,8]	- Fairness to buyers and sellers [5]	
• Free market [1]	• Attractiveness to financial users (speculators): [3]	
	- Volatility	
	- Opportunity of arbitrage	
	- Low transaction cost [3]	
	- Liquidity [3,4]	
	• Large number of counter parties [3]	
	• Small size contract (flexibility)* [3]	

1 (Black et al., 1986)
2 (Martens, Fish Pool interview, 2011)
3 (Bergfjord, 2007)
4 (Pennings and Meulenberg, 1997) (Ederington, 1979) (Gjerde, 1987) (Hill and Schneeweis, 1982) (Chang and Fang, 1990)
5 (Martínez-Garmendia and Anderson, 1999)
6 (Pennings and Leuthold, 1999)
7 (Hoyer and MacInnis, 2009)
8 (Geman, 2005)

* The selection of factors avoid using vague terms such as "flexibility" as it can be defined in multiple ways; and each way has a different impact on the other factors and the overall success measurement. Hence, straight forward criteria such as small size contract are used to reflect one of the most discussed flexibility requirements.

Figure 3.2. Interdependent Relationship



Because of these inter-dependencies, some factors are more important than the others if it is more fundamental to the existence of the futures market and if it has an impact on the other factors that are involved. In order to reflect this in the design of the weights, the idea is first to establish dependency relationships between these factors, and then assign more weights to the factors that is a prerequisite to the others. For example, *the homogeneity of products* (1) influences the *size of the market* (2) due to economics of scale, which in turn influences the *liquidity* (3) of the contract. Therefore if (3) is assigned a weight of 1, then (2) is assigned a weight of 2 and (1) is assigned a weight of 3. The weight increase by 1 every time a new dependency relationship is built.

Table 3.2 proposes the inter-dependency relationships between the listed factors.

Table 3.2. Interdependent relationships between key success factors

Inter-dependency relationship between key success factors			Weights of the cause (dependencies + original weights, starts from 1)
Size of the market	→	Liquidity	2
Price Volatility	→	Attractiveness to the speculators Good hedging effectiveness Hedging Motivation Entrepreneurship Motivation	5
Low moderate market concentration	→	Large number of market players	2
Homogeneity	→	Large number of market players Size of the market	3
Exiting forward market	→	Hedging Motivation Knowledge of futures market	3
Large number of players	→	Size of the market Liquidity	3
Price transparency	→	Reliability of pricing source Possibility to construct a reliable price index	4
Free market		Homogeneity	2
Reliability of pricing source	→	Possibility to construct a reliable price index	3
Possibility to construct a reliable price index	→	Price convergence to cash market	combine with reliability of pricing source
Price convergence to cash market	→	Arbitrage opportunity	2
Fairness to buyers and sellers	→	Good hedging effectiveness	2
Liquidity	→	Low transaction cost	3
Small size contract/flexibility	→	Liquidity	2
Knowledge of futures market	→	Motivation of hedging price Motivation of entrepreneurship (making profits)	3

After taking into account the inter-dependency relationships, Table 3.3 summarizes the weights that should be assigned to each factors. Note that factors which appear in more than two schools of thoughts (eg: both market characteristics and contracts design) are represented only once, in order to keep the key performance matrix coherent.

Table 3.3. Weights of key success factors

A. Characteristics of the underlying market	weights	B. Characteristics of the contract	weights	C. Characteristics of the owner manager	weights
Size of the market/ trading volume of the cash market	2	Reliable price source	3	Motivation of hedging price	1
Price Volatility	5	Possibility to construct a reliable price index		Motivation of entrepreneurship (making profits)	1
Low / moderate market concentration	2	Price convergence to cash market	2	Motivation of contractual relationship management	1
Homogeneity of the underlying product	3	Attractiveness to the physical users (hedgers):		Knowledge of futures market	3
Existing forward market	3	- Good hedging effectiveness (Reduced volatility)			
Large number of market players	3	- Liquidity	3		
Price transparency	4	- Fairness to buyers and sellers	2		
Free market	2	Attractiveness to financial users (speculators):			
		- Volatility			
		- Opportunity of arbitrage	1		
		- Low transaction cost	1		
		- Liquidity			
		Large number of counter parties			
		Small size contract	2		
Total weights	***44***				

3.3.3 The key success factor matrix

This Key Success Factor Framework now reflects a holistic view, both from the

marketing perspective and from a financial perspective. There could be many other ways to assign the weights of different factors, but this framework provides a very easy way to assess the current scenario or desired scenario of a potential commodity exchange. To illustrate the use of the model, three different scenarios and the resulting scores are generated in Table 3.4. The scenario selections take into account that some factors are easy to achieve, such as making small contracts, while some are more uncertain. Scenario 2 gives an optimistic situation and scenario 3 gives a rather pessimistic view. The importance of the Key Success Factors can be tested with industry practitioners. Sensitivity test shows that under this framework, 1 point decrease in the grading of the most important factors, for example, price volatility, causes around 0.1 decrease in the final score, given that all other factors remain the same. A 1 point change in a relatively less-weighted factor, such as the entrepreneurship motivation, results in a very small change in the overall assessment. The detailed scores of the matrix will be further discussed in chapter 6 after the marketing and econometrics analysis.

Table 3.4. Key success factor matrix

Key Success Factors	*Weights*	*Scenario 1 (Normal)*	*Scenario 2 (Optimistic)*	*Scenario 3 (Pessimistic)*	*Sensitivity tests*	
Price Volatility	5	5	7	3	4	5
Price transparency	4	4	6	2	4	4
Homogeneity of the underlying product	3	4	7	2	4	4
Existing forward market	3	3	9	3	3	3
Large number of market players	3	5	8	4	5	5
Reliable price source	3	7	9	4	7	7
Liquidity	3	6	8	3	6	6
Knowledge of futures market	3	2	7	2	2	2
Size of the market/trading volume of the cash market	2	9	9	9	9	9
Low / moderate market concentration	2	6	8	4	6	6
Free market	2	6	8	4	6	6
Price convergence to cash market	2	7	9	3	7	7
Fairness to buyers and sellers	2	9	9	7	9	9
Small size contract/flexibility	2	9	9	9	9	9
Opportunity of arbitrage	1	7	7	4	7	7
Low transaction cost	1	9	9	9	9	9
Motivation of hedging price	1	6	8	5	6	6
Motivation of entrepreneurship	1	3	7	3	3	2
Motivation of relationship management	1	7	8	4	7	7
Weighted average score		***5.6***	***7.9***	***4.0***	***5.5***	***5.6***

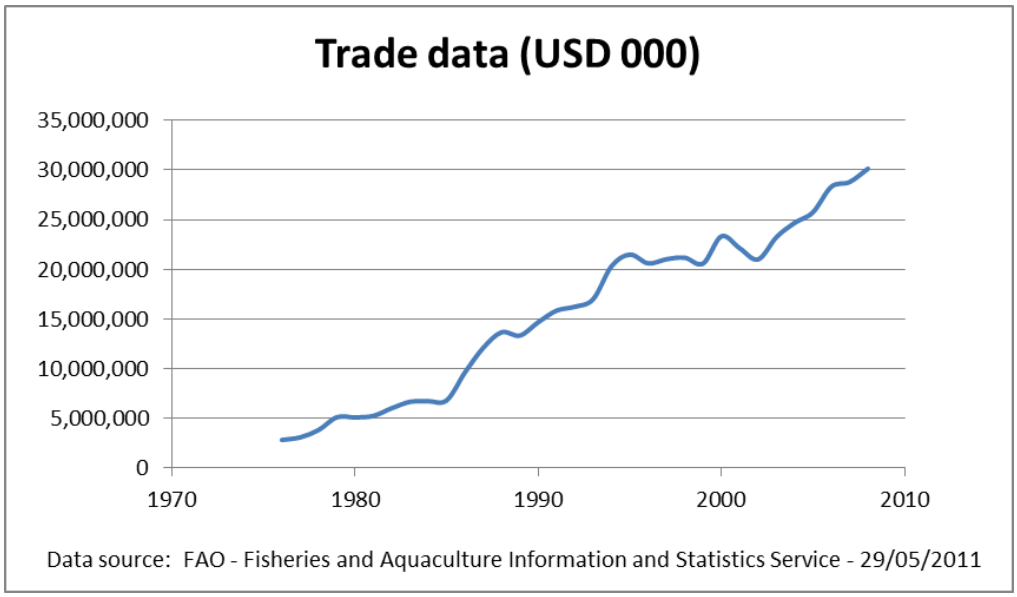
4. The Characteristics of Shrimp Market

After constructing a framework to assess the feasibility of establishing a shrimp futures market, from this chapter onwards, the author uses both qualitative studies and quantitative studies to provide more insights into the shrimp market in order to evaluate the relevant factors.

4.1 Market Size

Shrimp and prawns are actively traded commodities with significant cash market activities. The global production is estimated to be over 7 million metric tonnes, representing over $30 billion USD trading annually (Figure 4.1)[8]. Statistics from Food and Agriculture Organization of the United Nations (FAO)[8] illustrated the astonishing growth of global shrimp and prawns production in the last 60 years from less than 0.5 million metric tonnes to the 6.7 million metric tonnes in 2009. (Figure 4.2) The aggregated production has enjoyed a long term average year-on-year growth rate of 5% (Figure 4.3). Even with the presence of global economic recession, shrimp products have overall shown strong resilience and have been growing continuously since 1980s.

Figure 4.1. World shrimp and prawn trade



[8] FAO, http://www.fao.org/figis/servlet/TabSelector#lastnodeclicked

Figure 4.2. World shrimp and prawn production

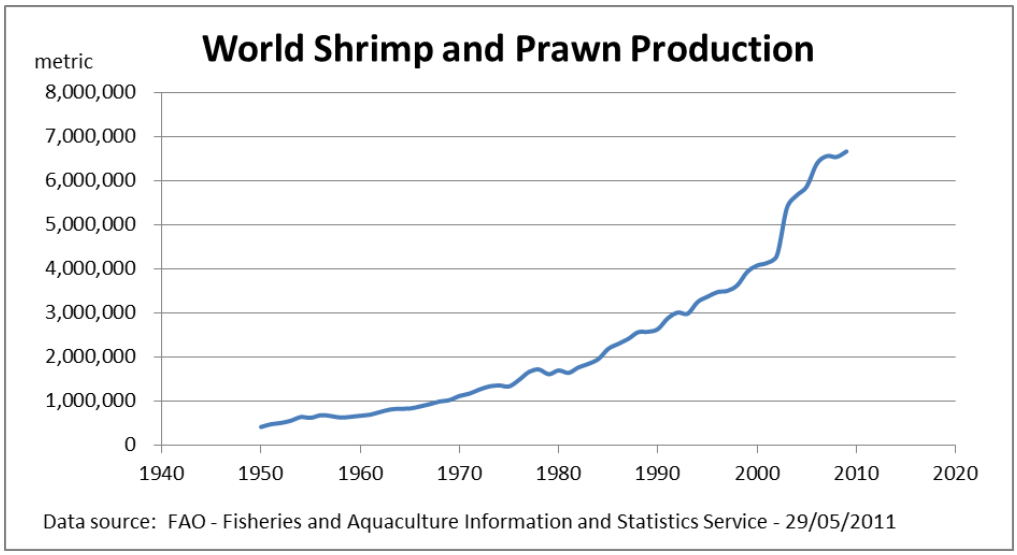
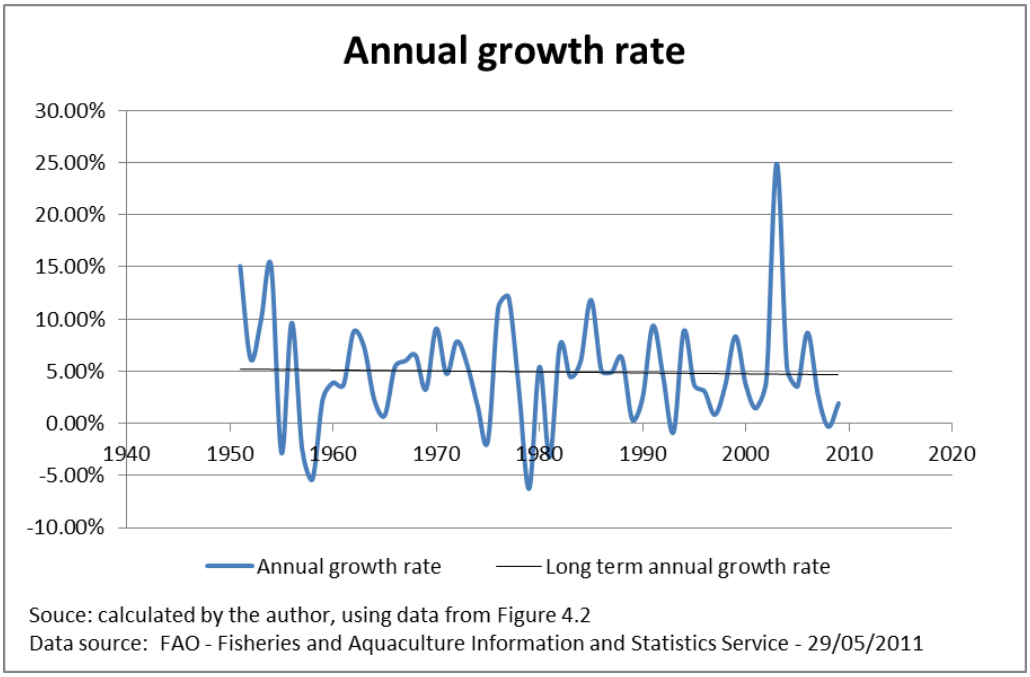


Figure 4.3. Annual growth rate for world shrimp and prawn production



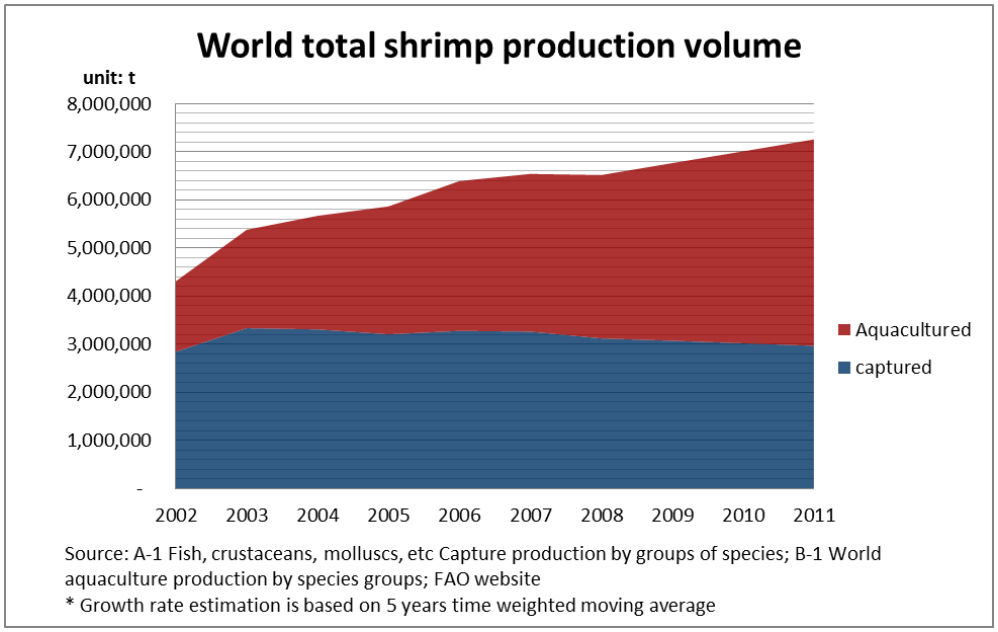
The underlying market appears to be an increasingly attractive sector. Compared to salmon market, which has already established good price indicator and active derivatives market, shrimp market is estimated to be at least 3 times the size in value. The former represents $10.7 billion in value and 3 million tonnes in volume in 2007. (FAO)[8] As IntraFish reported, shrimp business consists 17% of the world seafood total export revenues in 2005.

Part of the success of shrimp business is attributed to the increased availability that is driven by the enhancement along the supply chain, including production technology, freezing and storage technology and distribution network. (Strömsta, 2008) Part of it can be explained by the change in consumer preference, as shrimp provides a high value, low fat alternative to meat and other protein. But at the same time, there are concerns that such expansion is at the cost of over-production and squeezing the margins of some exporters, as the shrimp price has increased only 5% since 1995, contrasting the increase in production, which is 69%. (Strömsta, 2008)

Nevertheless, the massive underlying market indicates a tempting opportunity for derivatives such as futures and options.

Since the late 1980s, farmed shrimp has become a major contributor to overall shrimp supplies in the world, making up for the declining wild catch and meeting the steadily increasing demand. Figure 4.4 indicates the splits of shrimp production by wild catch and by culture.

Figure 4.4. Shrimp production by cultured and captured



Source: A-1 Fish, crustaceans, molluscs, etc Capture production by groups of species; B-1 World aquaculture production by species groups; FAO website
* Growth rate estimation is based on 5 years time weighted moving average

From the graph, we can see that, over the past decade, the wild catch shrimp production has almost stayed the same while the cultured production increased

steadily from less than 1.5 million tonnes in 2002 to nearly 4.3 million tonnes in 2011[9]. The average annual percentage growth rate for 2002-2004 is 28.7%. (Pham, 2008) Cultured shrimp now accounts for 60% of the world shrimp production.

4.2 Market Segmentation

4.2.1 Market Segmentation by Species

Leading species

Shrimp is an umbrella term for a vast number of crustacean products. There are over 3,000 species of shrimp known to exist, among which some 200 are currently under cultivation. There are many ways to categorize shrimps and prawns, such as by warm water and cold water, by origin, species, and size. But the number of farmed species is becoming smaller and smaller, as shrimp farmers have focused on the easiest-to-grow varieties that offer the highest profitability.

The present consensus of a dominant species is commonly referred to as *Penaeus vannamei* (Boone, 1931; FAO, 2011), also known as *Litopenaeus vannamei, Whiteleg shrimp* and *Pacific white shrimp.* It is native to the eastern Pacific Ocean, from Sonora in Mexico to northern Peru. Nowadays, it is widely farmed in China, Thailand, Indonesia, Vietnam, Ecuador, Mexico and Brazil.

It is replacing another type of traditional warm-water shrimp in Asia, *Penaeus monodon (Fabricius, 1789; FAO, 2011)*, also known as *giant tiger prawn, jumbo tiger prawn, black tiger prawn, leader prawn, sugpo and grass prawn*. Although P.monodon is known for its large size and good taste, P. vannamei yields much more given the same feed and pond.

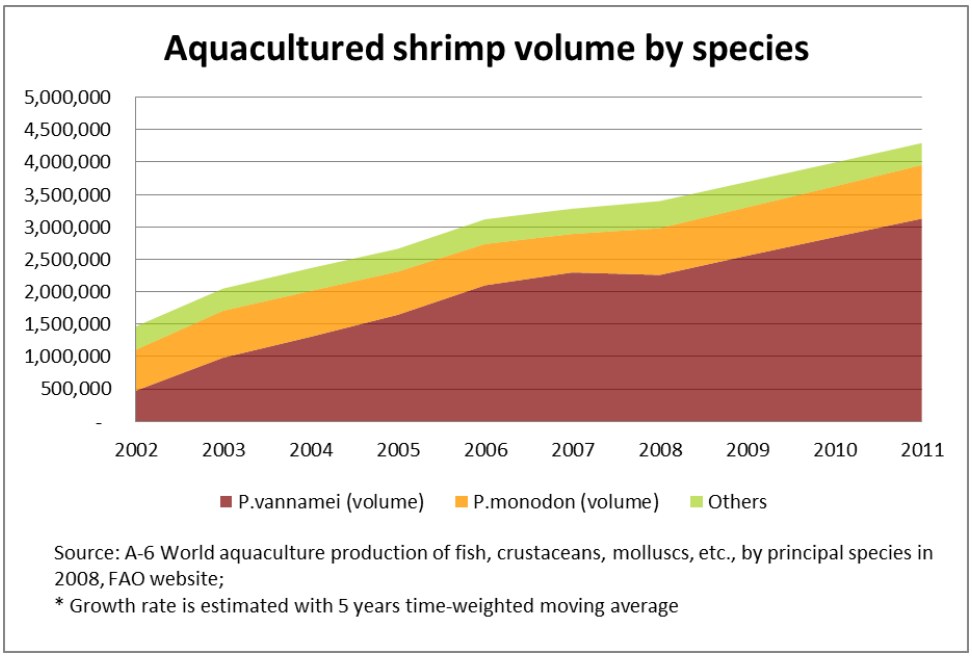
Cold water shrimp, mostly *Pandalus borealis (Krøyer, 1838; FAO, 2011)*, is another important sector, especially for Japan and EU consumers. This sector

[9] Source: A-1 Fish, crustaceans, molluscs, etc Capture production by groups of species; B-1 World culture production by species groups; FAO website; 2009 – 2011 estimation based on 5 years' time weighted moving average growth rate.

possesses many good features as a potential target for futures market. For example, the supply chain is relatively simple, which is easier to establish a reliable price indicator; the products are highly homogeneous; the development of product certification is more advanced, which could facilitate the establishment of industry standard and increase transparency. However, this sector is significantly smaller, compared to warm water products. According to Møller (Gemba Seafood Consulting, 2011), the world total production of cold water shrimp in 2011 does not exceed 120,000 metric tonnes, as opposed to over 2.3 million metric tonnes for whiteleged shrimp alone. (FAO, 2009[8])

Altogether, P.vannamei and P.monodon account for almost 90% of the world's total culture shrimp production (Figure 4.5).

Figure 4.5. Cultured shrimp volume by species

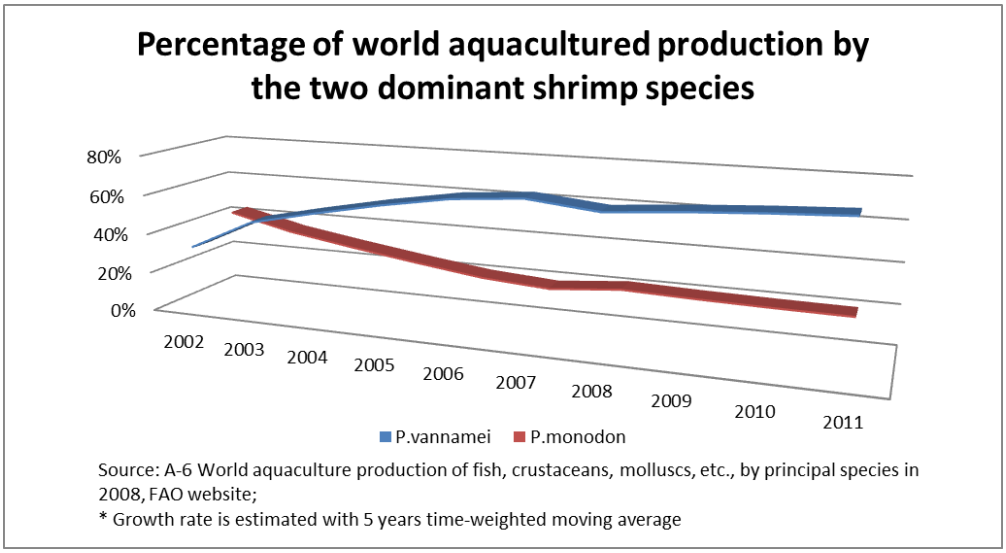


P.vannamei has overtaken P.monodon as the most cultured shrimp type, increased from 32% of world total in 2002 to 73% in 2011[10]; P.monodon culture production increased slightly over the years, but its importance of world total

[10] Source: A-6 World aquaculture production of fish, crustaceans, molluscs, etc., by principal species in 2008, FAO website; 2009 – 2011 estimation based on 5 years' time-weighted moving average growth rates.

decreased from 43% in 2002 to 19% in 2011[10] (Figure 4.6).

Figure 4.6. Percentage of world cultured production by the two dominant shrimp species



Meanwhile, the wild catch of P.vannamei has dropped from its peak in early 1990s at around 15,000 metric tonnes per year to only about 1,000 metric tonnes in 2010. The wild catch of P.monodon has also dropped a little to about 210,000 metric tonnes in 2010. (FAO, 2011)

Consolidation or diversification trends

The consolidation trend is an endeavour to battle out of the increasing production cost and high pressure on prices and competition. According to IntraFish, from 1995 to 2008, global shrimp production has grown by 69% while prices for shrimp have risen just 5%. They even call it "something the industry should be both ashamed and deeply concerned about" (Strömsta, 2008).

As it is rather difficult to distinguish shrimp products, the competition has traditionally been concentrated on price. Meanwhile, the production costs have risen rapidly. High fuel prices, rising feed prices, exposure to currency fluctuations, and increasing cost of disease and hygiene control have put a lot of pressure for sustainability of small-scaled shrimp farms. (Pham, 2008)

One way to increase profitability is through integration of value chain and harvest economies of scale. Another way is to switch to shrimp types that have

higher yield at cheaper costs. This is the main reason why many shrimp farms in Southeast Asia have switched from traditional P.monodon to P.vannamei. In Thailand, farmers have been successful in raising large-size P.vannamei, even bigger than P.monodon, to lower the price by 10-15%. Besides, P.vannamei can also achieve higher outputs, 25-30 tonnes/ha, which allows 2-3 times the profit of a P.monodon farm (Pham, 2008).

The consolidation trend has significant implication to the success of a shrimp futures contract, as we have established that a homogeneous product is more likely to attract a liquid derivatives market.

On the other hand, the effect will be mitigated by some diversifying needs in the market. First of all, the diversification can be served as a way to reduce risk exposure to unexpected events such as disease outbreak or change in the demand trend. For example, Thailand, after switching to P.vannamei completely to increase competitiveness, has realized the potential danger of totally relying on one product, hence has set up a target ratio of 10% of P.monodon by 2008 and a long term target of 30%. (Strömsta, 2008)

A second factor that might increase the heterogeneity of products comes from marketing efforts of retailers and distributors. An increasing trend of promoting value-added products, certified organic food and other brand building initiatives can lead to a change in consumer preference, or vice versa. For example, UK and France have long been favouring processed products and organic products, while some producers have also set up target export ratio of value added products.

4.2.2 Market Segmentation by Geography

Exporters

The world shrimp exports are dominated by a few emerging economies. China, Indonesia, India, Thailand and Vietnam – the world's top five shrimp producing countries – accounted for 72% of global production in 2005, and such a narrowing is

likely to intensify. (Strömsta, 2008) The producers are also experiencing increasing level of professionalism, with increasing consolidation and integration of labour, natural resources and farming units. *"We're coming into an era of professionalism, where amateurs and gold seekers won't get involved,"* said Robins McIntosh, senior vice president of Thailand's largest shrimp exporter CP Foods.

China is by far the largest shrimp producer in the world and biggest seafood consumer. (Strömsta, 2008) With 1.5 million metric tonnes production in 2007, which is about 22% of the world production, China exports only 28,099 metric tonnes of shrimps. This is partly due to trade barriers such as anti-dumping duties and partly due to skepticism of food safety issues. But more importantly, it is because of a huge domestic market from home-grown consumptions.

Thailand is the world's biggest shrimp exporter, with estimated production of 530,000 metric tonnes and estimated export of 350,000 metric tonnes in 2007. Thailand appears to stay ahead of its peers in resolving food safety issues and establishing industry standards. For example, it established the Marine Shrimp Culture Association of Thailand Organic which has taken up the FAO Code of Conduct and formulated Codes of Practice (COP); it has also created the Agricultural and Farm Products Certification Office, which operates under the criteria outlined by International Federation of Organic Agriculture Movements (IFOAM), and has established pilot organic farm project in Chanthaburi to produce organic black tiger prawn, targeting value added sectors.

Importers

In terms of import, **Europe** has taken over US and Japan to be the world's biggest markets for shrimp. This is partly due to the turbulent economies in US and Japan during the financial crisis, partly because of a resilient or even increasing demand of shrimps in Europe.

In addition to the rise of the food culture and a trend towards value-added

products brought by the innovation in food preparation and packaging, non-traditional shrimp countries such as Germany has also joined the shrimp party, supporting a positive long-term growth for the shrimp market.

Europe also boasts a thriving intra-European shrimp trading driven by extensive wild-catch, culture and processing sectors. The aggregated import for extra-European was 585,000 metric tonnes in 2007 (estimated, Intrafish), with a per-capita purchasing power of $33,482 (€21,394). According to the statistics below provided by IntraFish, The intra-European shrimp trade is estimated to be around 200,000 metric tonnes during the same period. (Figure 4.7)

Figure 4.7. EU, Japan, US shrimp imports (IntraFish, 2008)

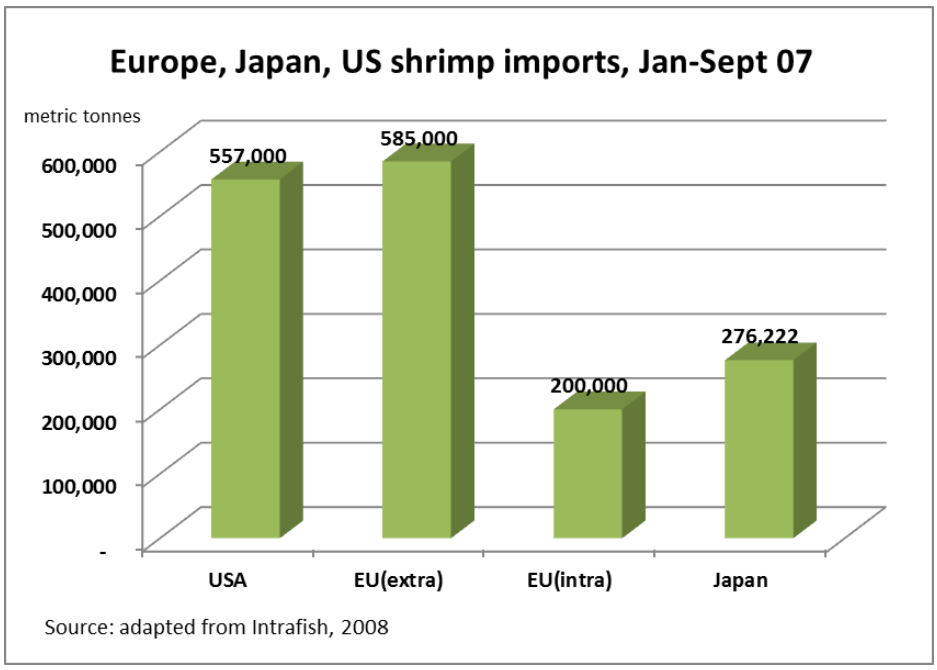
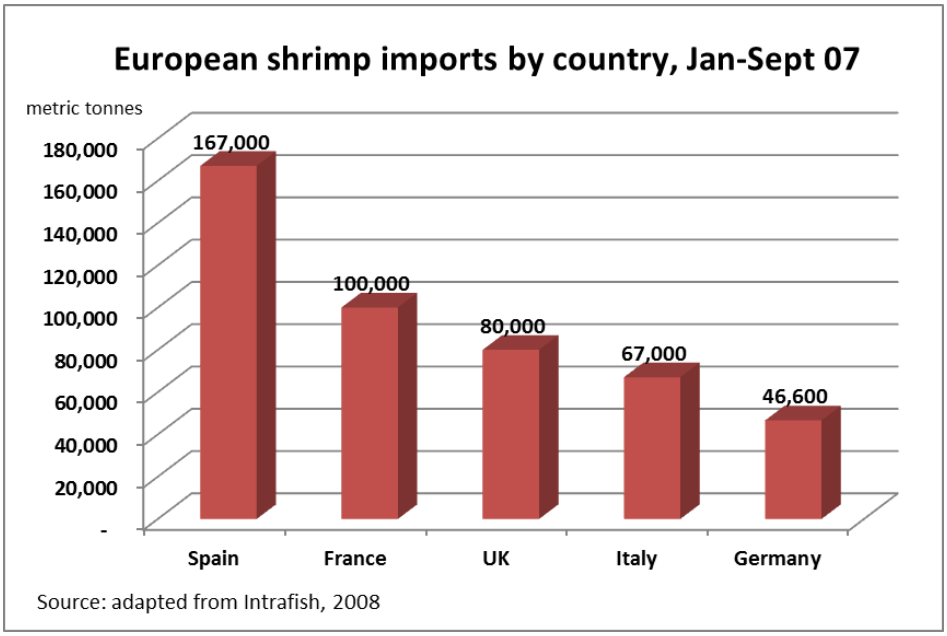


Figure 4.8 shows the import volume for leading shrimp markets in Europe – Spain, France, UK, Italy and Germany.

Figure 4.8. European shrimp imports by country (IntraFish, 2008)



With 167,000 metric tonnes of shrimp imported in 2007, **Spain** is by far the biggest shrimp importer in Europe, importing 70% more shrimps than the next follower France. This is driven largely by its shrimp processing sector, which buys the raw materials and resells them across the borders. Spain purchases large volumes and varieties of shrimps from all kinds of producing nations, placing heavy pressure on the prices and margins for producers. The origin and species are considered less important factor compared to price.

France sits on the second place in the European shrimp market with 100,000 yearly imports (2007). As another important shrimp middleman in Europe, France places a balance between convenient goods and high-end products.

UK has been a traditional market for cold water shrimps, but the trend in the last few years showed that warm water shrimp is stepping up even though the total importing volume is decreasing. The changing diet habit made more and more people perceive high quality warm water shrimp as a substitute for meat and other protein. At the same time, cold water shrimp market has suffered from quality issues and low availability. On the whole, with about 80,000 metric tonnes of imports, the UK shrimp market will remain lucrative with the increasing demand for

high-quality value-added products. Given its emphasis on sustainability and traceability, UK is likely to lead the direction of setting up industry standard for shrimp market, which will greatly facilitate the homogeneity and competition of the global shrimp market.

The number four shrimp trading country in Europe, **Italy**, imports 67,000 metric tonnes in 2007. Similar to its neighbouring country Spain and France, Italy spread its eggs – or shrimps, in this case – in many different baskets. The main type of shrimp traded in Italy is warm water shrimp from South America – Ecuador and Argentina.

With 46,600 metric tonnes of imports in 2007, **Germany** is by no means a big shrimp nation, yet. In the third quarter of 2007, the shrimp imports grew 31%, making Germany the fastest growing market in Europe. The producers from Thailand have been extremely successful with the German market, and the trend appears to be solid for the coming years.

With an annual import of 557,000 metric tonnes of €3.9 billion in value, the US is undoubtedly the biggest shrimp importing country. The weakened figure in 2007 was mainly a result of lack of availability. The US still enjoys the highest per capita purchasing power (Figure 4.9) of €27,814 per person. The peak per capita consumption was 4.6 kilograms in 2006. Contrary to the southern European countries, US shrimp market experienced considerable consolidation – more than 78% of its import come from Thailand, Vietnam, Indonesia, Mexico, Ecuador and China. A higher concentration of exporters could both become an advantage of standardizing the products and a disadvantage if the market power becomes too concentrated in a few producers' hands. The US imposes trade barriers such as heavy duty and "anti-dumping" regulations in shrimp to China and five other countries. This is considered one reason why Asian suppliers shifted much business to its European counterparty that further leads to the lack of availability.

As a traditional big shrimp market, Japan has experienced severe decline in 2007 – an 8.3% reduction to 276,222 metric tonnes. It still remains an important market for both cold water and warm water shrimps.

Figure 4.9. Per capita purchasing power (2007)

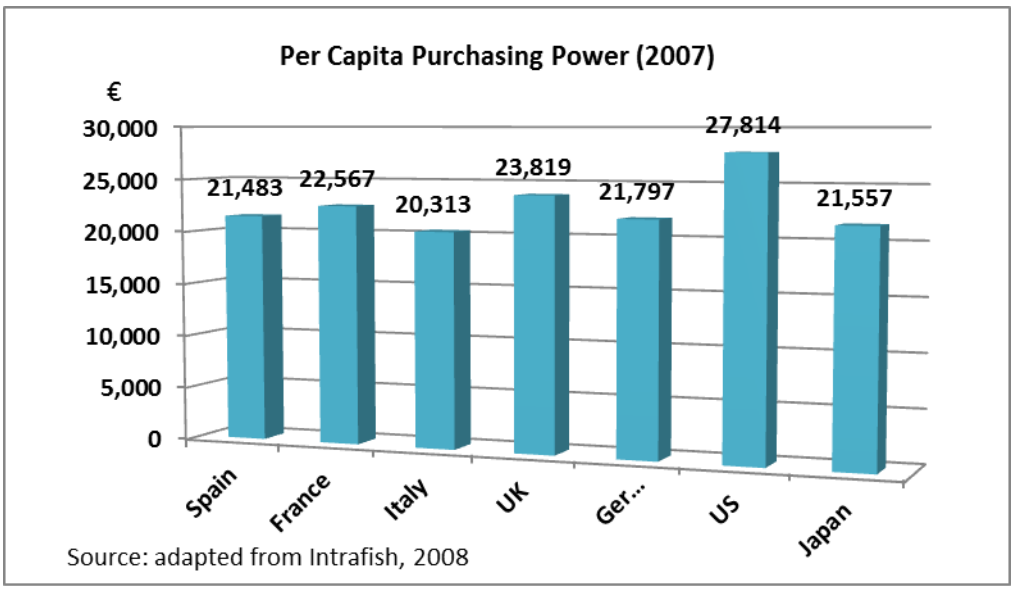
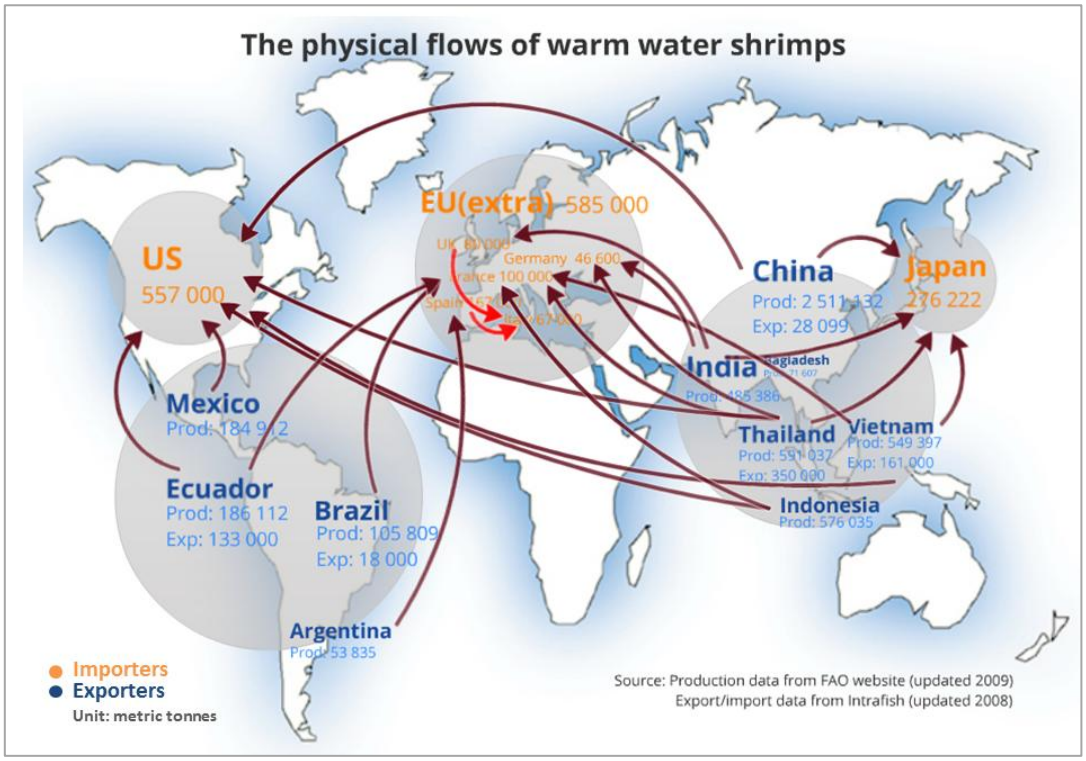


Figure 4.9 summarizes the per capita purchasing power of the major shrimp markets based on 2007 statistics.

The physical flows of warm water shrimps are summarized in Figure 4.10.

Figure 4.10. The physical flows of warm water shrimps



Home grown consumption

Compared to the 7 million metric tonnes yearly shrimp production, the import and export activities discussed above only represents part of the global shrimp trade. In 2008, the global shrimp export volume is about 3.3 million tonnes with a total value of 15 billion USD, representing just about half of the total trade value.[11] A significant part of the shrimp produced is consumed locally. If this amount is big enough, it will have a large impact on the price determination of global shrimp trading.

China and Brazil are the most eye-catching examples of this home grown consumption. From Figure 4.10, we can see that among the 2.5 million metric tonnes of shrimp produced in China in 2009, which accounts for more than 20% of the world production, only less than 2% are exported and China even has to import shrimp to fulfil its domestic demand.[12] The huge home grown consumption is already showing its impact on the shrimp market. The economic growth in Brazil also created similar effect in the country – with increasing purchasing power internally and decreasing competitiveness in exporting due to expensive domestic currency – the home market becomes the most important driving force for the development of the shrimp market.

Price – volume disparity

Almost all the countries in Europe and Japan are experiencing a rising trading volume with a stagnated or even falling price. Germany and the US are among the few markets that could support the current shrimp price or see a comparable growth. From 1995 to 2007, global shrimp production has grown by 69% while the prices for shrimp have risen just 5%. (Strömsta,2008) Meanwhile, the US All Item CPI has increased from 150.3[13] in January 1995 to 210.0[14] in December 2007. This means

[11] A-5: International exports of fishery commodities by FAO ISSCAAP

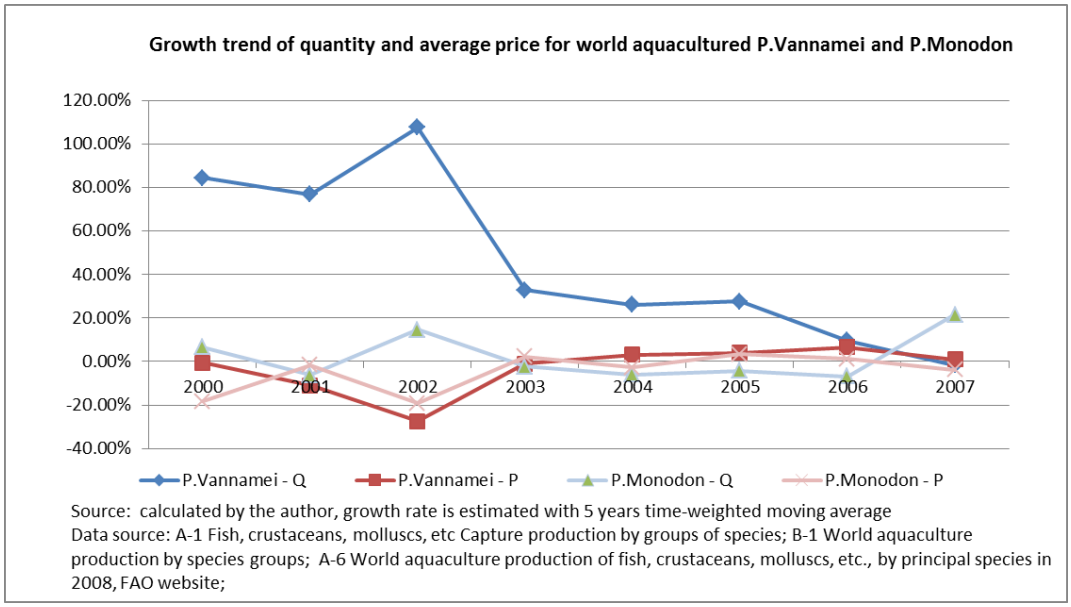
[12] China Seafood Show Highlights Rising Demands, IntraFish, http://www.intrafish.com/global/news/article1254629.ece, retrieved 18.11.2010

[13] http://www.bls.gov/news.release/history/cpi_021595.txt, retrieved 18.11.2010

[14] http://www.bls.gov/news.release/history/cpi_01162008.txt, retrieved 18.11.2010

that the real shrimp price has been falling significantly if inflation is taken into account.

Figure 4.11. Growth trend of production volume and average price



Source: calculated by the author, growth rate is estimated with 5 years time-weighted moving average
Data source: A-1 Fish, crustaceans, molluscs, etc Capture production by groups of species; B-1 World aquaculture production by species groups; A-6 World aquaculture production of fish, crustaceans, molluscs, etc., by principal species in 2008, FAO website;

Figure 4.11 summarizes the prices and production volumes in the global cultured P.vannamei and P.monodon markets. P.vannamei experienced sharp growth in volume in early 2000s. The growth rate has reached a mature level. Meanwhile, the calculated average nominal price has remained stable over the years.

As Strömsta (2008) has pointed out, such unbalance in the development of price and volume could hurt the long-term interest of the industry. On one hand, the production cost has risen sharply in the past decade, which could drain the profitability out of many producers. On the other hand, it could indicate an over-production at the current level which hurt the sustainability of the industry in the future. Therefore it is not likely that such situation could continue for a long time, and we should not take for granted that the current low price and large production would last forever.

4.3 Industry Value Chain

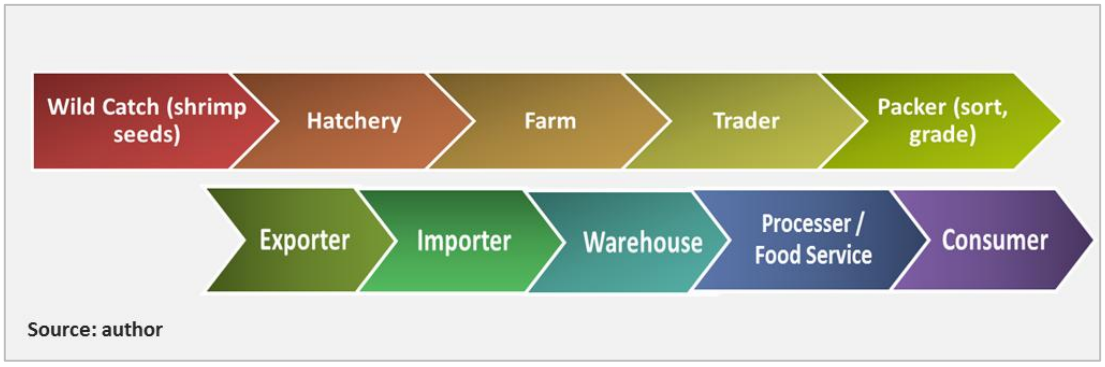
In this section the author gives an overview of the participants and the dynamics in

the shrimp industry. A number of researches have been conducted from technical, social and environmental perspectives. Due to fact that some of the primary studies are conducted in Southeast Asian native languages, a few secondary resources are used in this section.

4.3.1 Market Structure

There are many different ways that shrimps can be produced, marketed and distributed to the consumer. A typical industry value chain (or main activities) can be illustrated by Figure 4.12. Note some of these activities could be performed by the same market player; therefore not necessarily every role exists in every market.

Figure 4.12. Industry Value Chain



In the upper stream of the value chain, the players are relatively fragmented and are characterised by many small enterprises and local ownerships.

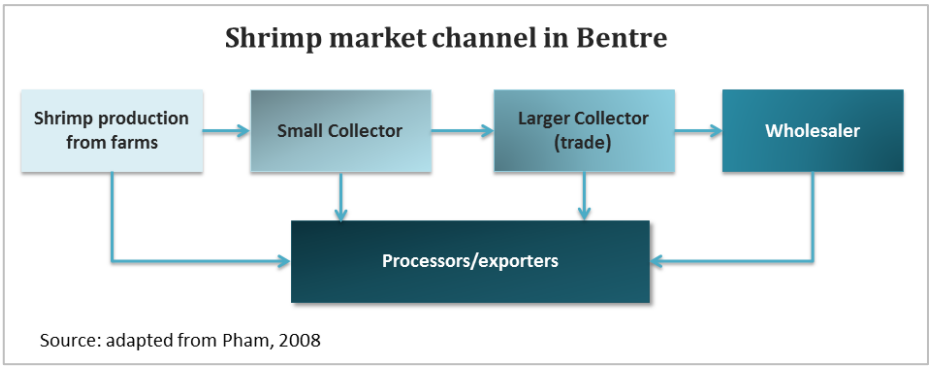
In Ecuador, one of the biggest shrimp producers in the western hemisphere, there are 343 shrimp hatcheries and 21 facilities that produce seeds stock. Over 1800 farms produce on 450,000 acres of ponds. Farm ownership is spread over 1000 different entities. There are 64 shrimp packing plants. 81 firms are officially reported to export shrimp products. The ten largest firms provide 60% of the total exports.[15] The largest exporters also tend to own some packing plants as well as farms. (Sanders and Pennings, 1999) Of the product that went into the United States, there were 115 importing firms of record. The ten largest U.S. importers handled

[15] ESTADISTICA CIA.LTDA: Importacion y Exportacion, a monthly trade report.

55% of the volume.

In Vietnam, one of the top five warm water shrimp producer in the world, 80% of the shrimps are produced by small scale shrimp farmers. (Pham, 2008; Sena De Silva, 2007) IAA (2001) reported similar situation for Thailand, with each farm operates 1-2 ponds, ranging in size from 0.16 – 1.6 hectares. Then the shrimp products are sold to middlemen who sell products in retail markets or assemble and sell to processing plants for export. Pham pointed out that because the trader/local agent is acting not only as a buyer, but also as financer, their relationship with the local farmers, which he refers to as "exploitative or symbiotic", directly leads to the consequences of lack of a transparent pricing mechanism. An illustration of the shrimp marketing channel in Bentre, Vietnam is provided in Figure 4.13.

Figure 4.13. Shrimp market channel in Bentre (Pham, 2008)



The consequence of the fragmented production chain and the concentrated import and export activities is that the exporters and the traders determine the price, while the shrimp farmers only have a little margin and low profit (Charles, 2001). The implication is that if there is a transparent pricing mechanism that is provided by the existence of a working shrimp exchange, the farmers will become the most benefitted player in the market. This is in accordance with the comments from Martens (Fishpool) about salmon market mentioned in earlier chapter.

In the lower stream of the value chain, seafood processors and retailers such as supermarkets in Europe and US have well-established distribution networks and highly integrated operation. They can also reduce part of the price risk by passing it

on to the consumer. Appendix D provides some information on a selection of major shrimp producers. The exact production volume by each producer is difficult to find, but some information about the production capacity could shed some lights on the scale of these companies.

4.3.2 Cost structure

Shrimp culture can be conducted by using shrimp monoculture or poly-culture with tilapia and seaweed. But generally speaking, shrimp culture is very demanding in land usage. The yield per hectare varies depending on the production facilities (shrimp fry, feed, fertilizer, medical remedies, machinery, oil and fuel); infrastructure (transportation, canal system); human resources; investment and financing. (Pham, 2008) Figure 4.14 illustrates a typical cost structure for shrimp producer.

Figure 4.14. Cost Structure in shrimp production

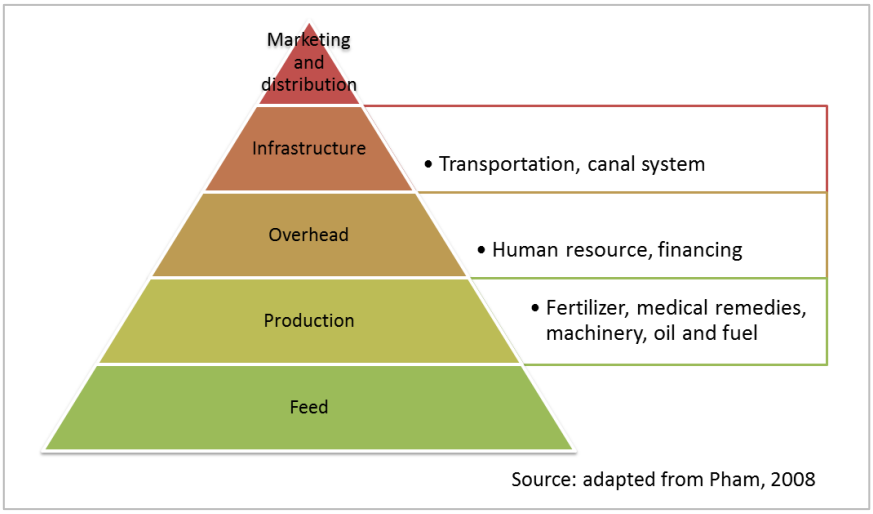
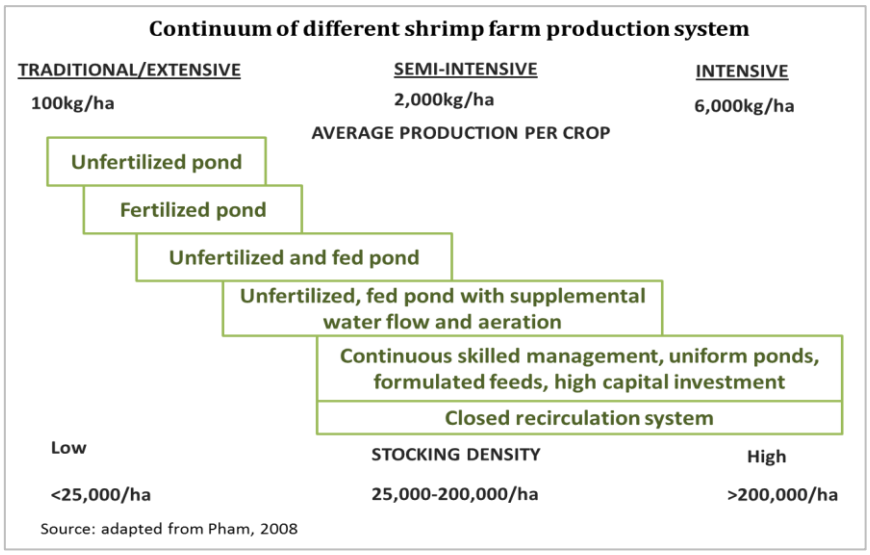


Figure 4.15 illustrates the yield per hectare based on extensive or intensive culture technologies. For 4 million metric tonnes of shrimp cultured every year in the world, even with the most intensive production technology, it would require 667,000 hectares ($= \frac{4{,}000{,}000\ mt}{6\ t/ha}$) of ponds or land or 2 million hectares ($= \frac{4{,}000{,}000\ mt}{2\ t/ha}$) with semi-intensive technology. Increasing the intensity of culture does save costs and generate higher profitability. For example, in Vietnam, an intensive pond yields US$ 4,375 to 6,875/ha in profit compared to the average of

US$ 1,666 to 1,999/ha. (MOFI, 2006) But it also increases the stress of some shrimp stocks and the risk of spreading epidemic viral diseases. (Indian Aquaculture Authority, 2001)

Figure 4.15 Continuum of different shrimp farm production system (Pham, 2008)



Although, as a high-value commodity, shrimp farming is more profitable than traditional agriculture such as rice (MOFI, 2006), shrimp pond farming is demanding on investments, therefore creating a barrier for small- and medium-sized shrimp farmers. Therefore credit financing is necessary for many investors, which adds to the cost base. Rising fuel prices and feed cost can undermine the long-term viability of shrimp culture. Normally the costs of shrimp feed constitutes 40-60 % of the total production costs. (Pham, 2008)

4.3.3 Industry powers

As established in previous section, the price of shrimp is not rising in real term; the increase of production costs could severely hinder the long-term sustainability of shrimp industry, especially in the upper stream.

Figure 4.16. Porter's 5 forces

To summarize the industry powers, we consider the shrimp farmers as the centre of Porter's five forces, as illustrated above, the bargaining power of suppliers (feed, energy, land, machinery) is relatively strong, so are the bargaining power of the customers (import and export firms, traders).

Threat of new entrants are medium, consider: 1) the financing requirement for the production facility and land is not very low; 2) the profitability of shrimp farming compared to other traditional agriculture is relatively high, therefore some new entrants will be attracted from those sectors. However, barriers to quality and technological standards, origins, traceability of products can crowd out small farmers and leads to more market integration in the future.

The threat of substitute products is medium because there are other products that can replace shrimp as a source of protein; but as a healthy source of nutrition, shrimp still has its unique charm. From a branding perspective, however, the threat to substitute could be quite high, as shrimp is still viewed as a commodity by many, therefore might not be easy to differentiate.

Overall, the competitive rivalry within the industry's upper stream can be considered as very intensive.

From the processor and importer/exporter's perspective, the supplier (the farmers) bargaining power is significantly lower. By controlling the pricing information and economies of scale, the buyers maintain good position in the industry value chain. The threat for new entrance will also be relatively low, as the capital requirement to compete with these players will be significantly higher than the upper stream.

The industry dynamics determined that the motivation for increase price transparency from owner managers is likely to be low. If the shrimp exchange were to be established, the immediate beneficiaries are the upper stream farmers. Of course, this does not rule out the possibilities of risk management motivation and other motivations for using a shrimp exchange even from a strong industry player.

4.4 Institutional Factors

Institutional factors matter to the market study because of its impact on the dynamics and long term sustainability of the industry and the market. In addition to the sector competition and over-production challenges discussed before, there are also issues with food safety, trade restrictions, overcapitalization and concerns over the environmental impacts of shrimp wild catch and culture. These institutional factors also generate uncertainty in supply and demand, creating price fluctuation of shrimp products on a local or global basis.

4.4.1 Trade barriers

In February 2005, the United States imposed definitive anti-dumping duties on imports of certain frozen warm water shrimps from Brazil, Ecuador, India, Thailand, the People's Republic of China, and the Socialist Republic of Vietnam.[16] The dumping margins range from around 4% to 113% for different companies and

[16] Amended Final Determinations and Issuance of Antidumping Duty Orders, Import Administration, the Department of Commerce, http://www.ita.doc.gov/media/FactSheet/0105/shrimp_012605.html

different countries.

In Europe, the MFN tariff for frozen shrimp was 12% and that for cooked and canned shrimp 20%. Since 1971, the European Union granted developing countries unilateral tariff reductions under the Generalized System of Preferences (GSP) to support industrialization. In 1996 Thailand's GSP benefits for shrimp was cut to half from January 1997 on and was to abolish them by 1999. Under the European Union's GSP, raw and cooked shrimp were subject to respectively up to 4.5% and 6% tariff. From 1999 on, Thai shrimp faced an MFN tariff of 12% and 20%, while other exporters maintained their GSP status. In 2001, antibiotics were found in shrimp residue shipped from East Asia, and the European Union (EU) declared a zero-tolerance policy that restricted exports especially from Vietnam and China. The EU also imposed 100% testing on shrimp from Thailand. (Debaere, 2010)

There are two important implications from this trade barrier.

First, it means that the current markets for shrimp are regionally based, especially in terms of pricing, although the trade activity is international. Debaere's (2010) research supports this implication. From the 2003 US import statistics[16], one can calculate the average import price before dumping margin. (Table 4.1)

Table 4.1. US import statistics (2003)

Country			Average Import Price ($/lbs)
PRC	volume (lbs)	169,452,220	2.47
	value ($)	419,323,287	
Vietnam	volume (lbs)	124,503,096	4.72
	value ($)	587,722,452	
Brazil	volume (lbs)	48,023,165	2.01
	value ($)	96,761,828	
Ecuador	volume (lbs)	73,112,375	2.82
	value ($)	206,052,471	
India	volume (lbs)	99,180,532	4.01
	value ($)	398,104,342	
Thailand	volume (lbs)	281,013,853	3.40
	value ($)	956,839,737	

Source: Import Administration, the Department of Commerce,

http://www.ita.doc.gov/media/FactSheet/0105/shrimp_012605.html

The dumping margin closes gaps in the prices inside the US market, but outside the US, distributors and retailers are likely to face different prices, which challenges the view of some researchers on a single price for shrimp market (eg: Vinuya, 2007).

Second, the existence of trade barrier prohibits free market and free flow of goods and hinders the realization of a coherent market place. Debaere's (2010) research supports the view that large countries through their trade policies can directly affect international prices. Although for each individual hedger, it is possible to still cross-hedge on a different market in another part of the world through advanced hedging strategies, but it means that the price index in a different geography might needs to be manipulated in complex ways before it could mean anything for them, and the existence of bureaucratic intervention create inefficiency in the market such as price distortion, price lags and unexpected price movements. This means that separate price index may be needed to achieve flexibility for the industry users. A trade-off between flexibility and trading volume must be made, which is not most favourable for the commodity exchange to succeed.

4.4.2 Eco-friendliness

Shrimp production has huge impact on local and global marine environment. As shrimps are generally cultured in land based ponds / impoundments, the large area required to meet shrimp production can sometimes lead to reduction of other crops' agriculture and loss or degradation of natural habitats such as mangrove forests. (Barbier, 2003; Barbier and Sathirathai, 2004; Pham, 2008) Disease outbreak could not only lead to short of production on a local basis, but also severely harm the local marine environment. This is appreciated now on a global basis and tremendous advances have been made globally to make shrimp culture development responsible and sustainable. (IAA, 2001)

What adds to the challenges is that shrimp culture is dominated by small-scale

operators who often lack the ability to take on the responsibility for following regulations or technical standards because of a poor economic situation or lack of knowledge or both. (Pham, 2008) They tend to focus on short-term survival of their own operation at the expense of the environment, sometimes even when they are aware of the potential consequences. Therefore in order to solve these challenges, considerable efforts and assistance must be provided by the local governments in the monitoring, forecasting and prevention of disease outbreak and environmental impact. For example, in Thailand, shrimp disease diagnosis and prevention systems are developed and incorporated with water irrigation systems by the government and are made available to the farmers. (IAA, 2001)

4.4.3 Regulation

Several international organizations are involved in the regulations on fishery products, including shrimps, for example: Food Agriculture Organization of the United Nations (FAO), Network of Aquaculture Centres in Asia-Pacific (NACA), United Nations Environment Programme (UNEP), World Bank (WB) and World Wildlife Fund (WWF). They deal with different aspects of shrimp farming such as: (i) Technical consultation on policies for sustainable shrimp culture, Bangkok 1998. (ii) Shrimp farming and the environment, World Bank 1998. (iii) Basic principles for management and development of culture toward improving the responsibility of shrimp farming, Norway 2003. (iv) International principles for responsible shrimp farming, FAO/NACA/UNEP/WB/WWF 2006. (Pham, 2008)

Food and Agriculture Organization (FAO) is revising and recommending the international practices for shrimp and prawn. The issues of focus include: to provide GMPs for processing frozen shrimp; standard for quick frozen shrimp and prawns; standard for canned shrimp and prawns; codex guidelines for the hygiene practices for culture products, etc.

HACCP (Hazard Analysis and Critical Control Point System)[17]

The Hazard Analysis and Critical Control Point System (HACCP) is a prevention-based food safety system created by FAO. It is a management system in which food safety is addressed through the analysis and control of biological, chemical, and physical hazards from raw material production, procurement and handling, to manufacturing, distribution and consumption of the finished product. It is equivalent to EEC's own-checks and Canada's QMP. Their common objectives are:

- Emphasize the importance of "Hazards" and the needs to identify and analyze them.
- Attention on "Critical Control Points"
- Include similar methods of monitoring and record keeping, taking corrective actions when risks to food safety are found, providing documented evidence.

CODEX Alimentarius[18]

The Codex Alimentarius, or the food code, has become the seminal global reference for consumers, food producers and processors, national food control agencies, and the international food trade. The code has had an enormous impact on the thinking of food producers and processors as well as on the awareness of the end users-the consumers.

The significance of the food code for consumer health protection was underscored in 1985 by the United Nations Resolution 39/248, whereby guidelines were adopted for use in the elaboration and reinforcement of consumer protection policies.

The Codex Alimentarius has relevance to the international food trade. Therefore, the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS) and the Agreement on Technical Barriers to Trade (TBT) both encourage the

17 http://www.fda.gov/downloads/Food/GuidanceComplianceRegulatoryInformation/GuidanceDocuments/Seafood/UCM251970.pdf

18 http://www.codexalimentarius.net/download/standards/104/CXS_037e.pdf

international harmonization of food standards. A product of the Uruguay Round of multinational trade negotiations, the SPS Agreement cites Codex standards, guidelines and recommendations as the preferred international measures for facilitating international trade in food. As such, Codex standards have become the benchmarks against which national food measures and regulations are evaluated within the legal parameters of the Uruguay Round Agreements.

Alimentarius is comprised of

- Food standards for commodities
- Codes of hygienic or technological practice
- Pesticides evaluated
- Limits for pesticide residues
- Guidelines for contaminants
- Food additives evaluated
- Veterinary drugs evaluated

Regional Import Regulations and Standards for fishery products

Countries and regions including EU, Japan, Australia, New Zealand and Canada have adopted vital rules in the process of product importing and inspection fishery products, including microbiological standards.

Council Directive 92/48/ EEC specifies rules or committee's orders concerning appropriate hygienic raw material acquisition and preservation; extension of raw material products, flavoring and frozen product preservation; regulations for food safety, general monitoring and additional inspection; prevention of import of living animals, which can be harmful to plants, from entering the EU, as well as the prevention of plant diseases from spreading out in the EU countries; and packing, preservation, and product delivery. Council Directive 79/112/EEC specifies rules or committee's order concerning food products' labeling. EC Directive 90/675 specifies rules or committee's order concerning import and export of animal products in 1996.

In Japan, the laws that control imports include Food Sanitation Law and Law concerning Standardization and Proper Labeling of Agricultural and Forestry Products controlled by Japanese Agricultural Standards, JAS.

Japan has developed and improved systems in food safety and quality by introducing Pre-Certification System. Besides of sharing many common characteristics with HACCP, this system mainly focuses on product hygiene.

4.4.4 Natural disaster

Shrimp culture is risky. Weather, ecological conditions, vulnerability to diseases can severely reduce crops, as in the case for China in 1993, Thailand in 1996 and 1997, and Ecuador in 1999. (Josupeti, 2004; Debaere, 2010)

Natural disaster such as cyclone, earthquake, tsunami and other unexpected events such as the Fukushima nuclear power plant explosion in March, 2011 could cause sudden changes in supply and demand, creating uncertainties in prices of seafood including shrimps. After the Fukushima event, Japanese seafood experienced tremendous difficulties with push-backs from consumers and importers. Indian banned Japanese seafood after the nuclear power plant pumped toxic water into the Pacific Ocean[19] in April. The seafood processors in the country estimated $23 million[20] in recovery from the damage, with many other farmers' losses and long-term impact on consumer's confidence still unaccounted for. Meanwhile, across the Atlantic, in a different market, Chilean salmon sees higher demand since their Asian opponent are forced to close down 20% of their facilities[21].

In the present of natural disasters, there is very little that businesses could have done on the spot to prevent it from happening. But by diversifying investments and use risk management tools, businesses might be able to avoid large financial losses caused by the change in prices and fundamental supply and demand.

[19] IntraFish, 06.04.2011, http://www.intrafish.com/global/news/article1255389.ece

[20] IntraFish, 22.06.2011, http://www.intrafish.com/global/news/article1255782.ece

[21] IntraFish, 30.03.2011, http://www.intrafish.com/global/news/article1269030.ece

5. Shrimp Cash Market Prices

In the previous chapter, the author discussed the characteristics of the shrimp market from an industry structure perspective, focusing on the market size, segments, key players, industry value chain, industry power and other institutional factors. It laid the ground for the potentials and the challenges in this particular market and also provided some understanding of the possible motivation (or lack of motivation) for the different players in the market. Yet we are studying the financial derivatives of shrimp market, some major characteristics of the market including volatility and degree of integration needs to be further analyzed using the available price information in the market.

Therefore in this chapter the author attempts to explore the volatility and the degree of market integration with the use of econometric techniques. Using cash market prices of P.vannamei and P.monodon, an empirical study of their relationships is conducted. The purpose is to understand whether the two major species are well correlated – either integrated in the same market or can be used to cross-hedge one another. In addition, a comparable study with the salmon market is given in order to illustrate the volatility. This can be used as an explanation of whether there is sufficient interest or motivation in managing price risk in this market.

For readers with no previous knowledge of econometrics, the stationary test in this chapter could be a little technical, but the findings and conclusions should be quite easy to understand.

5.1 A quick review of using econometrics for time series data

5.1.1 Correlation

A useful statistic indicator of the relationship between two variables is the correlation.

The correlation between two variables x and y can be defined as

$$\rho_{x,y} = \frac{Cov(x,y)}{\sigma_x \sigma_y} = \frac{E[(x-\mu_x)(y-\mu_y)]}{\sigma_x \sigma_y} \quad \textbf{(5.1)}$$

where σ_x and σ_y are the standard deviations of x and y, $Cov(x,y)$ is the covariance between x and y and μ_x and μ_y are the means of x and y. (Hull, 2008)

Correlations are useful because they can indicate a predictive relationship that can be exploited in practice. However, a statistical dependence is not sufficient to demonstrate the presence of a causal relationship.

5.1.2 Simple Linear Regression

To study the causal relationship between two variables with a sample of observations, it is more reliable to use the simple linear regression model.

Assumptions[22]

A1: In this model, first of all, we assume that the population model is ***linear in parameters***, which means that the relationship between dependent variable y and independent variable x can be illustrated by the following equation:

$$y = \beta_0 + \beta_1 x + u \quad \textbf{(5.2)}$$

where

β_0 is the population constant/intercept parameter.

β_1 is the population slope parameter.

u is the error term, represents the factors other than x that affect y.

With u fixed, x has a linear effect on y (ceteris paribus), and $\Delta y = \beta_1 \Delta x$. When $\ln(y)$ and $\ln(x)$ are used instead of y and x, β_1 becomes the elasticity of y with respect to x, and a 1% change in x gives rise to $\beta_1\%$ change in y, or $\%\Delta y = \beta_1 \%\Delta x$. If y and x are relative growth, as in the case we will be using in

[22] Ragnhild Balsvik, 2010, Lecture notes, ECO 402

later section, then β_1 is the elasticity of the relative growth, and a 1% change in the growth of x gives rise to $\beta_1\%$ change in the growth of y.

A2: If we have a random sample of size n, $\{(x_i, y_i): i = 1,2, \dots, n\}$ follow the population model from Assumption 1. This means that each unit from the underlying population has ***equal probability*** of being in the sample.

A3: The sample outcomes of the explanatory variable x are ***not constant***. This is because without variation in x, it is hard to figure out how a change in x may affect y.

A4: The expected value of the error term u is the same for all possible values of x. u is mean independent of x. Moreover, since we assume in this model that x is all we need to explain y, u should have a mean of 0. These two points together formed the ***zero conditional mean*** assumption. In mathematical term, this means:

$$E(u|x) = E(u) = 0 \quad \textbf{(5.3)}$$

A4 is crucial for a causal interpretation of the simple regression model. Only if A4 holds can we argue that the slope parameter in the simple regression model estimates the ceteris paribus effect of x on y.

A5: The error u has the same variance given any values of the explanatory variable x, $Var(u|x) = \sigma^2$.

Assumptions 1-5 are called the ***Gauss-Markov assumptions*** (Woodridge, 2009). Under these assumptions, the estimated parameters, in this case, $\widehat{\beta_0}$ and $\widehat{\beta_1}$ are the ***best linear unbiased estimators (BLUEs)*** of the population parameters β_0 and β_1.

A6: A stronger assumption of the error term is that the population error u is independent of the explanatory variable x and is normally distributed with mean zero and variance σ^2, or $u \sim Normal(0, \sigma^2)$. It can also be said that the error term is i.i.d (independently and identically distributed). This assumption enables us

to use the $p-value$ of a regression result to determine if the estimators are statistically significant – a low $p-value$ (close to zero) is an indicator that the estimators are statistically significant.

The OLS estimators

The ***ordinary least squares*** method is used to estimate the intercept and slope parameters. The OLS estimator chooses $\widehat{\beta_0}$ and $\widehat{\beta_1}$ to minimize

$$\sum_{i=0}^{n} \widehat{u_i}^2 = \sum_{i=0}^{n} (y_i - \widehat{\beta_0} - \widehat{\beta_1} x_i)^2. \quad \textbf{(5.4)}$$

Measure of fitness

The fitness of the estimated OLS parameters can be measured through the ***R-Square*** of the regression, sometimes called the coefficient of determination.

$$R^2 \equiv \frac{SSE}{SST} \equiv 1 - \frac{SSR}{SST} = \frac{\sum_{i=0}^{n} (\hat{y}_i - \bar{y})^2}{\sum_{i=0}^{n} (y_i - \bar{y})^2} \quad \textbf{(5.5)}^{23}$$

5.1.3 Stationary tests

Definition and statistic importance of stationarity

The usual properties of the OLS estimators in regression analysis are based on the assumption that the times series variables involved are ***stationary stochastic processes***. A stochastic process (time series) y_t is ***stationary*** if its mean and variance are constant over time, and the covariance between two values from the series depends only on the length of time separating the two values, and not on the actual times at which the variables are observed. If this assumption is violated, then the econometric consequences could be quite severe, leading to OLS estimators, test statistics and predictors are unreliable, or leading to ***spurious regression***.

Many macroeconomic, monetary, and financial data are essentially non-stationary time series data. Because the underlying conditions of these data

[23] Total sum of squares (SST), the explained sum of squares (SSE), and the residual sum of squares (SSR)

changes with time, therefore it is dangerous to assume that they are equal samples of the same population. Often these data consist of a time trend. They might appear to have strong causal relationship with each other, but in fact, it could be that they are changing together because they are taken at different time point (representing different underlying conditions). Therefore the correlation between them is not essentially caused by each other.

Autocorrelation function

One way to detect non-stationarity is to run a ***correlogram*** in econometric software such as Stata. Take a time lap of s, plot the sample correlations $\widehat{\rho_s}$ against s, we can observe the correlation between a value and the values further in the past. If the autocorrelations dies out slowly, then it means that the current values are strongly influenced by the values in the past. Similarly, if the autocorrelations dies out quickly, then the current values are less correlated with the values in the past.

Dickey-Fuller tests

Alternatively, we can use a Dickey-Fuller test to compare the absolute value of the test statistic $Z(t)$ for the hypothesis that $\gamma = 0$ (in formula 5.6, 5.7, 5.8) to the critical value under certain confidence levels. (Dickey and Fuller, 1979) If the $Z(t)$ is smaller than the critical value, then the null hypothesis of non-stationarity $H_0: Unit\ Root$ will be rejected, and the time series data should be considered stationary. If the $Z(t)$ is greater than the critical value, then the time series should be considered stationary.

In Stata, we can perform three standard Dickey-Fuller tests, which will be used later:

$H_0: Unit\ Root$ (non-stationary)

$H_1: Non\ Unit\ Root$ (stationary)

(1) No constant $\Delta y_t = \gamma y_{t-1} + v_t$ **(5.6)**

(2) With constant (drift) $\Delta y_t = \alpha_0 + \gamma y_{t-1} + v_t$ **(5.7)**

(3) With constant (drift) and deterministic time trend

$$\Delta y_t = \alpha_0 + \alpha_1 t + \gamma y_{t-1} + v_t \qquad \textbf{(5.8)}$$

Cointegration test

Generally speaking, non-stationary time series should not be used in regression, because the results could be spurious. One exception is if they are cointegrated, which can be a nice alternative to explain their relationship.

When two series are not stationary, we can study their absolute growth by taking the first difference (eg: $y_t - y_{t-1}$ and $x_t - x_{t-1}$). If the absolute growth of the series are stationary, then we say that these series are integrated of order 1, or $I(1)$. If the linear combination of two $I(1)$ series is $I(0)$, then they are said to be cointegrated.

If y_t and x_t are cointegrated, it implies that they share similar stochastic trends, and since their difference is stationary, they never diverge too far from each other and they exhibit long-term equilibrium relationship. This can easily been tested by examine the residuals from the OLS regression of one series on the other. If the two series are cointegrated, the residuals should be stationary.

5.1.4 Volatility

Volatility is a measure of the uncertainty about the returns provided by an instrument or a product. It can be defined as the standard deviation of the return provided by the instrument in one year when the return is expressed using continuous compounding. (Hull, 2008)

Define $n+1$: Number of observations

P_i: Price at end of ith interval, with $i = 1,2,\dots,n$

τ: Length of time interval in years

Let $u_i = \ln\left(\frac{P_i}{P_{i-1}}\right), for\ i = 1,2,\dots,n$ **(5.9a)**

The usual estimate, s, of the standard deviation of the u_i is given by

$s = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(u_i - \bar{u})^2}$, where $\bar{u}$ is the mean of u_i. **(5.9b)**

Then s is an estimation of the standard deviation of the u_i, $\sigma\sqrt{\tau}$. Therefore annualized volatility σ can be estimated as $\hat{\sigma} = \frac{s}{\sqrt{\tau}}$ **(5.9c)**.

As discussed in previous chapters, volatility is a crucial indicator of the market risks and an important measure to understand the motivation for risk management in the market.

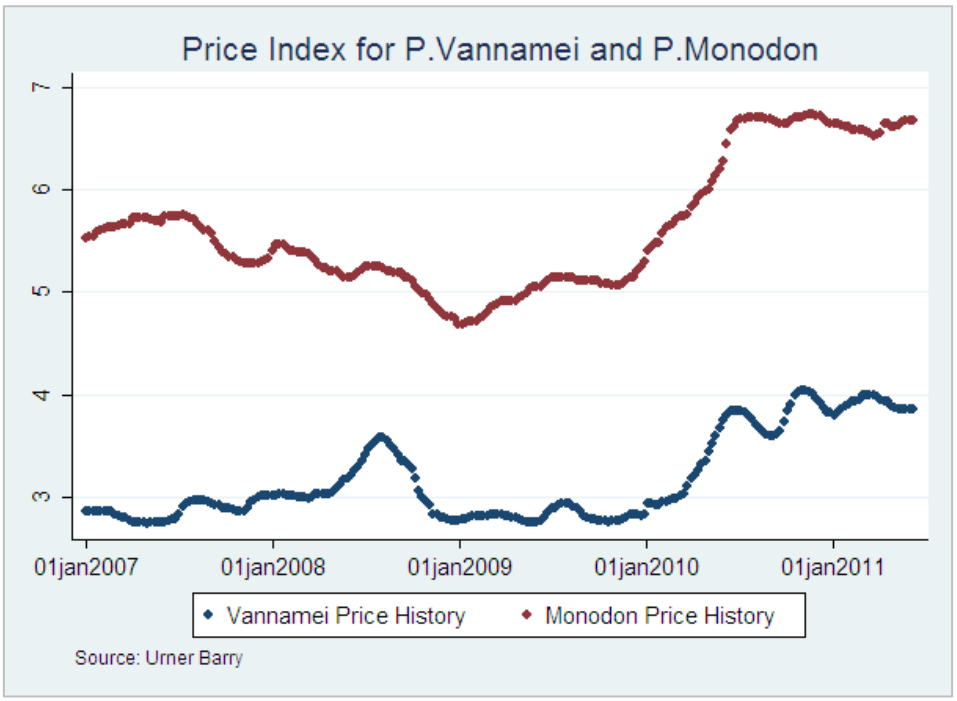
5.2 Input data

5.2.1 Shrimp prices

In this paper, the shrimp prices used are 5 years weekly Penaeus Vannamei and Penaeus Monodon prices reported by Urner Barry Survey, with starting date of 01/01/2007 and ending date of 06/06/2011. (Appendix A)

Figure 5.1 illustrates the actual price indices for these two shrimp species over time.

Figure 5.1. Price Indices for P.Vannamei and P.Monodon



Denote P.vannamei price index as Vann and P.monodon price index as Mono in Stata. Table 5.1 summarized the key statistics of the price observations.

Tabel 5.1. Key stats for price indices

Variable	Obs	Mean	Std. Dev.	Min	Max
Vann	232	3.174698	.4277869	2.74	4.05
Mono	232	5.622198	.6349659	4.68	6.74

From Figure 5.1 we can see that the mean-reverting characteristics of stationary series are not very obvious. From previous chapters we can also reasonable suspect that there might be upwards drift, especially for P.vannamei prices, as the graph shows. Therefore it is possible that we are dealing with non-stationary time series data. We confirm this suspicion with visual inspection of the autocorrelations in Figure 5.2 and 5.3. The autocorrelation signal takes a while to die away. This means that prices in the past are correlated with the current prices. Dickey-Fuller tests can further prove that the shrimp prices are non-stationary.

Figure 5.2. Autocorrelations of P.Vannamei

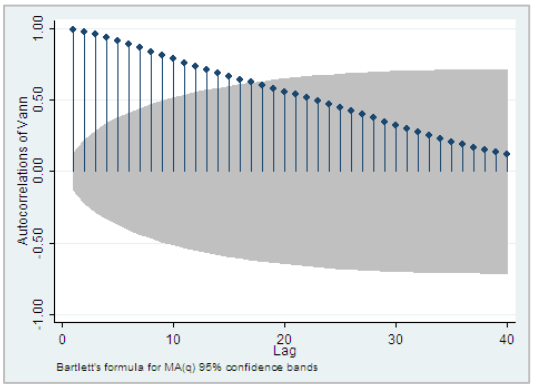
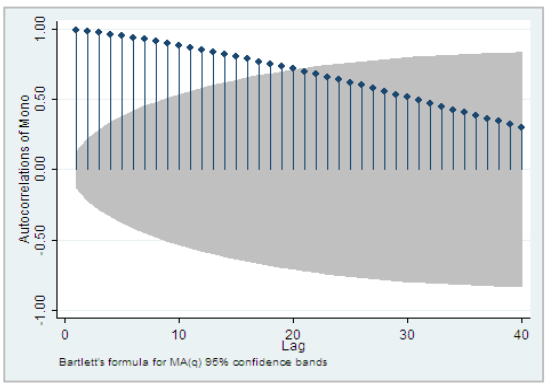


Figure 5.3. Autocorrelations of P.Monodon



This means that using the prices of the two shrimp species directly in regression could lead to spurious regression. In order to solve this problem, we need to study the relationship of the growths of the two price series, rather than the prices themselves.

There are two ways to do so. First, we study the relationship between the relative growths of the two price series. Denote $p_t = \ln(P_t)$ at a given time t, the lg growth $\delta p_t = \ln(P_t/P_{t-1})$ can be interpreted as the percentage change or

the returns of P_t. If δp_t of the two price series are stationary, then we can perform a regression on the relative growth.

Second, by taking the first difference (denote as $\Delta p_t = P_t - P_{t-1}$) of both series, we can study the relationship between their absolute growths. If the first difference of the price series are stationary, then they can be used in regression exercise, and the price series are integrated of order 1, or $I(1)$. In addition, if both price series are $I(1)$, a cointegration test will be included.

5.2.2 Stationarity tests for relative growth

Figure 5.2 and Table 5.2 illustrate the historical movements and key statistics of the lg growth $\delta p_t = \ln(P_t/P_{t-1})$ for P.vannamei and P.monodon. This is followed by the DF tests from Stata. Denote lgg[Var] for lg growth of the variables in Stata.

Figure 5.2. Historical lg growth of P.Vannamei and P.Monodon

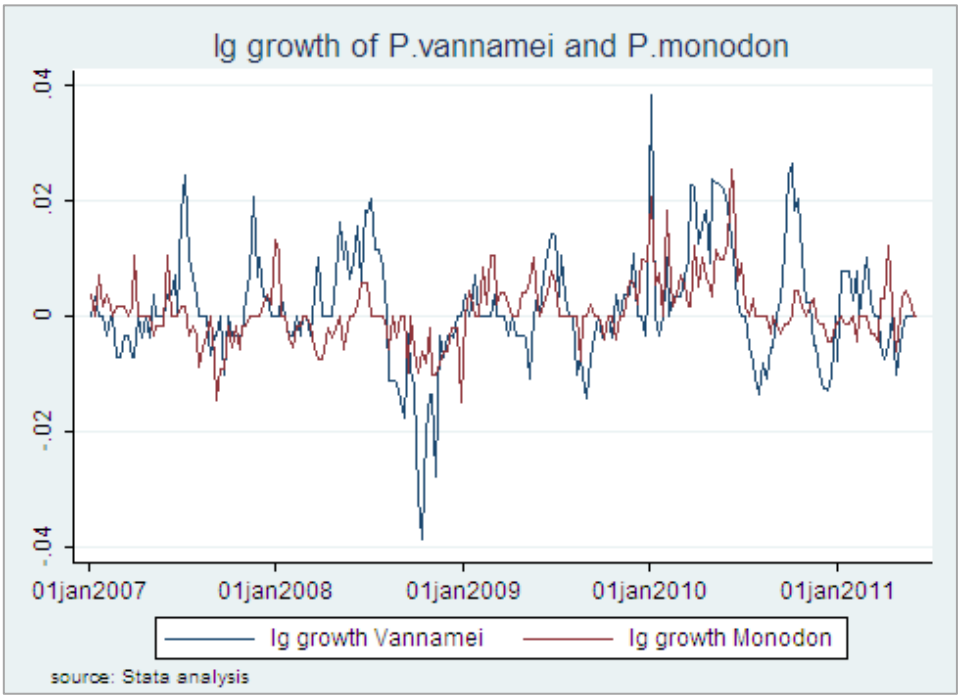


Table 5.2. Key stats for the lg growths

```
. sum lggVann lggMono
```

Variable	Obs	Mean	Std. Dev.	Min	Max
lggVann	231	.001298	.0097419	-.0384663	.0381329
lggMono	231	.0008179	.005585	-.0148465	.0251586

(1) No constant

Table 5.3. Dickey-Fuller Test for lg growth of P.Vannamei 1

```
. dfuller lggVann, reg noconst

Dickey-Fuller test for unit root                    Number of obs   =       230

                                 ---------- Interpolated Dickey-Fuller ----------
                    Test         1% Critical       5% Critical      10% Critical
                 Statistic           Value             Value            Value
------------------------------------------------------------------------------
 Z(t)            -5.723             -2.583            -1.950           -1.619
------------------------------------------------------------------------------

------------------------------------------------------------------------------
    D.lggVann |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
--------------+---------------------------------------------------------------
      lggVann |
          L1. |   -.2502784   .0437299    -5.72   0.000    -.3364427    -.164114
------------------------------------------------------------------------------
```

Table 5.4. Dickey-Fuller Test for lg growth of P.Monodon 1

```
. dfuller lggMono, reg noconst

Dickey-Fuller test for unit root                    Number of obs   =       230

                                 ---------- Interpolated Dickey-Fuller ----------
                    Test         1% Critical       5% Critical      10% Critical
                 Statistic           Value             Value            Value
------------------------------------------------------------------------------
 Z(t)            -6.991             -2.583            -1.950           -1.619
------------------------------------------------------------------------------

------------------------------------------------------------------------------
    D.lggMono |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
--------------+---------------------------------------------------------------
      lggMono |
          L1. |   -.3508702   .0501897    -6.99   0.000    -.4497629   -.2519776
------------------------------------------------------------------------------
```

(2) With constant (i.e. drift)

Table 5.5. Dickey-Fuller Test for lg growth for P.Vannamei 2

```
. dfuller lggVann, regress

Dickey-Fuller test for unit root                    Number of obs   =       230

                                 ---------- Interpolated Dickey-Fuller ----------
                    Test         1% Critical       5% Critical      10% Critical
                 Statistic           Value             Value            Value
------------------------------------------------------------------------------
 Z(t)            -5.769             -3.467            -2.881           -2.571
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

------------------------------------------------------------------------------
    D.lggVann |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
--------------+---------------------------------------------------------------
      lggVann |
          L1. |   -.2547608   .0441597    -5.77   0.000    -.3417741   -.1677474
        _cons |    .0003321    .000434     0.77   0.445    -.0005231    .0011873
------------------------------------------------------------------------------
```

Table 5.6. Dickey-Fuller Test for lg growth for P.Monodon 2

```
. dfuller lggMono, regress

Dickey-Fuller test for unit root                    Number of obs   =       230

                                 ---------- Interpolated Dickey-Fuller ----------
                    Test         1% Critical       5% Critical      10% Critical
                 Statistic           Value             Value            Value
------------------------------------------------------------------------------
 Z(t)            -7.057             -3.467            -2.881           -2.571
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

------------------------------------------------------------------------------
   D.lggMono |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     lggMono |
         L1. |  -.3580478   .0507358    -7.06   0.000    -.4580187   -.2580768
             |
       _cons |   .0002784   .0002864     0.97   0.332    -.0002859    .0008427
------------------------------------------------------------------------------
```

(3) With constant (drift) and deterministic time trend

Table 5.7. Dickey-Fuller Test for lg growth for P. Vannamei 3

```
. dfuller lggVann, reg trend

Dickey-Fuller test for unit root                    Number of obs   =       230

                                 ---------- Interpolated Dickey-Fuller ----------
                    Test         1% Critical       5% Critical      10% Critical
                 Statistic           Value             Value            Value
------------------------------------------------------------------------------
 Z(t)            -5.776             -3.997            -3.433           -3.133
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

------------------------------------------------------------------------------
   D.lggVann |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     lggVann |
         L1. |  -.2564556   .0443993    -5.78   0.000     -.343943   -.1689682
       _trend |   2.91e-06   6.51e-06     0.45   0.655    -9.92e-06    .0000158
       _cons |  -2.29e-06   .0008647    -0.00   0.998    -.0017062    .0017016
------------------------------------------------------------------------------
```

Table 5.8. Dickey-Fuller Test for lg growth for P.Monodon 3

```
. dfuller lggMono, reg trend

Dickey-Fuller test for unit root                    Number of obs   =       230

                                 ---------- Interpolated Dickey-Fuller ----------
                    Test         1% Critical       5% Critical      10% Critical
                 Statistic           Value             Value            Value
------------------------------------------------------------------------------
 Z(t)            -7.295             -3.997            -3.433           -3.133
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

------------------------------------------------------------------------------
   D.lggMono |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     lggMono |
         L1. |  -.3786563   .0519053    -7.30   0.000     -.480934   -.2763785
       _trend |   7.54e-06   4.37e-06     1.73   0.085    -1.06e-06    .0000161
       _cons |   -.000576   .0005708    -1.01   0.314    -.0017007    .0005488
------------------------------------------------------------------------------
```

Comparing the test statistic $Z(t)$ with the critical value, we can reject the null hypothesis of non-stationarity for all the Dickey-Fuller specifications (1), (2) and (3) at 1% level. Therefore the tests indicate that the relative growths of the price series are stationary.

5.2.3 Stationarity tests for first difference

Figure 5.3 and Table 5.9 illustrate the historical movements and key statistics of the absolute growth $(\Delta p_t = P_t - P_{t-1})$ for P.vannamei and P.monodon. This is followed by the DF tests from Stata. Denote dt[Var] for first difference of the variables in Stata.

Figure 5.3. First difference of P.Vannamai and P.Monodon

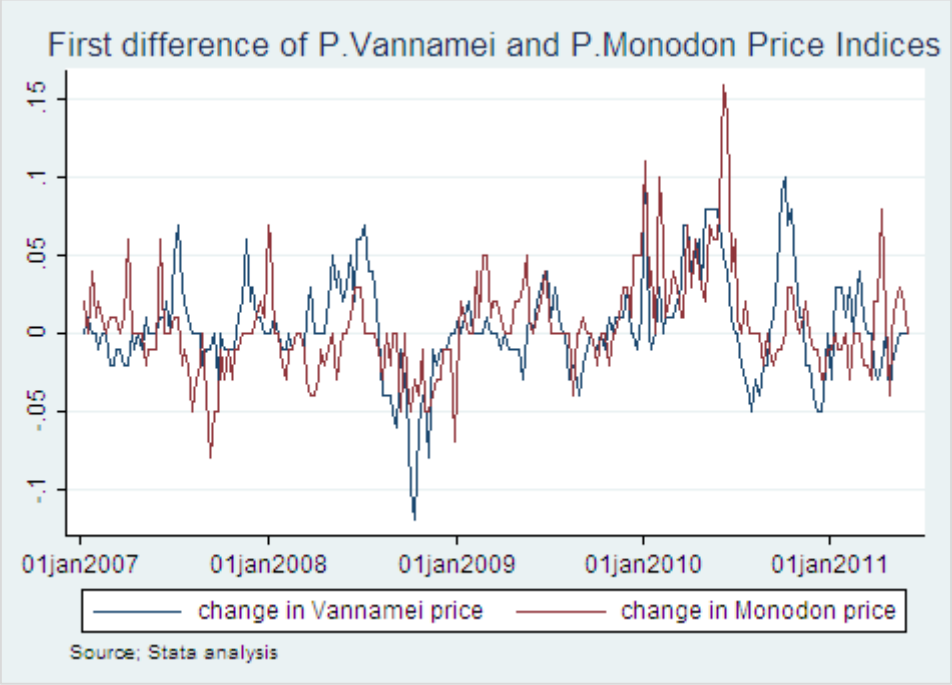


Table 5.9. Key stats for first difference of P.Vannamei and P.Monodon

Variable	Obs	Mean	Std. Dev.	Min	Max
dtVann	231	.004329	.0320916	-.12	.11
dtMono	231	.0049784	.0315522	-.08	.16

(1) No constant

Table 5.10. Dickey-Fuller Test for first difference of P.Vannamei 1

```
. dfuller dtVann, reg noconst

Dickey-Fuller test for unit root                    Number of obs   =       230

                     ---------- Interpolated Dickey-Fuller ---------
                Test         1% Critical       5% Critical      10% Critical
             Statistic           Value             Value            Value
------------------------------------------------------------------------------
 Z(t)          -5.395            -2.583            -1.950           -1.619
------------------------------------------------------------------------------

------------------------------------------------------------------------------
    D.dtVann |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      dtVann |
         L1. |   -.225539   .0418048    -5.40   0.000    -.3079102   -.1431677
------------------------------------------------------------------------------
```

Table 5.11. Dickey-Fuller Test for first difference of P.Monodon 1

```
. dfuller dtMono, reg noconst

Dickey-Fuller test for unit root                    Number of obs   =       230

                     ---------- Interpolated Dickey-Fuller ---------
                Test         1% Critical       5% Critical      10% Critical
             Statistic           Value             Value            Value
------------------------------------------------------------------------------
 Z(t)          -6.890            -2.583            -1.950           -1.619
------------------------------------------------------------------------------

------------------------------------------------------------------------------
    D.dtMono |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      dtMono |
         L1. |   -.342565   .0497186    -6.89   0.000    -.4405294   -.2446005
------------------------------------------------------------------------------
```

(2) With constant (i.e. drift)

Table 5.12. Dickey-Fuller Test for first difference for P.Vannamei 2

```
. dfuller dtVann, regress

Dickey-Fuller test for unit root                    Number of obs   =       230

                     ---------- Interpolated Dickey-Fuller ---------
                Test         1% Critical       5% Critical      10% Critical
             Statistic           Value             Value            Value
------------------------------------------------------------------------------
 Z(t)          -5.439            -3.467            -2.881           -2.571
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

------------------------------------------------------------------------------
    D.dtVann |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      dtVann |
         L1. |  -.2296791   .0422298    -5.44   0.000    -.3128898   -.1464685
             |
       _cons |   .0009986   .0013676     0.73   0.466    -.0016961    .0036933
------------------------------------------------------------------------------
```

Table 5.13. Dickey-Fuller Test for first difference for P.Monodon 2

```
. dfuller dtMono, regress

Dickey-Fuller test for unit root                    Number of obs   =       230

                         ------------ Interpolated Dickey-Fuller ------------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic         Value             Value            Value
------------------------------------------------------------------------------
 Z(t)            -6.969           -3.467            -2.881           -2.571
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000
```

D.dtMono	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
dtMono L1.	-.3507316	.0503309	-6.97	0.000	-.4499048	-.2515584
_cons	.0016667	.0016078	1.04	0.301	-.0015013	.0048347

(3) With constant (drift) and deterministic time trend

Table 5.14. Dickey-Fuller Test for first difference of P.Vannamei 3

```
. dfuller dtVann, reg trend

Dickey-Fuller test for unit root                    Number of obs   =       230

                         ------------ Interpolated Dickey-Fuller ------------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic         Value             Value            Value
------------------------------------------------------------------------------
 Z(t)            -5.446           -3.997            -3.433           -3.133
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000
```

D.dtVann	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
dtVann L1.	-.2313199	.0424727	-5.45	0.000	-.315011	-.1476288
_trend	8.94e-06	.0000205	0.44	0.664	-.0000315	.0000494
_cons	-.0000264	.0027242	-0.01	0.992	-.0053943	.0053415

Table 5.15. Dickey-Fuller Test for first difference for P.Monodon 3

```
. dfuller dtMono, reg trend

Dickey-Fuller test for unit root                    Number of obs   =       230

                         ------------ Interpolated Dickey-Fuller ------------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic         Value             Value            Value
------------------------------------------------------------------------------
 Z(t)            -7.210           -3.997            -3.433           -3.133
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000
```

D.dtMono	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
dtMono L1.	-.3715843	.0515387	-7.21	0.000	-.4731397	-.2700289
_trend	.0000424	.0000245	1.73	0.085	-5.85e-06	.0000907
_cons	-.0031269	.003198	-0.98	0.329	-.0094284	.0031747

Comparing the test statistic $Z(t)$ with the critical value, we can reject the null hypothesis of non-stationarity for all the Dickey-Fuller specifications (1), (2) and (3) at 1% level. Therefore the tests indicate that the absolute growth of the price series are stationary, so both price series are $I(1)$.

5.2.4 Test for cointegration

Since both P.vannamei and P.monodon price index are $I(1)$, it makes it interesting to see if they are cointegrated.

Below are the output from Stata.

Table 5.16. Regression on P.Vannamei and P.Monodon, including a time trend

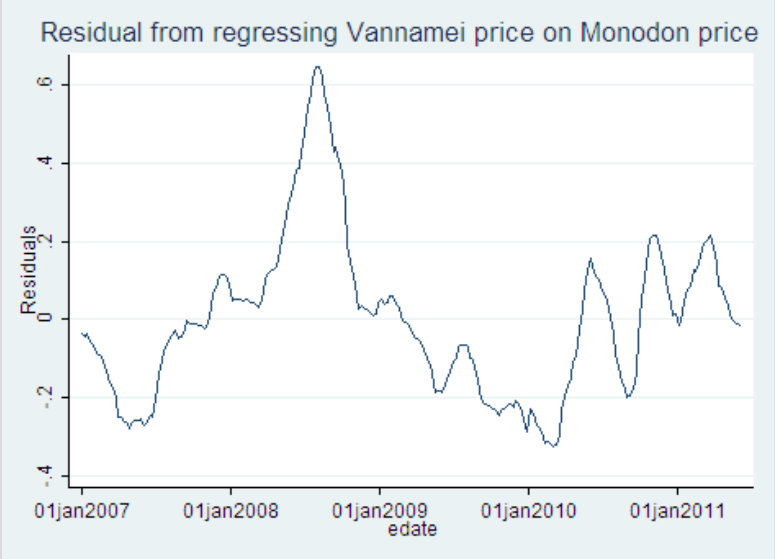
```
. reg Vann Mono t
```

Source	SS	df	MS		
Model	32.5743531	2	16.2871765	Number of obs	= 232
Residual	9.6990277	229	.042353833	F(2, 229)	= 384.55
				Prob > F	= 0.0000
				R-squared	= 0.7706
				Adj R-squared	= 0.7686
Total	42.2733808	231	.183001648	Root MSE	= .2058

Vann	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Mono	.4381572	.0260355	16.83	0.000	.3868575	.4894569
t	.002069	.0002463	8.40	0.000	.0015837	.0025543
_cons	.4702532	.1327131	3.54	0.000	.2087583	.7317481

Figure 5.4 shows the residual from the regression.

Figure 5.4. Residuals plot



Denote the residuals as u_1. Table 5.17 gives the Dickey-Fuller test of the residuals.

Table 5.17. Dickey-Fuller test for the residuals

```
. summ u1

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
          u1 |        232   -2.29e-10    .2049076   -.3255846   .6500071

. dfuller u1, reg noconst

Dickey-Fuller test for unit root                   Number of obs   =       231

                     ------------ Interpolated Dickey-Fuller ------------
                Test         1% Critical       5% Critical      10% Critical
             Statistic           Value             Value            Value
-------------------------------------------------------------------------------
Z(t)            -1.087            -2.583            -1.950           -1.619

------------------------------------------------------------------------------
        D.u1 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          u1 |
         L1. |  -.0101709   .0093576    -1.09   0.278    -.0286086    .0082667
------------------------------------------------------------------------------
```

The Dickey-Fuller test shows that the test statistic $Z(t)$ is bigger than the critical value at 10% level, therefore we cannot reject the null hypothesis of non-stationarity, which means that the prices of P.vannamei and P.monodon are not cointegrated.

5.3 Correlation

Applying formula 5.1 (page 67), the correlations of relative changes and absolute changes between P.vannamei and P.monodon prices are calculated in table 5.18.

Table 5.18. Correlations between P.vannamei and P.monodon price changes

Correlations	
Absolute changes	Relative changes
0.41	0.42

Correlations of about 40% indicate that the changes of two shrimp prices are not independent from each other. It is a nice property for cross-hedging possibilities. But it does not equal to a causal relationship between the two. They could be both driven by similar underlying conditions such as income, inflation, production, demand, etc. To further understand if the two shrimp markets are integrated, we need to rely more on the regression analysis.

5.4 OLS Regression

The tests above give us two options in performing OLS regressions to further study the relationships of the two shrimp prices in the long term. First, we can study the relationship between the relative growths of the two prices; second, we can study the absolute growth of the two prices. So first we will try to establish some models to illustrate the price relationships of the two shrimps using the OLS regressions. Then, we will discuss the implications of these regressions and possible ways to improve them in the future.

5.4.1 Use relative growth

Assume there are T observations, in this thesis, let $\delta(x_t) = \ln x_t / \ln x_{t-1}$, $t \in (0, T)$.

Dependent variable: $y = \delta(P.Vanamei\ Price\ Index)$

Independent variable: $x = \delta(P.Monodon\ Price\ Index)$

Table 5.19 and 5.20 summarize the regression results and the covariance matrix.

Table 5.19. Regression on lg growth of P. Vannamei and P.Monodon

```
. reg lggVann lggMono
```

Source	SS	df	MS		
Model	.003862501	1	.003862501	Number of obs =	231
Residual	.017965341	229	.000078451	F(1, 229) =	49.23
				Prob > F =	0.0000
				R-squared =	0.1770
				Adj R-squared =	0.1734
Total	.021827841	230	.000094904	Root MSE =	.00886

lggVann	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lggMono	.733753	.104572	7.02	0.000	.5277066	.9397994
_cons	.0006979	.000589	1.18	0.237	-.0004627	.0018585

Table 5.20. Covariance Matrix of the Coefficients of the Regression – lg growth

```
. vce

Covariance matrix of coefficients of regress model

       e(V) |    lggMono       _cons
------------+------------------------
   lggMono |   .01093531
     _cons |  -8.944e-06   3.469e-07
```

Adjusted R-square of 17% (Table 5.19) suggests that 17% of the percentage change of P.vannamei price can be explained by the percentage change of P.monodon price. A small $p - value$ suggests that the coefficient is statistically significant. Therefore the relationship between P.vannamei and P.monodon can be illustrated in the pricing model below:

Pricing Model Proposition 1 – using relative growth:

$$\boldsymbol{\delta(P.Vannamei) = 0.73\,\delta(P.Monodon)} \qquad \boldsymbol{(5.10)}$$

Model 5.10 means that the price changes of P.vannamei and the price changes of P.monodon are positively correlated: a 1% change in P.monodon price results in a 0.73% change in P.vannamei price in the same direction. With 95% of confidence we can predict that a 1% of price change in P.monodon would result in 53% to 94% of price change in P.vannamei (Table 5.19). The constant is dropped since it is too small.

Figure 5.5. Actual vs Predicted P.Vannamei lg growth

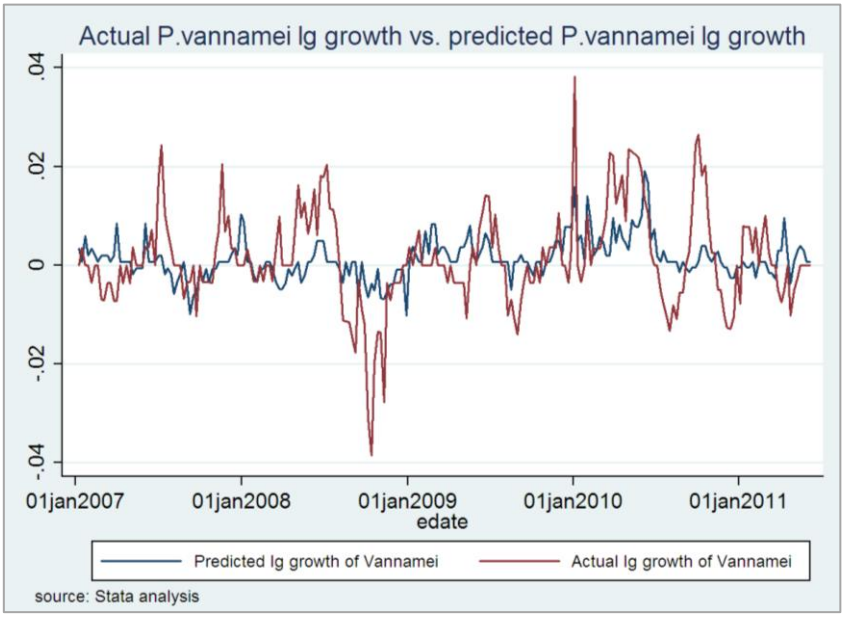


Figure 5.5 illustrates the actual and predicted P.vannamei lg growth. From the graph, it appears that the predicted values reflect some of the direction of the price movements, but are much smoother than the actual changes. This is reflected in a low adjusted R-square, meaning that a large part of the price movements of P.vannamei are not explained by the price change of P.monodon.

5.4.2 Use absolute growth

Assume there are Tobservations, in this thesis, let $\Delta(x_t) = x_t - x_{t-1},\ t \in (0, T)$.

Dependent variable: $y = \Delta(P.Vanamei\ Price\ Index)$

Independent variable: $x = \Delta(P.Monodon\ Price\ Index)$

Table 5.21 and 5.22 summarize the regression results and the covariance matrix.

Table 5.21. Regression results on first difference of P.Vannamei and P.Monodon

```
. reg dtVann dtMono
```

Source	SS	df	MS	Number of obs =	231
Model	.040603288	1	.040603288	F(1, 229) =	47.37
Residual	.196267703	229	.000857064	Prob > F =	0.0000
Total	.236870991	230	.001029874	R-squared =	0.1714
				Adj R-squared =	0.1678
				Root MSE =	.02928

dtVann	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
dtMono	.4211014	.0611805	6.88	0.000	.3005528	.54165
_cons	.0022326	.0019501	1.14	0.253	-.0016099	.0060751

Table 5.22. Covariance Matrix of the Coefficient – first difference

```
. vce
Covariance matrix of coefficients of regress model
```

e(V)	dtMono	_cons
dtMono	.00374305	
_cons	-.00001863	3.803e-06

Adjusted R-square of 17% (Table 5.21) suggests that 17% of the absolute change of P.vannamei price can be explained by the absolute change of P.monodon price, which is similar to using relative growths. A small $p - value$ suggests that

the coefficient is statistically significant. Therefore the relationship between P.vannamei and P.monodon can be illustrated in the pricing model below:

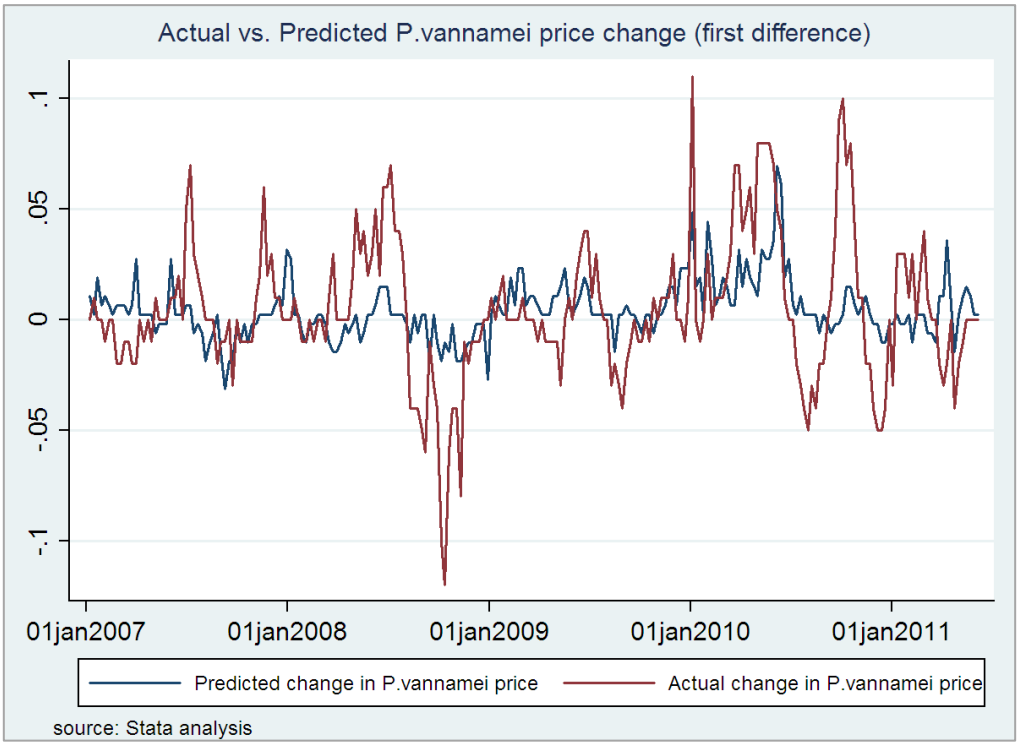
Pricing Model Proposition 2 – using absolute growth:

$$\Delta(\boldsymbol{P.Vannamei}) = \mathbf{0.42}\,\Delta(\boldsymbol{P.Monodon}) \qquad (\mathbf{5.11})$$

Model 5.11 means that the price of P.vannamei and the price of P.monodon are positively correlated: 1 unit change in P.monodon price results in 0.42 unit change in P.vannamei price in the same direction. With 95% of confidence we can predict that 1 unit change in P.monodon price would result in 0.3 to 0.55 unit change in P.vannamei price (Table 5.21).

Figure 5.6 illustrates the actual and predicted P.vannamei absolute price change (first difference). From the graph, it appears that the predicted values are much smoother than the actual price changes in the market. In a few periods the price changes are not captured by the model. This further proves that the overall explanation power of this model is quite low.

Figure 5.6. Actual vs Predicted P.vannamei price change (first difference)



Complications:

Both models seem statistically significant. But intuitively it is not difficult to see that these two models cannot always yield the same results over time, or under significant change in the variables. These two models can be seen as attempts to forecast future price changes using historical price movements, which in itself could be a questionable assumption. The fact that these two models work under the current prices could be explained by the coincidence that the price difference (or the premium of P.monodon) is close to the P.vannamei price level. Therefore although the models are trying to explain the long-term relationship between the two major shrimp prices, it may only be useful in predicting medium-term price ranges, since over longer period of time, the other factors that affect the price could change, and the changes of the prices could be so dramatic that at least one of the models would result in false forecast.

5.5 Volatility

5.5.1 Volatility of the shrimp cash markets

Recall from Table 5.2 (chapter 5.2.2, page 74), we already calculated the standard deviation of the lg growths, or weekly returns of the shrimp prices. Therefore we can calculate the yearly volatility of the shrimp prices by times the standard deviation by $\sqrt{52}$. The results are summarized in Table 5. 23. In the next section, I provide the same analysis for salmon market as a point of reference. Compared to salmon market, where an established exchange exists, the volatility in shrimp market appears to be very low.

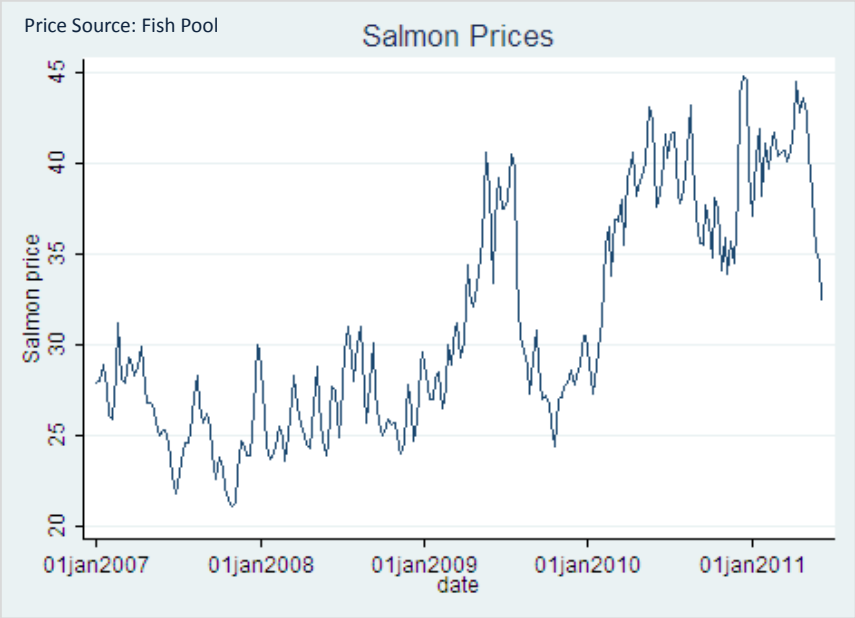
Table 5.23. Volatility for P.vannamei and P.monodon

Shrimp types	Annualized Volatility
P.vannamei	7%
P.monodon	4%

5.5.2 Reference Case – Volatility in Salmon

Figure 5.7 illustrates the historical cash prices in the salmon market.

Figure 5.7.Historical Salmon Cash Prices



To make it comparable to the shrimp markets, we are also going to use relative growth and absolute growth of the cash prices in the calculation of volatility. Figure 5.8 illustrates the relative growth and Figure 5.9 illustrates the absolute growth. The growth data are tested with Dickey-Fuller tests to make sure that they are stationary. (Appendix B) Table 5.24 summarizes the basic statistics for all the input data mentioned above.

Table 5.24. Summary statistics for salmon market

```
. sum Salm lggSal dtSal

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
        Salm |       232    31.14379    6.285895     21.09      44.76
     lggSal |       231   .0006533   .0582684  -.1586916   .132127
       dtSal |       231   .0196104    1.879707  -5.829998       5.41
```

Figure 5.8. Relative growth of salmon prices (lg growth)

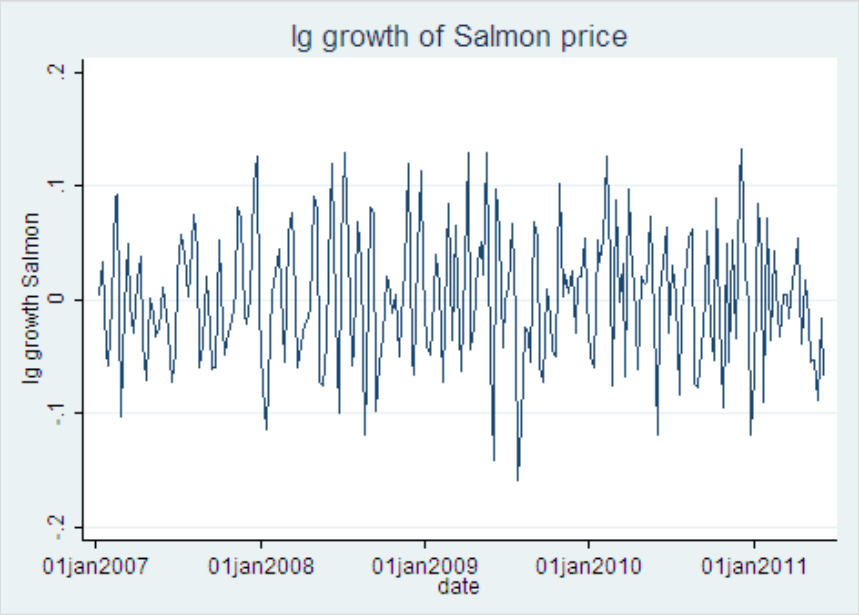
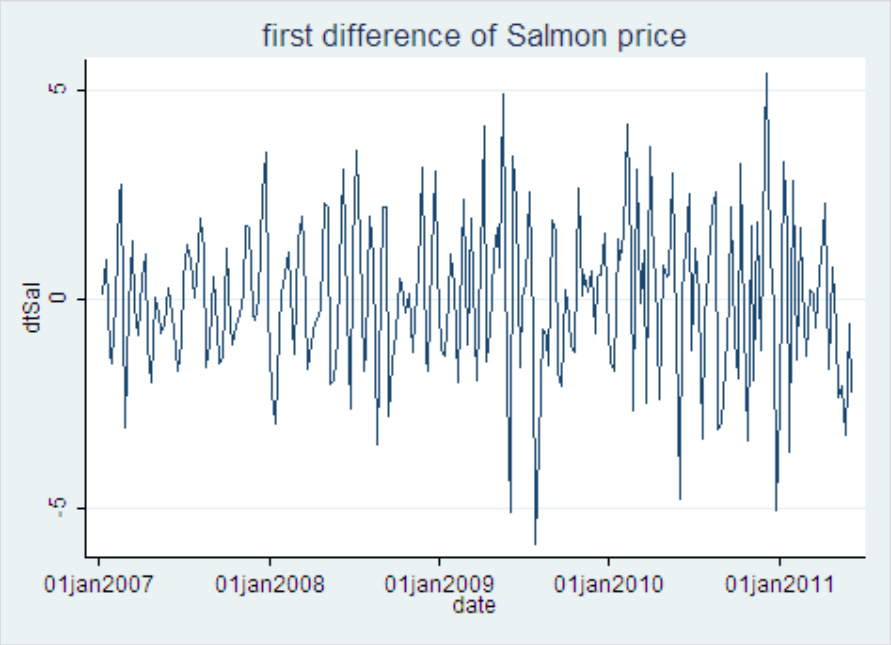


Figure 5.9. Absolute changes of salmon prices (first difference)



Visually we can already see that the changes in salmon cash prices are significantly more volatile than in the shrimp cash prices (Figure 5.2, page 74; Figure 5.3, page 78). From Table 5.24 we can calculate the volatility of the salmon market by multiplying $\sqrt{52}$ to the weekly volatility (standard deviation of lg growth), which gives us the annualized volatility of 42%. (Table 5.25)

Table 5.25. Volatility for Salmon

Market	Annualized Volatility
Salmon	42%

Compared to Table 5.23, salmon market clearly has a much higher volatility. This raises the concern of whether there is truly enough volatility in the shrimp market to actually make price risk management a primary motive to use any financial derivatives. From an exchange's point of view, low volatility also poses concerns to whether enough trading volume would be attracted to support liquidity and long-term sustainability of the futures instrument.

5.5.3 Discussion with the management of Fish Pool

With the above-mentioned concerns, the author discussed the low volatility issue showed in the shrimp cash market based on Urner Barry's prices with Fish Pool. The exchange raised a few interesting views that might complement the existing theories.

First of all, although they agree that high volatility increases attractiveness to the futures instrument and will benefit the exchange in establishing such instrument, they believe that for the initial existence of a futures market, the absolute price variation is more important. As volatility is a main attraction to the financial users, the actual price variation, which could be measured by standard deviation or coefficient of variation, is the primary motivation for the commercial users, ie: the producers and buyers of shrimps, to use a risk-management tool such as a futures market.

Using the mean and the standard deviation from Table 5.1 (page 73) and Table 5.24 (page 88), one can calculate the coefficient of variation[24] in P.vannamei, P.monodon and salmon markets: 13.47%, 11.29% and 20.18%, respectively. (Table 5.26)

[24] The standard deviation divided by the mean. (Bergfjord, 2007)

Table 5.26. Coefficient of variation of three markets

Market	Annualized Volatility
P.vannamei	13.47%
P.monodon	11.29%
Salmon	20.18%

The coefficient of variation evaluates how much the price movements are diverged away from the means on average. So Table 5.26 basically says that we have 68% confidence that the price variation in P.vannamei market is within 13.47% plus or minus from its average (one standard deviation), and we are 95% sure that the price variation would fall within 27% plus or minus (two standard deviations) from the average price level. Recall in section 3.1.3 we already mentioned that the salmon price variation is less than some other commodities such as cocoa and pork markets. Therefore the price variations in shrimp markets are not particularly high compared to these commodities. But compared to the volatility evaluation we used before, the gap seems to be a little smaller.

One theory Fish Pool proposed to support the use of coefficient of variation is based on production costs or "break-even point". When the absolute price dropped to a level that is close to or even below the production costs, the producers will have a strong incentive to lock-in the long-term selling price in order not to go bankrupt. They believe compared to a high-profit-margin market such as salmon, a market with relatively low profit margin such as shrimp will have a stronger incentive to use futures instruments. A second argument for the use of coefficient of variation instead of volatility is that most aquaculture productions are long-term investments and there is little flexibility to switch to other production or change production level in a short time.

In practice, this theory is not entirely proven in any similar markets. In the case of salmon, the trading volume in Fish Pool rises sharply at peak prices, but is relatively stable around the break-even prices of 24-27 NOK/Kg. The possible

explanations are the expectation of a price rebound or the lack of counter parties when price is at such a low level. The life cycle theory is also not completely supported by facts from different markets. The salmon production cycle could be up to 2 years according to Fish Pool; hog production is typically 6 months (Geman, 2005); and shrimp production from hatchery to marketable sizes takes 5 to 6 months in tropical conditions (FAO, 2002). Yet hog has the highest price variation among the three, followed by salmon and then by shrimp markets. Intuitively, a longer production cycle could lead to more uncertainty in the price in the future, therefore increases the price variation. Practically, it is also limited to the degree of maturity in the futures market, the availability of fundamental information and the industry's ability to make long-term plan according to the market information. The heavy drop of salmon price due to over production and concentrated slaughtering in 2011 indicates that the industry is still not making synchronized efforts in long-term planning.

Nevertheless, these new views provided evidence that no statistics can be interpreted alone. It must be combined with other qualitative factors that commercial users must take into account such as break-even point or length of production cycle. These theories can be possible research directions for future researchers.

Secondly, one discussion point emerged in the interview is the difference of risk profile between the users. Martens refers to the salmon producers as "risk-takers", due to the history of salmon wild-catch and salmon farming. This is in line with the theory mentioned in chapter 3 regarding the firms and the owner-managers. The same volatility and/or price variation means different things to different users. Further studies are needed in order to determine the risk profiles particularly for commercial users in the shrimp industry.

5.6 Future research with multiple regression

The simple regression models based on growth data show that there are some dependent relationships between the change of P.vannamei price and the change of P.monodon prices. But the overall explanation power of simple regressions is not very high, around 17%. (Table 5.19, page 83; Table 5.21, page 85) One reason is because by studying changes such as taking differences, we lose certain variations of the input data.

But simple regression method also has limitation in itself. Generally speaking, it is difficult to draw ceteris paribus conclusion about how x affects y when there is only one independent variable. Also the assumptions that all other factors affecting y are uncorrelated with x is often unrealistic.

Therefore by adding more control variables it is possible to explicitly control the other factors affecting y, and more likely that the zero conditional mean assumption holds, thus more likely to infer causality from the models. By controlling more factors, it also increases the explanation power for the variation in y, which leads to better predictions.

In addition to improve the accuracy of the pricing model, multiple regression studies could potentially discover important drivers of the market and provide more transparency in the price discovery mechanism, which will benefit the creation of a transparent and efficient market place.

A full multiple regression is beyond the scope of the paper, but in this section, the author will discuss a few factors that might be interesting for future researchers and the complexities of incorporating these factors, include income factors, input factors, supply and demand relationships, and other market forces such as substitute products. There are a few challenges in applying these factors in practice. First of all, most of these factors are also economic data which are non-stationary by nature. So before using them, stationary tests on the relative and absolute returns should be

applied. In addition, economic data are generally not updated as frequently as price information. Of course in software such as Stata, users can manipulate quarterly data to analyse alongside monthly or weekly data, but prices tend to change in real-time, so the effects of economic data might not be fully displayed if we put quarterly, or in some cases, yearly data. Last but not least, some economic factors such as market demand are difficult to collect or to estimate.

Economic factors

Price for Substitute/Competitive Products

The basic economic theories and the industry forces point out that substitute products and competitive products can have an influence on the shrimp prices. For example, if the production of competitive products such as other seafood or other protein products increases, it could drive down the prices for that product, and further lower the prices for shrimps.

In order to take into account the effects of changes in prices of substitute products on shrimp prices, indicators such as US Fish and Seafood CPI could be included. Since shrimp price is also a component of the Fish and Seafood CPI, it is reasonable to assume that they are correlated. Depending on the proportion of shrimp products in the composition of the CPI, both positive correlation and negative correlation could be expected. If a large percentage of the index is consisted of shrimp products, a large price movement in shrimp price could significantly shift the seafood price index; on the other hand, a small to moderate proportion of shrimp products in the index could have more complex results of their interaction. For example, a price increase in shrimp products could lead to a reduction in the demand for shrimp products, but an increase in the demand for other seafood products, and then results in a price increase in the substitute product. The combined effect on the overall index could be an increase or a reduction.

As a protein and nutrition source, shrimp has many other competitive products.

One close competitive product is meat. Since shrimp is not a direct component of these indices, it would be interesting to see if the prices of such competitive products have any influence on shrimp prices. In this case, future researchers might consider US Meat CPI as a source of indicator.

Monthly US CPI data could be found on the website of Bureau of Labour Statistics, US Department of Labour (http://www.bls.gov/cpi). As discussed above, the application of the economic indicator could be quite tricky and requires a lot of careful manipulation. The selection of the indicator is likely to be a trade-off between availability, relevance, timeliness and quality of the data.

US CPI data has a few advantages: it takes into account inflation and other factors; it is consistent with the dependent variable, since the shrimp prices are reported from a US perspective; in addition, the US data are reported relatively frequently and are categorized by sector. The disadvantage is that the regional differences cannot be explored in this case, although as one of the biggest importer, US market is a good representative of the global market. But as all indices, the CPI data are aggregated data, which does not give the variance for each individual constituent.

Income

As shrimp is primarily a consumer product, its demand can be influenced by movements in income level. Income is influenced by general economic development, and in turn reflected in general economic indicators. Therefore GDP data or household income could be considered as the indicator. Table 5.27 illustrates the U.S. GDP data of the same period of the regression in this paper. The problem of GDP or household income data is that they are updated rather irregularly, thus it is difficult to observe causal relationship between the income change and the price change in the market.

Table 5. 27. GDP for U.S.A

US GDP Unit: Billions of dollars
Value Added by Industry, Bureau of Economic Analysis
Release Date: April 26, 2011

2006	2007	2008	2009	2010	2011 est*
13,399	14,062	14,369	14,119	14,660	15,056

* Based on 2.7% increase, source: OECD Economic Outlook, Volume 2011 Issue 1 - No. 89 - © OECD 2011

Price for Input Products

As we analyzed in the previous chapter, the production cost in shrimp industry is increasing. Including more of the input factors is likely to increase the predictability of the pricing models. It is also very important for individual producers to adapt these factors to suit their own production (and/or distribution) models. For example, one of the most important and volatile factor is the sharp changes in energy prices in recent years, which would drive up the production and transportation costs. Another factor to consider is the feed prices, as the prices for agricultural products are increasing in recent years. Therefore, agricultural prices, oil prices, electricity prices and Transportation CPI could be included to represent the influence of the input factors.

Supply

As most commodities, supply is one of the most important factors that influence prices. In many other commodities futures markets, such as crude oil, supply is almost the most important factor that drives prices, in both long-term and short-term.

Table 5.28 summarizes both captured and cultured shrimp production by volume and by value.

Table 5.29 breaks down the cultured volume and value of two biggest shrimp types: Penaeus Vannamei and Penaeus Monodon, which constitute about 90% of the global culture shrimp production. Since cultured production is overtaking wild catch production in recent years – about 60% in 2011, for simplicity, the cultured

production by the two species could be included in the model. The production figures in the last 5 years are highlighted. The 2009 – 2011 data are estimated based on 5 years' time-weighted moving average growth rates. These figures are also limited to yearly data, therefore need to be translated to corresponding weekly data with a production model. The simplest way is to assume that all the production are increased at a fixed rate throughout the year and interpolate these figures into weekly data. As in the case of the other economic factors, the supply data should be adapted to reflect regional differences or the unique market that the researcher is interested in.

Table 5.28. World total shrimp production data

									Estimated*		
Total Shrimps, Prawns Production		**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Captured											
Quantity	t	2,844,050	3,332,205	3,307,852	3,204,801	3,276,818	3,261,330	3,120,566	3,071,279	3,019,680	2,966,605
% of world total		66%	62%	58%	55%	51%	50%	48%	45%	43%	41%
% growth		-	17.16%	-0.73%	-3.12%	2.25%	-0.47%	-4.32%	-1.58%	-1.68%	-1.76%
Value	US$ mill	9,385	10,930	10,651	10,736	11,141	11,415	11,234			
Price	US$/t	3,300	3,280	3,220	3,350	3,400	3,500	3,600			
Aquacultured											
Quantity	t	1,465,538	2,049,011	2,363,575	2,662,411	3,117,978	3,281,558	3,399,105	3,695,660	3,992,681	4,294,616
% of world total		34%	38%	42%	45%	49%	50%	52%	55%	57%	59%
% growth		-	39.81%	15.35%	12.64%	17.11%	5.25%	3.58%	8.72%	8.04%	7.56%
Value	US$ mill	7,687	8,118	9,301	10,412	12,447	13,562	14,292			
Price	US$/t	5,245	3,962	3,935	3,911	3,992	4,133	4,205			
World Total											
Quantity	t	**4,309,588**	**5,381,216**	**5,671,427**	**5,867,212**	**6,394,796**	**6,542,888**	**6,519,671**	**6,766,939**	**7,012,361**	**7,261,221**
Value	US$ mill	**17,072**	**19,048**	**19,952**	**21,148**	**23,588**	**24,977**	**25,526**			

Source: A-1 Fish, crustaceans, molluscs, etc Capture production by groups of species; B-1 World aquaculture production by species groups; FAO website
* Growth rate estimation is based on 5 years time weighted moving average

Table 5.29. Two major species culture production data

2 Major Shrimp Species Aquaculture Production										Estimated*		
Penaeus vannamei	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Q (t)	145,386	267,953	473,449	982,663	1,304,433	1,644,821	2,099,713	2,298,775	2,259,183	2,556,209	2,843,691	3,128,576
% of world aquacultured total	-	-	32%	48%	55%	62%	67%	70%	66%	69%	71%	73%
% growth	-	84.30%	76.69%	107.55%	32.74%	26.09%	27.66%	9.48%	-1.72%	13%	11%	10%
V (USD 1000)	792,883	1,451,039	2,284,076	3,433,640	4,506,327	5,853,024	7,767,420	9,054,224	8,985,289	8,916,879	8,848,990	8,781,617
Penaeus monodon												
Q (t)	630,984	673,012	631,471	723,881	707,422	665,489	637,425	593,607	721,867	747,738	782,314	826,286
% of world aquacultured total	-	-	43%	35%	30%	25%	20%	18%	21%	20%	20%	19%
% growth	-	6.66%	-6.17%	14.63%	-2.27%	-5.93%	-4.22%	-6.87%	21.61%	4%	5%	6%
V (USD 1000)	4,518,801	3,935,192	3,631,012	3,360,533	3,360,054	3,071,058	3,041,438	2,863,219	3,349,552	3,918,491	4,584,068	5,362,696
Total of 2 species												
Q (t)	776,370	940,965	1,104,920	1,706,544	2,011,855	2,310,310	2,737,138	2,892,382	2,981,050	3,303,946	3,626,005	3,954,862
% of world aquacultured total	-	-	75%	83%	85%	87%	88%	88%	88%	89%	91%	92%
% growth	-	21.20%	17.42%	54.45%	17.89%	14.83%	18.47%	5.67%	3.07%	11%	10%	9%
V (USD 1000)	5,311,684	5,386,231	5,915,088	6,794,173	7,866,381	8,924,082	10,808,858	11,917,443	12,334,841	12,835,370	13,433,057	14,144,313

Source: A-6 World aquaculture production of fish, crustaceans, molluscs, etc., by principal species in 2008, FAO website;
* Growth rate is estimated with 5 years time-weighted moving average

Demand

Another important factor that can influence the commodity price is changes in demand. It is hard to find a direct and precise measurement for demand, as demand is often neither explicit nor realized. Therefore a demand model needs to be created to estimate or represent the changes. Suppose the researcher believes that the demand is the population multiplied by the per capita consumption of fishery products, assuming that a) the shrimp consumption is a fixed portion of the

overall fishery consumption b) the current per capita consumption is a good estimation of the consumption in the near future and c) the current supply and demand is in equilibrium. Then one can calculate the demand (global) as in Table 5.30. 2010-2011 per capita supply are estimated based on 3 years' moving average growth rate. When we interpret this relationship, we need to bear in mind that there could be difference across different seafood species because of price, nutrition, availability, marketing, culture, and other factors. These yearly figures need to be translated into corresponding weekly.

Table 5.30. World demand for fishery products

World demand for fish and fishery products					Estimated	
	2006	2007	2008	2009	2010	2011
Per Capita Supply *	16.80	16.90	17.10	17.20	17.34	17.48
Growth rate **	1.82%	0.60%	1.18%	0.58%	0.79%	0.85%
Population #	6,558,066,329	6,636,826,517	6,715,207,267	6,792,892,971	6,868,528,206	6,946,043,989
Total Demand (t)	110,175,514	112,162,368	114,830,044	116,837,759	119,069,407	121,439,123
* Source: FAO - The State of World Fisheries and Aquaculture 2010						
** Growth rate is based on 3 years moving average						
# Source: http://www.census.gov/population/international/data/idb/worldpoptotal.php						

5.7 Exploring other data sources

At the beginning of the paper, the various sources for shrimp prices and their qualities are discussed. In this section the author will use a small paragraph to evaluate one of the most mentioned price source: NOAA, Southwest Regional Office, National Marine Fishery Service in the United States. On its website NOAA publishes trade data, weekly shrimp wholesale prices in Tokyo, in addition to landing reports on gulf shrimp ex-vessel prices. The Tokyo wholesale price is the only one with price history publically available, which can be used to compare with the Urner Barry Survey. Different sizes, origins and species are listed. For the purpose of illustration, the prices for frozen P.vannamei and P. monodon of the same size (21-25 count/lb) are illustrated in Figure 5.10a. The same period as our previous regression (01.01.2007 – 06.06.2011) is examined and the prices are in JPY. Figure 5.10b is the same price calculated in USD based on the daily exchange rate published on the same site.

Figure 5.10a. Tokyo P.Vannamei Wholesale Prices, 21-25 ct/lb unit: JPY/1.8kg

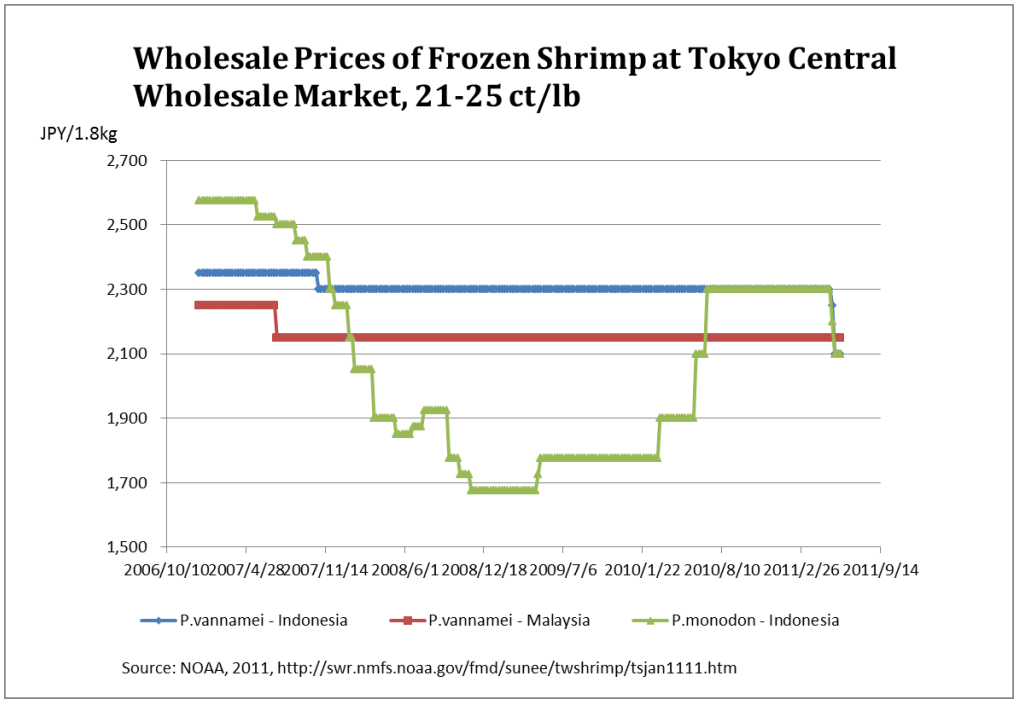
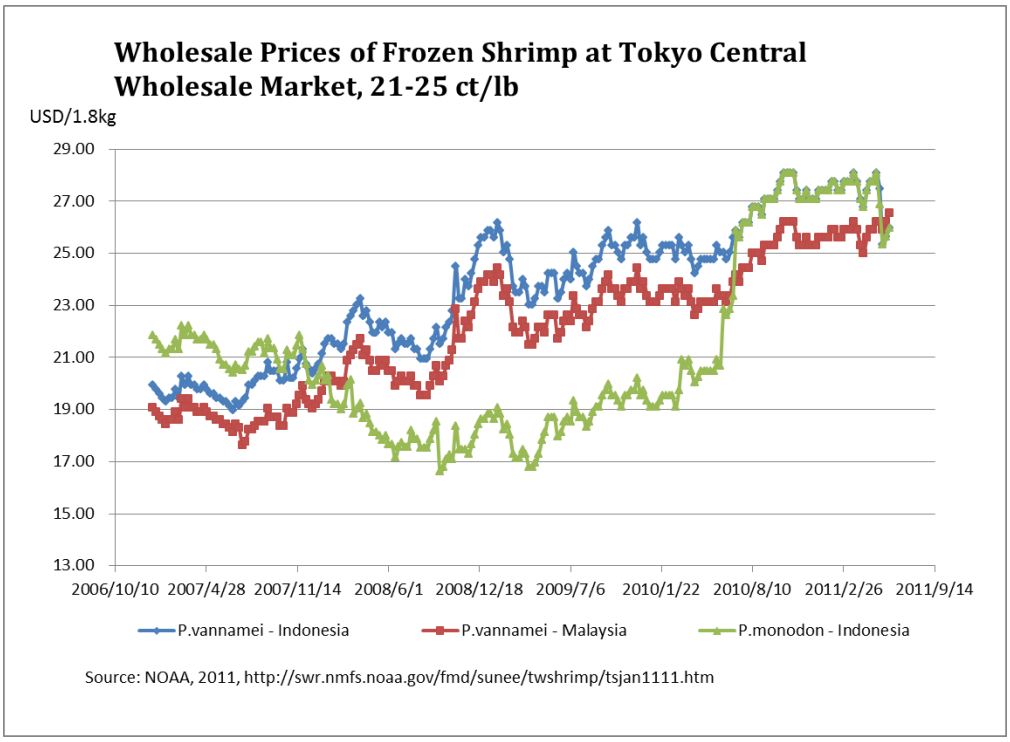


Figure 5.10b. Tokyo Wholesale Prices, 21-25 ct/lb unit: USD/1.8kg



From these graphs it is not difficult to conclude that the price in JPY is almost not changing over the years except that the P.monodon prices changes in a few occasions. The variation demonstrated in this graph is inconsistent with the other

data sources (some with shorter history), and is inconsistent with the only shrimp futures exchange that we know of today, Kansai Commodities Exchange in Tokyo. [25]

The USD prices exhibit more variation because of the change in exchange rate. Therefore the author concludes that the price published by NOAA does not reflect the real dynamics of the cash market and is not suitable as a reference price for the price index for futures market. The reasons are not clear as the methodology for calculating the prices are not disclosed. A few reasons could cause this: a) the price is regulated; b) it is a basket price so the prices are off-setting each other and the prices do not reflect enough depth of the market; c) the prices are not updated unless a significant change is reported.

5.8 Conclusion

In this chapter, the author attempts to analyse the attributes of the shrimp markets using more quantitative approach. The implications and the limitation of the studies will be summarized in this section.

Correlation/homogeneity/market integration

The changes of the two major shrimp prices exhibited a correlation of 41-42% (Table 5.18, page 82), which indicate that they have influence on each other or they are both influenced by similar factors. However, the econometric analysis shows that the two shrimp prices are not cointegrated and the causal relationship between the prices of the two species is not particular high (17%) by drawing a simple regression between them. From a practical perspective, it indicates that although it is possible to use one shrimp to cross-hedge the other, the markets themselves are not really integrated.

It is not easy to infer directly from the models what the reasons might be. But

[25] http://www.kanex.or.jp/index.html The price history is only available until 2008, but there are still contracts listed.

there can be a few possibilities. First of all, it could mean that shrimps, as a physical product, are not very homogeneous. Therefore, although they are quite similar, they do not tend to be used to replace each other. Second, it could mean that although the shrimps might replace each other, the markets are relatively separated so that it is not easy to do so. The trade barrier theory could be supportive for this theory. Under such assumption, the underlying demand and supply of the regional markets could be quite different from each other. Therefore the price change in one shrimp price (typically related to one region) does not easily trigger the price change in the other shrimp type (which is produced or consumed in a different region). Of course, the difference in demand and supply does not only come from different region. It could also come from different institutional factors. For example, if the shrimp pricing in a particular market is dominant by a few buyer or producer, then even if the price of one shrimp type changes in one region, it might not affect the other shrimp type in the same region because of the dominant price-making entity.

Of course, the results of econometric analysis could become different if different data sets, assumptions and methods are used. For example, Vinuya (2007) has used cointegration techniques to study the import price data from Japan, United States, and the European Union and concluded that the prices in these markets share a common stochastic trend and there is a strong link amongst Japanese, American, and European markets. He believes that one price is going to be the trend in shrimp markets.

By including more factors using multiple regression and continuously updating the pricing models over some time, we could shed more light on this question. If the regression shows a higher causal relationship between the prices two shrimp species, then the one price trend could be true for 90% of the shrimp production in the world. Without this condition, it means that at least two separate indices for the two shrimp species need to be constructed. Luckily for both types of shrimps,

the underlying market sizes are quite big. In this study, we did not have enough price information to study the regional differences. This would be an interesting point for future researchers.

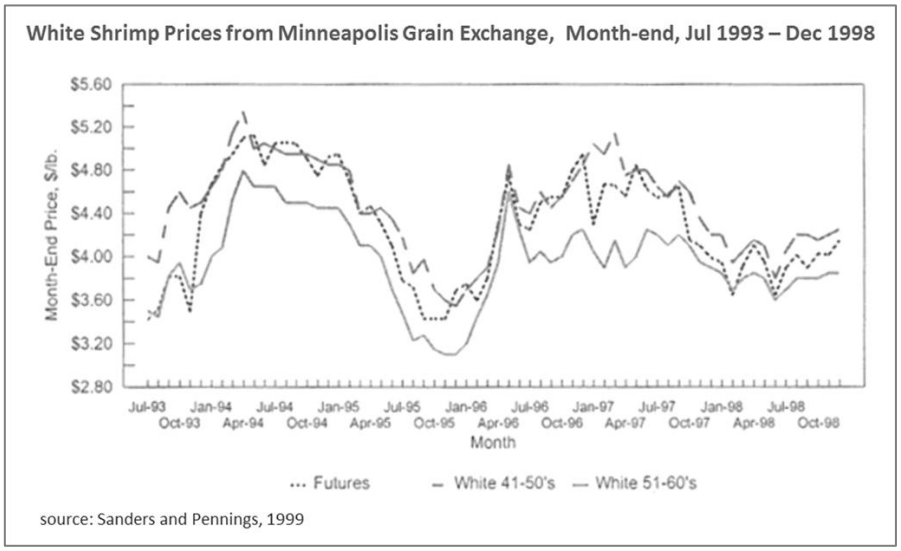
Volatility/coefficient of variation/market uncertainty

In section 5.5, the use of volatility or coefficient of variance is discussed extensively, and we can see both of them as two sides to describe the uncertainty of price movements in the market. The interpretation of the statistics must be combined with the understanding of the industry characteristics such as risk preference, production cycle and break-even analysis. Perhaps the best way to understand the market uncertainty is through the use of both estimations: volatility indicates the attractiveness to financial users and coefficient of variation indicates the attractiveness to commercial/physical users.

In this paper, the shrimp market is estimated to have very low volatility. From the 5 years price history provided by Urner Barry, the P.vannamei market exhibited an annualized volatility of 7% while the P.monodon market exhibited 4% of annualized volatility (Table 5.23, page 87), compared to 42% in salmon market. (Table 5.25, page 90) Of course, using different price series might results in very different conclusions on volatility. When more advanced techniques are used to calculate the volatility over time, it is also easier to make better judgement of whether the volatility in shrimp market is enough to attract futures trading. In Sanders and Pennings' (1999) paper regarding the previous shrimp exchange by Minneapolis Grain Exchange, the monthly volatilities of white shrimps are estimated to be around 4-5% from July 1993 to Dec 1998, which means that the annualized volatility is between 13-17%, depending on the different size categories. This estimation is higher than volatility estimation in this paper, although still much lower than in the salmon market. Figure 5.11 shows the cash market prices (Urner Barry) and futures market prices (MGE) between July 1993 and Dec 1998. Compared the cash prices to the ones in Figure 5.1, the cash market from 1993 to 1998 is much more volatile

compared to the period of 2007 – 2011. Sanders and Pennings' (1999) study shows very little difference in volatility between different size categories. Therefore although in this paper, the author used different size category compared to Sanders and Pennings' study, it is most likely that the current shrimp cash market is experiencing less volatility compared to the mid-1990s. In this sense, maybe the MGE has entered the shrimp market at a better time.

Figure 5.11. White shrimp prices on MGE, month-end, Jul 1993 – Dec 1998



The low volatility in cash market is going to challenge the exchanges that attempt to establish a futures market. It is difficult to argue that a low volatility in existing cash market would become a motivation for the practitioners to use derivatives market. Low volatility could also be an indication of low liquidity (less trading volume) in the market (Geman, 2005). This might be a very fundamental reason why the previous shrimp exchanges have failed. Although the supporters for using coefficient of variation believes that when price fall close to production cost, there should be more demand for futures trading. It was also not the case in MGE. When prices fell to its bottom between late 1995 to beginning of 1996, the shrimp futures trading in MGE also fell below 50 contracts per months, compared to about 600 contracts per months at the beginning of the launch of the futures contracts. (Sanders and Pennings, 1999). More analysis of the MGE shrimp futures market is available in the next chapter. At this point, the comparison of volatilities of the two

periods shows that the market condition is not most favourable for establishing a shrimp futures exchange.

Managerial Implication

In a market that is relatively un-transparent, exchanges like Fish Pool, who wants to establish a futures market or a price index faces an inevitable dilemma and challenge – how to establish price transparency when the sources are limited and opaque, or costly to get. At some point, the journey must involve a consolidation process with the industry participates and a collection of historical prices with greater details and more accuracy.

In this section, the econometrics analysis also identified a few other challenges to the current condition to establish a futures exchange in the shrimp market. The most important of them is the current volatility in the cash market, which appears to be quite low. Practitioners need to pay attention to this and be careful if they believe that this will be the main motivation for using futures exchange. Practically this means that in addition to keep the volatility measurement in check, the exchange needs to first try to discover other motivations from the owner managers in adopting futures as management tools; second, further study the regional differences: as the market integration is not particular high, some regions might face higher volatility or have higher demand of a risk management instrument. Last but not least, timing is also very important for the success of creating a futures market. The change of market prices is a dynamic process. With the improvement of education, facilities and reduction of trade barriers, the market integration could be enhanced. As discussed in previous chapters, the low shrimp price creates pressure for the producers and in the long term there could be more price movements if the underlying institutional factors change. Therefore, although the current estimation of volatility and market integration is not particularly in favour of the futures market, the situation could change if there is a real demand for introducing more price transparency in the market. But it is worthwhile to perform an econometric

analysis, because on the issue of homogeneity and market integration, marketers and purchasers (the owner managers) often have very different views. Financial approach helps researchers to make independent judgements and stay neutral and rational to these different responses.

6. Application of the Key Success Factor Framework

6.1 Feasibility of introducing futures contracts in shrimp market

Recall in the theoretical construction at earlier chapter of this paper, the author put forwards a Key Success Factor Framework with three different scenarios. (Table 3.4, page 39) From previous chapters, we could draw a few conclusions about the characteristics of the shrimp market and apply them in the matrix.

But before proceeding, it is necessary to discuss the most important factor in the matrix – the price volatility. In previous chapters, we established the importance of using volatility as a measure of price uncertainty; at the same time, we understand that from the business and exchange perspective, it could have some limitations and other alternative uncertainty measurements should be used alongside volatility. Therefore, in order to solve this problem, the author decides to change the price volatility factor to price uncertainty, which should contain two perspectives: volatility and coefficient of variation. Alternatively, one can also include both measures in the Key Success Factor Framework, but practically it is difficult to separate the inter-relationships between these two measurements and other factors, hence bringing new difficulties to assigning proper weights to two separate measurements. Therefore, for the purpose of keeping the measurements simple to use, an overall price uncertainty will be evaluated.

In table 6.1 below, if we use Scenario 1 as the starting point, some of the assessments are quite close to the shrimp market in reality. For example, we know now that the market size of shrimp production and trading are very big, therefore we can keep the score of 9 as our estimation. Some factors can be easily achieved by using a cash-only exchange, such as flexible contract terms, fairness to buyers and

sellers and low transaction costs. Therefore they also receive relatively high scores. There is no definite answer to homogeneity of the underlying products, but a below-average score 4 can be seen as a relatively conservative estimation, even taking into account the low estimation of market integration from the econometric analysis. Existing forward contracts are seen in some industry participants, but not known to everyone.

Table 6.1. Revised Key Success Factor Framework

Key Success Factors	*Weights*	*Scenario 1 (Normal)*	*Scenario 2 (Optimistic)*	*Scenario 3 (Pessimistic)*	*Author's Estimation*	
					Shrimp	*Salmon*
Price Uncertainty (Volatility, Coefficient of Variation)	5	5	7	3	3	7
Price transparency	4	4	6	2	2	4
Homogeneity of the underlying product	3	4	7	2	4	9
Existing forward market	3	3	9	3	3	5
Large number of market players	3	5	8	4	5	4
Reliable price source	3	7	9	4	5	6
Liquidity	3	6	8	3	4	4
Knowledge of futures market	3	2	7	2	2	2
Size of the market/trading volume of the cash market	2	9	9	9	9	6
Low / moderate market concentration	2	6	8	4	5	5
Free market	2	6	8	4	6	6
Price convergence to cash market	2	7	9	3	5	5
Fairness to buyers and sellers	2	9	9	7	9	9
Small size contract/flexibility	2	9	9	9	9	9
Opportunity of arbitrage	1	7	7	4	7	7
Low transaction cost	1	9	9	9	9	9
Motivation of hedging price	1	6	8	5	5	5
Motivation of entrepreneurship	1	3	7	3	3	3
Motivation of relationship management	1	7	8	4	7	7
Weighted average score		***5.6***	***7.9***	***4.0***	***4.8***	***5.7***

There are also a few factors that need to be adjusted or down-graded to be prudent in our estimation. The most important factor is the price uncertainty. As we illustrated in the last chapter, a 4-7% of annualized volatility is extremely low. This measurement alone will greatly reduce the overall rating of the success factors, also reducing the motivating for hedging prices. But taking into account the price variation which is illustrated with coefficient of variation, the down grade is mediated as there is still some price variation in the cash market. Therefore the author estimates the overall price uncertainty is 3 out of 10. The current different price sources are also described and compared in this paper. Due to the lack of available

price sources with good quality, the score is reduced. Of course, if the exchange considers ways to collect the price information directly, the score can be increased accordingly.

The changes to Scenario 1 are highlighted in red. The overall evaluation for the success factors in shrimp markets is estimated to be 4.8. For the purpose of comparison, the author also provided a test grading for salmon market using the same framework. The overall evaluation for the salmon market is 5.7, slightly higher than the original Fish Pool estimation of 5.5. It is reasonably expected since the storability is no longer a key success factor. From the qualitative analysis in previous chapters, we can also reasonably expect that the shrimp markets have some disadvantages in a few key success factors compared to the salmon market.

In reality, not all the factors will go in the same direction all at the same time. However, some of the factors with strong causal relationships could move together. For example, price transparency and reliable pricing sources can in fact be really moving hand in hand. At the moment, they are among the least favourable factors. Therefore conservatively speaking, we can estimate that the real life situation as between Scenario 1 and Scenario 3. So the feasibility of the introducing shrimp futures contracts into the market is likely to be between 4 to 5, on a 0-to-10 scale. These factors are possible to change, but with tremendous efforts. We can see that among the least favourable factors, there is another challenge with the knowledge or education of the use of futures market, which is also a relatively important factor. From this key success factor framework, only if the price transparency, the homogeneity and the pricing reliability increase moderately and the volatility, the knowledge of the industry participants increase dramatically can the overall feasibility of introducing shrimp futures contracts enhance to a satisfactory level.

6.2 Studies on previous shrimp exchange by MGE and reasons why it may have failed

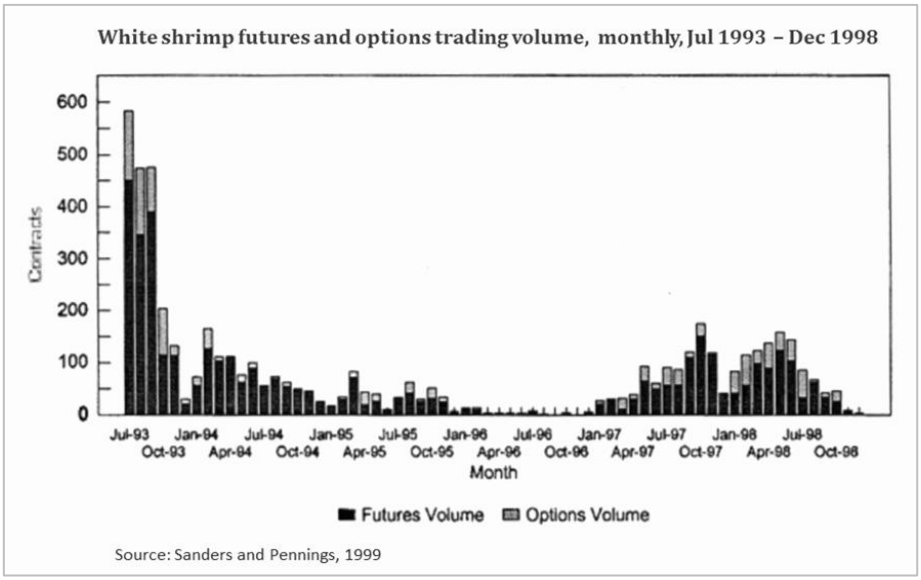
In this section, the author introduces a few studies related to previous failures in attempting to start futures exchange in shrimp market. Combining the market characteristics, the econometrics analysis and the key success factor framework which have been discussed in this paper, the readers should be able to get a good idea of the factors that influence the shrimp market and their development over time.

History and Background

In the commodity world, surprisingly, shrimp is actually not a new mystery that has interested and puzzled many industry participants and researchers. The billion dollar underlying markets have attracted several attempts to start futures exchange. As early as 1960s, two futures contracts for frozen brown, pink and white shrimps are traded on the Chicago Mercantile Exchange (CME) and were closed in 1966 after two years of existence due to lack of trading volume. (Martínez-Garmendia and Anderson, 1999) After 30 years, the Minneapolis Grain Exchange (MGE) has resumed the game and introduced both Black Tiger (Panaeus Monodon) contracts and White shrimps (primarily Panaeus Vannamei[26]). This time it is much more dependent on the cultured shrimp production and imports. The trading volume was initially met with a small enthusiasm and soon faded. (Figure 6.1, Sanders and Pennings, 1999) After almost 10 years of experimenting, both contracts ceased trading since January 2002.

[26] According to Sanders and Pennings (1999), the other two of Western Hemisphere white shrimps (Panaeus occidentalis and Panaeus stylirostris) are allowed under par delivery. However, they are almost never tendered for delivery. Deviations from the par product typically occur in the alternative sizes.

Figure 6.1. White shrimp futures and options trading volume



Contract Specifications

The MGE futures contracts are monthly-based. For white shrimps contracts, the par delivery is 5,000 pounds (net weight) of 41-50 count per pound (cpp), block frozen, headless, shell-on P. vannamei from western hemisphere. Each lot must be a single brand from a single packer held in an approved warehouse within fifty miles of New York City, Jacksonville, Miami, or Tampa. West Coast delivery (Los Angeles) receives a $0.07 per pound premium. Shrimp must meet the technical standards for MGE Class 1 Shrimp (roughly equivalent to U.S. Grade A). For P. monodon contracts, the par category is 21-25 cpp from Thailand, the Philippines and Indonesia, and non-par categories include 16-20 cpp and 26-30 cpp. Premiums and discounts have been introduced to non-par categories: 31-35, 36-40, and 51-60 cpp. The premiums and discount are updated a few times[27] (Table 6.2, 6.3, Martínez-Garmendia and Anderson, 1999), but are relatively fixed in the medium time span.

[27] MGE, 1993, 1997a, 1997b

Table 6.2 MGE White Shrimp Futures Non-Par Size Category Delivery Premiums ($/lb)

Size Category	Sept 1993 – Dec 1993	Mar 1994 – Jul 1997	Starting Aug 1997
31-35	1.05	0.40	0.35
36-40	0.45	0.15	0.10
51-60	-0.50	-0.65	-0.90

Source: Martínez-Garmendia and Anderson, 1999

Table 6.3. MGE P. Monodon Futures Non-Par Size Category Delivery Premiums ($/lb)

Size Category	Dec 1994 – Jul 1997	Starting Aug 1997
16-20	0.80	0.20
26-30	-0.60	-1.10

Source: Martínez-Garmendia and Anderson, 1999

Analysis on unsuccessful reasons

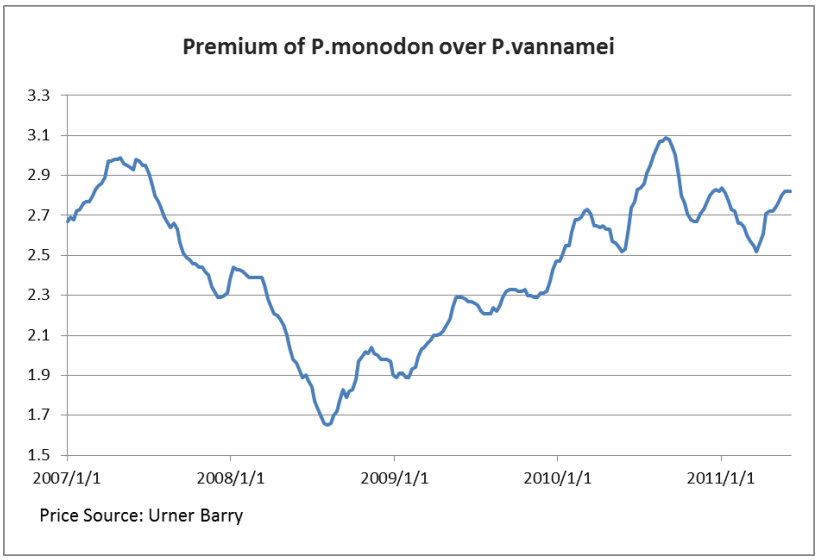
A number of researchers have analyzed the MGE white shrimp contracts and offered some theories on the reason why it failed. While the consensus are that the underlying markets presented some really good attributes such as large cash trading volume, price variation, and numerous market participants including traders, distributors, producers and wholesalers, (Martínez-Garmendia and Anderson, 1999; Sanders and Pennings,1999), attentions have been paid to the evaluation of hedging effectiveness, the homogeneity/heterogeneity nature of the underlying product and the transparency of cash market price discovery mechanism.

Although the correlation coefficients between futures and cash prices of the size categories considered may seem robust for certain size categories (0.64 – 0.95), there exist large fluctuations in their values in shorter periods that coincide with the hedge ratio estimation periods. (Martínez-Garmendia and Anderson, 1999) One explanation that Martínez-Garmendia and Anderson gave is that the constant premium and discount system do not reflect the true dynamics in the market. They proved that some premiums are too big and it also resulted in distorted option price. When multiple delivery alternatives are allowed, sellers have the option to deliver the products that are most favourable to them, affecting the hedging effectiveness of

the futures contracts.

Figure 6.2 illustrates the premium of P.monodon over P.vannamei from Jan 2007 to Jun 2011 using the Urner Barry prices we used in earlier chapter. We can tell from the graph that the premium is not a fixed amount, nor is it clearly reverting around a mean. It shows that the conclusion from the previous researchers regarding premiums are still valid, even in today's environment.

Figure 6.2. Premium of P.monodon over P.vannamei



It is also difficult to discover the true value for premiums and discount because some costs are less quantifiable such as the country of origin. Garbebe and Silber (1983) pointed out that if the prices of different varieties tend to fluctuate a lot, premiums and discounts turn out to be less powerful tools in allocating residual risks. These factors have a dramatic impact on the participation of traders in these contracts. They attributed the initial small success of the futures contracts to the in-the-money option at the beginning when the futures contracts are launched.

Sanders and Pennings (1999) reached similar results in the evaluation of correlation coefficients and further proved that the correlations are noticeably lower across different species for the same size of shrimp, which is consistent with the regression results in this paper. In addition, by comparing the standard deviation of each cash market – representing a completely unhedged position (hedge ratio = 0.0),

with the standard deviation of its basis – representing the relative risk for a completely hedged position positions (hedge ratio = 1.0), Sanders and Pennings showed that basis risk is at least as large as the price risk. This result does not support a high hedge effectiveness of the futures contracts. Although there is an *ex post* hedge ratio that statistically reduces price risk, it is unlikely that a practitioner would know it *ex ante*.

Yet it is not conclusive to whether the contract's performance is due to some inherent fault in contract design, or whether it is due to the industry's failure to perform the cash-futures arbitrage that results in convergence and a predictable basis. Sanders and Pennings suggested that there is a lack of interest from the owner managers due to both a lack of liquidity in the derivative market and a perceived lack of relevance to business objectives. From the marketing and behavioural perspective, it means that lack of education and experience in using futures market as a risk management tool could make any well-designed contract failed to perform.

In addition, a few factors could contribute to the lack of liquidity in the market. First of all, the cash market is not liquid and not easily accessible. The concentrated market power analyzed in previous section supports this argument. Although the cash market trading volume is high, if it is handled through small numbers of deals by a small number of importer and exporter, then the liquidity and accessibility is low and costly to most market participants. The un-transparent cash market pricing mechanism also created barrier to create a reliable futures price index. Similar to the findings of the author, Martínez-Garmendia and Anderson and Sanders and Pennings suggested that the price information is very limited (both used Urner Barry Survey) and so are any timely fundamental data.

Second, from an infrastructure point of view, the industry has not established standardized trade practices such as grades, contract rules, dispute resolution, and does not widely accept third party grades.

Last but not least, Sanders and Pennings suggested that the industry could be using other mechanism to reduce price risks: buy on the spot market every day to pay the average market price and pass it along to the ultimate consumer; back-to-back transactions among packers, exporters and importers to carry no inventory; earn margins including a risk premium in various segments to compensate for taking the price risk. These price protection mechanisms may explain why even at "break-even price point" the futures trading were still not very active. In other words, the industry or at least some parts along the value chain is not "hungry enough" to start to explore the options of adopting futures trading.

6.3 Conclusion – A holistic perspective

In this chapter, the author tries to re-apply a holistic view to the key success factors that have been analyzed in this paper and provide a developing perspective by comparing the previous aborted shrimp futures exchange to our understanding of the current market conditions. We can see from the example of Minneapolis Grain Exchange that the market characteristics, the contract design and the user characteristics are intertwined and their dynamics are influencing the success and failure of a futures market. These views will continue to apply to the current market condition and are pivotal for the introduction of new futures exchange to the shrimp markets.

From the underlying market's perspective, the market size is really attractive with many potential participants. Although the price dependency relationship between the two major shrimps is not particularly strong, the two segments on their own are so large that the homogeneity question seems to be less of an issue. However, the market is also challenged by market power concentration, low price transparency, and perhaps also low liquidity. From the users' perspective, the challenges are two folded. The upper stream of the market is dominant by large amount of small producers who have the demand for more price transparency but lacks the means, tools and knowledge to use the futures market at the moment.

The lack of knowledge in futures market limits the industry's ability to take advantage of any arbitrage opportunity, creating difficulties in realizing an efficient futures market. On the other hand, the powerful exporters and middlemen who might possess the capability to take advantage of market information do not seem to have clear motivation to increase the market transparency. In addition, the lack of volatility in the cash market might just be the missing puzzle of Sanders and Pennings' behavioural perspective, which explains the lack of motivation for both hedgers and speculators. By comparing the shrimp market to salmon market, which is considered just moderately volatile, the author illustrated that the volatility in shrimp market is not as high as many industry practitioners would have expected.

In terms of contract design, the research on MGE also shed lights on how to evaluate the futures contract. A few key performance measurements should be developed and monitored by the exchanges including the hedging effectiveness, trading volume and number of participants.

The cash settlement method could be used to resolve some challenges such as transportation, storage, even the unfairness that might occur from using a fixed premium/discount system. However, the design of contracts always needs to balance the requirement of having homogeneous products to generate enough liquidity and the requirement of flexibility to adapt to various users. Therefore it is still important to think in terms of the price relationships among different segments in the shrimp market based on size, origin and species.

Since 2002, more industry standards are being created, making it possible to find out better and more timely-updated premium and discount system. The prospect of doing so is limited by two factors. First of all, the transparency of the market, both in terms of real time pricing information and in terms of fundamental data, needs to be significantly increased. Second, if the exchange chooses to provide less delivery options or create a single/basket price index, then much of the price discovery work will be transferred to the industry participants. Their ability to

fully utilize arbitrage opportunities for cross-hedging among different shrimp species, size and origin is fundamental for the price convergence of the cash and futures markets. At the moment, it is still a long way before such capabilities could be developed and adopted as a standard industry practice.

7. Future Challenges for Academia and for Businesses

In this paper, the author took a holistic approach to assess the feasibility and challenges of introducing futures exchange into shrimp markets. The marketing research and econometric analysis provide evidence to support some intuition from the industry while also challenge some other presumptions. There is no easy and definite answer to the question of whether a futures exchange would be successful in the shrimp market, not only because there are still a lot of uncertainties in the market, but also because a lot of changes will take place and a lot of efforts must be made together by the exchange and other industry participants. Since the market is not yet transparent and the institutional factors are rather complex today, this topic becomes even more meaningful. As a big, growing market, shrimp is going to continue to attract endeavours from the industry for better ways to acquire information and to take advantage of this knowledge. However the industry should realize that there is probably no easy solution. The key success factor framework provides a method for the industry to rationalize the scope and degree of the challenges. A lot of hard work needs to be done exactly because they are not yet done, whether it is to collect the aggregate the pricing data or to mobilize and educate the industry. Perhaps the next rational question to ask is whether the company itself possess strategic advantages, governance advantages or simply a better capability to execute that allows it to solve these challenges better than the others.

To summarize, three uncertainties add to the challenges to fully understand the shrimp market and to establish an active futures exchange: the uncertainties about data quality; the uncertainties of the fundamental features of the market; the uncertainties of the motivation and the business process management of the shrimp industry.

7.1 Limitation and future studies

Including this paper, a few empirical studies have been done in the shrimp market. Since there is not a widely-known futures market in shrimps, the price information is very much limited to a few providers. The data quality and the methods of reporting vary, which made it difficult to compare and interpret. In addition, because of the existence of some powerful players in the market, the real price and price drivers are still very much in a "black box". To find out these price drivers, gather data and test them will be of great importance for the industry and for academia in the futures.

A number of future studies could help the understanding of the current issues. For example, a study dedicated to the pricing mechanisms of the shrimp market could be conducted to incorporate fundamental data from a regional basis so that better estimation of the price dynamics can be made and a number of theories of the pricing mechanisms can be tested and/or established.

Another interesting research could be to combine the study of biological features, grading systems, and new regulations of shrimp market to establish advanced models that help exchange or companies to quantify premiums and discounts which change on a timely basis for cross-hedging.

Last but not least, since we challenged high price volatility assumption in this paper and the motivation of risk management among the industry practitioners, it will be very meaningful to carry out a master or PHD project to understand the motivation of the owner managers in this market. It needs to be carefully designed to screen out the noises from biases of each individual participant.

The market dynamics, institutional factors, knowledge and motivation of the industry can change dramatically. Therefore the key success factor framework should be revised and updated continuously.

7.2 Exchange house – where to start?

Market selection

In this paper, the author extensively studied the market segmentation of shrimp products by the species, cash market trading volume, country of origin, import and export activities, industry value chain, etc. The purpose is not only to provide the readers some background information about shrimp industry, but also to provide objective evidence in selecting the most suitable market to enter. While cold water shrimp is relatively simple, homogeneous market with better marketing information, the size of the market is way too small for a futures exchange to exist. The two major shrimp species are identified and labelled as Panaeus Vannamei and Panaeus Monodon. The industry exhibited some integration trend since the technology advancement allows the two shrimp species to be closer in size and quality. Therefore, as Panaeus Vannamei has a cost advantage, it is likely to become the most dominant commercial shrimp species in the future. This trend is most obvious in the eastern hemisphere of the world, where more and more producing countries have switched to P.vannamei production from P.monodon. As the western hemisphere has traditionally been producing P. vannamei, it is likely that in the long term the export prices converge towards one major shrimp price over time.

Therefore, from the exchange's perspective, P. vannamei is no doubt the most important sector to start introducing futures contracts. P. monodon futures contracts have also been introduced in MGE previously and in Kansai Commodity Exchange. From the underlying market, it is also large enough for the time being to launch futures contracts. The choice of a single- or a duo- product futures market can be seen as a trade-off between flexibility and liquidity.

However, an inevitable challenge in both markets is to understand the uncertainty and what it means to the owner managers. Compare to other markets, shrimp exhibits less volatility overall. As the futures contracts are primarily

considered as a risk management tool, for the exchange, either a lack of volatility or an existing mechanism to pass on the price volatility should raise a red flag to the procession of introducing a futures market. The exchange should continue to test the volatility of the market using different selections of prices from a different time period or a different product category.

Price Discovery and alternative entry strategies

We discussed extensively in this paper that currently the price transparency and accessibility to timely fundamental data in the market is very limited due to the concentration of market power. The main price source used by researchers Urner Barry Survey is not yet a widely acknowledge price benchmark by the industry practitioners, yet there is not much alternative data sources such as import/export prices. If an exchange wants to be successful in establishing a shrimp futures market, much effort needs to be made to increase the price transparency.

One feasible solution is to gather the price information directly from industry participants such as the producers, importers/exporters and distributors. The exchange could collect daily quotes from a good pool of industry participants from all over the world and publish a price index based on average quotation. It is by no means an easy way, especially since it is difficult to convince the powerful players who do not have the motivation to increase market transparency. But the exchange can also use this opportunity to educate the market. This requires the exchange to have the ability to create long term value for all the participants, both by introducing price transparency and by helping the industry to rationalize its production from a sustainable perspective. It is important to help the industry to realize the opportunity of using futures market not only to hedge risk exposure but also to proactively seek for arbitrage opportunities. Some automated ways could be used in the long term to streamline the process of collecting data.

Alternatively, instead of aggregating the price itself, the exchange could choose to establish an OTC market place by allowing electronic quoting and transaction on

its platform in the same way as how the foreign exchange OTC market is created on Reuters, or crude oil market is via Skype. In fact, many of the shrimp market participants are using Skype making contacts and initiating trades. The bonus of creating an exchange platform is that certain market intelligence could be collected such as the market depth; and from a trader's perspective, a bigger trading community could be reached to achieve more favourable trading prices. In addition, the OTC trading could be connected to clearing service provided by the exchange.

It is possible to tap into the shrimp market with other propositions. One feasible way is to establish online community for shrimp industry practitioners, allowing them to connect and to publish user-generated information, such as fundamental data (eg: production), trade information, industry analysis, news release, branding messages, etc. The exchange could choose to perform some value-added service such as market analysis or commentary. But by providing the venue for a wider community, knowledge can be accumulated and disseminated in this process, creating a channel to increase market transparency. The exchange could also consider focusing on a particular user group such as the farming industry, since they are a primary beneficiary of increased price transparency. This strategy has been successfully implemented by DTN in agricultural market in the US. It requires the exchange to collect and report targeted price information within the region of the target user group. It is by no means an easy way. Therefore the exchange should consider its own capability and advantages. Eventually, it is the business that creates values for the customers that will succeed in the long run.

List of References

Alam, I. (2002) *An exploratory investigation of user involvement in new service development.* Journal of the Academy of Marketing Science, 30:250-261

Asplund, N.M., Foster, D.L., and Stout, T.T. (1989) *Farmers' use of forward contracting and hedging*. Review of Futures Markets 8, 24-37.

Barbier, E. B. and Sathirathai, S. (2004) *Shrimp farming and mangrove loss in Thailand*, pp. xi, 268, Cheltenham, U.K. and Northampton

Barbier, E.B. (2003) *Habitat-Fishery Linkages and Mangrove Loss in Thailand*, Contemporary Economic Policy, January, v. 21, iss. 1, pp. 59-77

Bergfjord, O. J. (2007) *Is there a future for salmon futures? An analysis of the prospects of a potential futures market for salmon*, Dept of Finance, NHH, Aquaculture Economics & Management, Taylor & Francis, ISSN: 1365-7305

Black, D. G. (1986) *Success and Failure of Futures Contracts: Theory and Empirical Evidence.* Monograph 1986-1 Salomon Brothers Center for the Study of Financial Institutions, New York

Boone (1931) *Penaeus vannamei*, Species Fact Sheets, Food and Agriculture Organization, http://www.fao.org/fishery/species/3404/en [Accessed 08/06/ 2011]

Carter, D.A. and Sinkey, J.F. (1998) *The use of interest rate derivatives by end-users: the case of large community banks.* Journal of Financial Services Research 14, 17-34.

Chang, J. S. K., and Fang H. (1990) *An Intertemporal Measure of Hedging Effectiveness*, The Journal of Futures Markets, 10:307–321

Charles, A. T. (2001*): Sustainable fishery systems* (Fish and aquatic resources series 5) Oxford: Blackwell Science.

Debaere, P. (2010) *Small fish–big issues: the effect of trade policy on the global shrimp market*, World Trade Review, 353–374, Darden Business School, University of Virginia, CEPR

Ederington, L. H. (1979) *The Hedging Performance of the New Futures Markets*, The Journal of Finance, 34, 157

Fabricius (1798) *Penaeus monodon*, Species Fact Sheets, FAO Species Identification and Data Programme (SIDP) http://www.fao.org/figis/servlet/FiRefServlet?ds=species&fid=3405. [Accessed 08/06/ 2011]

FAO (1995) *CODEX Standard for canned shrimps or prawns, CODEX Stan 37 - 1991, Rev. 1 – 1995*

FAO (2002) *Aquabook,* Chapter 2. Shrimp Aquaculture, page 9.

FAO (2006) *The State of World Fisheries and Aquaculture*

Garbade, K.D., and Silber, W. L. (1983) Futures contracts on commodities with multiple varieties: An analysis of premiums and discounts. The Journal of Business, 56,249-272.

Géczy, C., Minton, B.A, and Schrand, C. (1997) *Why firms use currency derivatives*. Journal of Finance 52, 1323-1354.

Geman, H. (2005) *Commodities and commodities derivatives: Modeling and Pricing for Agriculturals, Metals and Energy*, John Wiley & Sons, Ltd, ISBN 0-470-01218-8

Gjerde, O. (1987) *"Measuring Hedging Effectiveness in a Traditional One-Period Portfolio Framework*," The Journal of Futures Markets, 7:663–674

Goodwin, B.K. and Schroeder, T.C. (1994) *Human capital, producer education programs, and the adoption of forward pricing methods.* American Journal of Agricultural Economics 76, 936-947.

Hill, J. and Schneeweis, T. (1982) *"The Hedging Effectiveness of Foreign Currency Futures,"* The Journal of Financial Research, 5, 95

Hilton, T. (2008) *Leveraging Operant Resources of Consumers: Improving Consumer Experiences or Productivity?*, The Marketing Review, 8(4): 359-366.

Hirshleifer, D. (1988) *Risk, futures pricing, and the organization of production in commodity markets.* Journal of Political Economy 96, 1206-1220.

Holthausen, D.M. (1979) *Hedging and the competitive firm under price uncertainty.* American Economic Review 69, 989-995.

Howton, S.D. and Perfect, S.B. (1998) *Managerial compensation and firm derivatives usage: an empirical analysis.* Journal of Derivatives 6, 53-64.

Hoyer, W. D. and Maclnnis, D. J. (2009) *Consumer Behavior*, 5th Edition, University of Texas at Austin, University of Southern California, South-Western Cengage Learning. ISBN-13: 978-0-324-83427-7, ISBN-10: 0-324-83427-6

Hull, J. C. (2011) *Option, Futures and Other Derivatives*, Global Edition, 8th Edition, Pearson, ISBN 13: 978-0-273-75907-2, ISBN 10: 0-273-75907-8

Indian Aquaculture Authority, (2001) *Shrimp Aquaculture and the Environment - An Environment Impact Assessment Report, chapter 2, IAA report*, http://aquaculture.tn.nic.in/pdf/farming.pdf [Accessed 22/09/2011]

Jacoby, J. "*Consumer Psychology: An Octennium*" (1976) in ed. Paul Mussen and Mark Rosenzweig, Annual Review of Psychology (Palo Alto, Calif.: Annual Reviews), pp.331-358. With permission from the Annual Review of Psychology, vol.27, by Annual Reviews

Josupeti, H. (2004) *ShrimpMarket Access, Tariffs and Regulations*, Conference Presentation, FAO, World Shrimp Markets, October 2004, Madrid.

Koski, J.L. and Pontiff, J. (1999) *How are derivatives used? Evidence from the mutual fund industry*. Journal of Finance 54, 791-816

Krøyer, (1838) *Pandalus borealis*, Species Fact Sheet. Food and Agriculture Organization. http://www.fao.org/fishery/species/3425/en. [Accessed 08/06/ 2011]

Lee, C.L. and Hoyt, R.E. (1997) *Determinants of corporate hedging behavior: evidence from the life insurance industry.* Journal of Risk and Uncertainty 64, 649-671.

Lien, D. and Tse, Y. K. (2003) *A survey on Physical Delivery Versus Cash Settlement in Futures Contracts.* Singapore Management University Economics and Statistics.

Lovelock, C & Wirtz, J (2010) *Service Marketing – People, Technology, Strategy*, Global Edition, Yale University, National University of Singapore, Pearson, ISBN 13: 978-0-13-611874-9, ISBN 10: 0-13-611874-7

Makus, L.D., Lin, B.H., Carlson, J. and Krebill-Prather, R. (1990) *Factors influencing farm level use of futures and options in commodity marketing.* Agribusiness: An International Journal 6, 621-631.

Martínez-Garmendia, J. and Anderson, J.L., (1999) *An Examination of the Shrimp Futures Market*, University of Rhode Island

Martínez-Garmendia, J. and Anderson, J.L., (1999) *Hedging performance of shrimp futures contracts with multiple-deliverable grades*, The Journal of Futures Markets, 19, 957-990.

Mian, S.L. (1996) *Evidence on corporate hedging policy.* Journal of Financial and Quantitative Analysis 31, 419-439.

Minneapolis Grain Exchange (MGE) (1993). *The power of shrimp futures and alternatives.*

Minneapolis Grain Exchange (MGE) (1997a). *Shrimp futures and alternatives tutorial.*

Minneapolis Grain Exchange (MGE) (1997b). News release.

Mofi (2006) *The review report on the Implementation of the Aquaculture Development Program period of 2000-2005 and solutions for the next period of to 2010* Ministry of Fisheries

Musser, W.N., Patrick, G.F. and Eckman, D.T. (1996) *Risk and grain marketing behavior of large-scale farmers*. Review of Agricultural Economics 18, 65-77.

Møller, J. H. (2011) *Outlook for European Cold Water Shrimp Market, March*, Gemba Seafood Consulting/Department of Fisheries and Aquaculture, Government of Newfoundland and Labrador, Industry Report

Nance, D.R., Smith, C.W. Jr. and Smithson, C.W. (1993) *On the determinants of corporate hedging*. Journal of Finance 48, 267-284.

Paroush, J. and Wolf, A. (1992) *The derived demand with hedging cost uncertainty in the futures markets*. Economic Journal 102, 831-844.

Patrick, G.F., W.N. Musser and Eckman, D.T. (1998) *Forward marketing practices and attitudes of large-scale Midwestern grain producers*. Review of Agricultural Economics 20, 38-53.

Pennings, J. M. E. and Meulenberg, M. T. G. (1997) *Hedging Efficiency: A Futures Exchange Management Approach*, Journal of Futures Markets, Vol. 17, No. 5, 599-615, John Wiley & Sons

Pennings, J. M. E. and Meulenberg, M. T. G. (1997) *The Hedging Performance in New Agricultural Futures Markets: A Note*, Agribusiness Vol. 13, No. 3, pp. 295-300, John Wiley & Sons, Inc.

Pennings, J. M. E. and Leuthold, R.M. (1999) *Commodity Futures Contract Viability: A Multidiciplinary Approach*

Pham, V. K. (2008) *Challenges to Shrimp Production in the Bentre Province, Vietnam*, Norwegian College of Fishery Science, University of Tromso

Porter, M.E. (1979) *How Competitive Forces Shape Strategy*, Harvard Business Review, March/April 1979

Sanders, D.R. and Pennings, J. M. E. (1999) *They Trade Shrimp in Minneapolis? An Examination of the MGE White Shrimp Futures Contract.* Proceedings of the NCR-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management. Chicago, IL. http://www.farmdoc.uiuc.edu/nccc134 [Accessed 10/12/2010]

Schrand, C. and Unal, H. (1998) *Hedging and coordinated risk management: evidence from thrift conversions.* Journal of Finance 53, 979-1013.

Shapiro, B.I. and Brorsen, B.W. (1988) *Factors affecting farmers' hedging decisions*. North Central Journal of Agricultural Economics 10, 141-156.

Silva, S. S. De M. J. P., and Mohan, C.V. (2007): *Meeting the Demands and Challenges of Globalization of Trade in Aquaculture: The Role of a Regional Inter-Governmental Body.*

Smith, C. W. R. S. (1985) *The determinants of firms' hedging policies.* Journal of Financial and Quantitative Analysis 20, 391-405.

Strömsta, Karl-Erik (2008) *Industry Report – Global Shrimp Outlook*, IntraFish

Tufano, P. (1996) *Who manages risk? An empirical examination of risk management practices in the gold mining industry*. Journal of Finance 51, 1097-1137.

U.S. Department of Health and Human Services, Food and Drug Administration, Center for Food Safety and Applied Nutrition, 2011, *Fish and Fishery Products Hazards and Controls Guidance*, Fourth Edition, http://www.fda.gov/FoodGuidances [Accessed 08/02/2012]

Vinuya, F. D. (2007) *Testing for Market Integration and the Law of One Price in World Shrimp Markets*, Aquaculture Economics and Management, 2007, v. 11, iss. 3, pp. 243-65, ISSN: 13657305
http://web.ebscohost.com/ehost/detail?sid=f664e94f-35d1-4be8-bf33-3bc1e2d854dc%40sessionmgr10&vid=1&hid=7&bdata=JnNpdGU9ZWhvc3QtbGl2ZQ%3d%3d#db=ecn&AN=0932232
[Accessed 01/12/2011]

Visvanathan, G. (1998) *Who uses interest rate swaps? A cross-sectional analysis.* Journal of Accounting, Auditing & Finance 13, 173-200.

Wooldridge, J. M. (2009) *Introductory Econometrics – A Modern Approach*, 4th Edition, South-Western Cengage Learning, ISBN -13: 978-0-324-58548-3, ISBN -10: 0-324-58548-9

Appendix

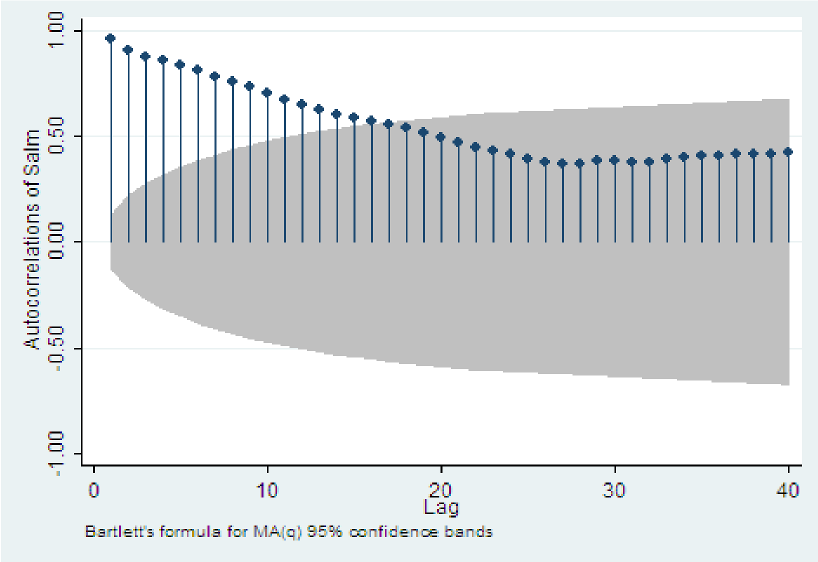
A. P.vannamei and P.monodon Price history (Urner Barry)

Date	P.Vannamei Price Index	P.Monodon Price Index	Date	P.Vannamei Price Index	P.Monodon Price Index	Date	P.Vannamei Price Index	P.Monodon Price Index	Date	P.Vannamei Price Index	P.Monodon Price Index
2007/1/1	2.86	5.53	2008/2/11	3.01	5.4	2009/3/23	2.83	4.91	2010/5/3	3.44	6.01
2007/1/8	2.86	5.55	2008/2/18	3	5.39	2009/3/30	2.82	4.92	2010/5/10	3.52	6.08
2007/1/15	2.87	5.55	2008/2/25	3	5.39	2009/4/6	2.82	4.92	2010/5/17	3.6	6.14
2007/1/22	2.87	5.59	2008/3/3	3	5.39	2009/4/13	2.81	4.92	2010/5/24	3.68	6.2
2007/1/29	2.87	5.6	2008/3/10	2.99	5.38	2009/4/20	2.8	4.92	2010/5/31	3.75	6.28
2007/2/5	2.86	5.62	2008/3/17	3	5.35	2009/4/27	2.79	4.94	2010/6/7	3.8	6.44
2007/2/12	2.86	5.63	2008/3/24	3.03	5.31	2009/5/4	2.78	4.96	2010/6/14	3.84	6.58
2007/2/19	2.86	5.63	2008/3/31	3.03	5.27	2009/5/11	2.75	4.99	2010/6/21	3.85	6.62
2007/2/26	2.84	5.64	2008/4/7	3.03	5.24	2009/5/18	2.75	5.04	2010/6/28	3.85	6.68
2007/3/5	2.82	5.65	2008/4/14	3.03	5.23	2009/5/25	2.76	5.05	2010/7/5	3.85	6.69
2007/3/12	2.81	5.66	2008/4/21	3.03	5.21	2009/6/1	2.76	5.05	2010/7/12	3.83	6.69
2007/3/19	2.8	5.66	2008/4/28	3.05	5.2	2009/6/8	2.78	5.06	2010/7/19	3.8	6.71
2007/3/26	2.78	5.67	2008/5/5	3.1	5.2	2009/6/15	2.81	5.08	2010/7/26	3.76	6.71
2007/4/2	2.76	5.73	2008/5/12	3.13	5.17	2009/6/22	2.85	5.12	2010/8/2	3.71	6.71
2007/4/9	2.76	5.73	2008/5/19	3.17	5.15	2009/6/29	2.89	5.15	2010/8/9	3.68	6.71
2007/4/16	2.75	5.73	2008/5/26	3.19	5.15	2009/7/6	2.9	5.15	2010/8/16	3.64	6.71
2007/4/23	2.75	5.73	2008/6/2	3.22	5.15	2009/7/13	2.93	5.15	2010/8/23	3.62	6.69
2007/4/30	2.74	5.73	2008/6/9	3.27	5.16	2009/7/20	2.94	5.15	2010/8/30	3.6	6.69
2007/5/7	2.75	5.71	2008/6/16	3.29	5.19	2009/7/27	2.94	5.15	2010/9/6	3.6	6.68
2007/5/14	2.75	5.7	2008/6/23	3.35	5.22	2009/8/3	2.94	5.15	2010/9/13	3.61	6.66
2007/5/21	2.75	5.69	2008/6/30	3.41	5.25	2009/8/10	2.91	5.15	2010/9/20	3.65	6.65
2007/5/28	2.75	5.68	2008/7/7	3.48	5.25	2009/8/17	2.89	5.11	2010/9/27	3.74	6.64
2007/6/4	2.76	5.74	2008/7/14	3.52	5.25	2009/8/24	2.86	5.11	2010/10/4	3.84	6.64
2007/6/11	2.77	5.74	2008/7/21	3.56	5.25	2009/8/31	2.82	5.11	2010/10/11	3.91	6.67
2007/6/18	2.79	5.74	2008/7/28	3.59	5.25	2009/9/7	2.8	5.12	2010/10/18	3.99	6.7
2007/6/25	2.79	5.74	2008/8/4	3.59	5.24	2009/9/14	2.79	5.12	2010/10/25	4.03	6.71
2007/7/2	2.84	5.75	2008/8/11	3.55	5.21	2009/9/21	2.79	5.12	2010/11/1	4.04	6.71
2007/7/9	2.91	5.76	2008/8/18	3.51	5.21	2009/9/28	2.78	5.11	2010/11/8	4.05	6.72
2007/7/16	2.94	5.74	2008/8/25	3.47	5.19	2009/10/5	2.77	5.09	2010/11/15	4.03	6.74
2007/7/23	2.96	5.73	2008/9/1	3.42	5.19	2009/10/12	2.77	5.09	2010/11/22	4.01	6.74
2007/7/30	2.97	5.71	2008/9/8	3.36	5.19	2009/10/19	2.76	5.09	2010/11/29	3.97	6.73
2007/8/6	2.97	5.66	2008/9/15	3.35	5.14	2009/10/26	2.77	5.07	2010/12/6	3.92	6.72
2007/8/13	2.97	5.63	2008/9/22	3.32	5.14	2009/11/2	2.77	5.07	2010/12/13	3.87	6.69
2007/8/20	2.97	5.61	2008/9/29	3.28	5.11	2009/11/9	2.78	5.07	2010/12/20	3.83	6.66
2007/8/27	2.95	5.61	2008/10/6	3.18	5.06	2009/11/16	2.79	5.08	2010/12/27	3.83	6.65
2007/9/3	2.94	5.57	2008/10/13	3.06	5.03	2009/11/23	2.8	5.11	2011/1/3	3.8	6.64
2007/9/10	2.93	5.49	2008/10/20	3	4.99	2009/11/30	2.83	5.14	2011/1/10	3.83	6.64
2007/9/17	2.93	5.44	2008/10/27	2.96	4.98	2009/12/7	2.83	5.15	2011/1/17	3.86	6.63
2007/9/24	2.9	5.39	2008/11/3	2.92	4.93	2009/12/14	2.83	5.2	2011/1/24	3.89	6.62
2007/10/1	2.9	5.38	2008/11/10	2.84	4.88	2009/12/21	2.82	5.25	2011/1/31	3.9	6.62
2007/10/8	2.89	5.35	2008/11/17	2.83	4.84	2009/12/28	2.83	5.3	2011/2/7	3.93	6.59
2007/10/15	2.88	5.34	2008/11/24	2.81	4.81	2010/1/4	2.94	5.41	2011/2/14	3.93	6.59
2007/10/22	2.87	5.31	2008/12/1	2.8	4.78	2010/1/11	2.94	5.44	2011/2/21	3.95	6.59
2007/10/29	2.86	5.3	2008/12/8	2.79	4.77	2010/1/18	2.93	5.48	2011/2/28	3.99	6.59
2007/11/5	2.87	5.29	2008/12/15	2.78	4.76	2010/1/25	2.93	5.48	2011/3/7	4	6.57
2007/11/12	2.89	5.29	2008/12/22	2.78	4.75	2010/2/1	2.96	5.58	2011/3/14	4	6.55
2007/11/19	2.95	5.29	2008/12/29	2.78	4.68	2010/2/8	2.96	5.64	2011/3/21	4	6.52
2007/11/26	2.97	5.29	2009/1/5	2.79	4.68	2010/2/15	2.97	5.65	2011/3/28	3.98	6.54
2007/12/3	3	5.29	2009/1/12	2.79	4.7	2010/2/22	2.98	5.67	2011/4/4	3.95	6.56
2007/12/10	3.01	5.3	2009/1/19	2.8	4.71	2010/3/1	2.99	5.71	2011/4/11	3.93	6.64
2007/12/17	3.02	5.32	2009/1/26	2.82	4.71	2010/3/8	3.01	5.74	2011/4/18	3.93	6.65
2007/12/24	3.02	5.33	2009/2/2	2.82	4.71	2010/3/15	3.04	5.75	2011/4/25	3.89	6.61
2007/12/31	3.02	5.4	2009/2/9	2.82	4.75	2010/3/22	3.11	5.76	2011/5/2	3.87	6.61
2008/1/7	3.02	5.46	2009/2/16	2.82	4.76	2010/3/29	3.18	5.83	2011/5/9	3.86	6.63
2008/1/14	3.03	5.46	2009/2/23	2.82	4.81	2010/4/5	3.22	5.86	2011/5/16	3.86	6.66
2008/1/21	3.03	5.46	2009/3/2	2.83	4.86	2010/4/12	3.27	5.92	2011/5/23	3.86	6.68
2008/1/28	3.02	5.44	2009/3/9	2.83	4.87	2010/4/19	3.33	5.96	2011/5/30	3.86	6.68
2008/2/4	3.01	5.41	2009/3/16	2.83	4.89	2010/4/26	3.36	5.99	2011/6/6	3.86	6.68

B. Stationarity Test for Salmon statistics

I. Price indices

Figure A.1. Correlogram for salmon prices



The correlogram above shows that the salmon prices are not stationary since the autocorrelations take long time to die out. Therefore we need to consider using relative growth and absolute growth of prices in regression as well as in other econometric analysis. Similar to what we have done with shrimp prices, we consider three types of Dickey-Fuller tests.

II. Lg growth

(1) DF Test with no constant

Table A.1. Dickey-Fuller test for relative growth of salmon prices 1

```
. dfuller lggSal, reg noconst

Dickey-Fuller test for unit root                   Number of obs   =       230

                              ---------- Interpolated Dickey-Fuller ----------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)            -13.277            -2.583            -1.950            -1.619

------------------------------------------------------------------------------
    D.lggSal |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      lggSal |
         L1. |  -.8727947    .065738   -13.28   0.000    -1.002323    -.743266
------------------------------------------------------------------------------
```

(2) DF Test with constant (i.e. drift)

Table A.2. Dickey-Fuller test for relative growth of salmon prices 2

```
. dfuller lggSal, regress

Dickey-Fuller test for unit root                    Number of obs   =       230

                         ------------ Interpolated Dickey-Fuller ------------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic         Value             Value            Value
------------------------------------------------------------------------------
 Z(t)           -13.249          -3.467            -2.881           -2.571
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

------------------------------------------------------------------------------
    D.lggSal |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      lggSal |
         L1. |    -.87294   .0658882   -13.25   0.000    -1.002768   -.7431123
             |
       _cons |   .0005169   .0038283     0.14   0.893    -.0070265    .0080603
------------------------------------------------------------------------------
```

(3) DF Test with constant (drift) and deterministic time trend

Table A.3. Dickey-Fuller test for relative growth of salmon prices 3

```
. dfuller lggSal, reg trend

Dickey-Fuller test for unit root                    Number of obs   =       230

                         ------------ Interpolated Dickey-Fuller ------------
                 Test         1% Critical       5% Critical      10% Critical
               Statistic         Value             Value            Value
------------------------------------------------------------------------------
 Z(t)           -13.219          -3.997            -3.433           -3.133
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

------------------------------------------------------------------------------
    D.lggSal |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      lggSal |
         L1. |  -.8729203   .0660329   -13.22   0.000    -1.003036   -.7428044
      _trend |  -4.19e-06   .0000578    -0.07   0.942     -.000118    .0001097
       _cons |   .0010009   .0076975     0.13   0.897    -.0141669    .0161686
------------------------------------------------------------------------------
```

Comparing the test statistic $Z(t)$ with the critical value, we can reject the null hypothesis of non-stationarity for all the Dickey-Fuller specifications (1), (2) and (3) at 1% level. Therefore the tests indicate that the relative growths of the price series are stationary.

III. First difference

(1) DF Test with no constant

Table A.4. Dickey-Fuller test for absolute growth of salmon prices 1

```
. dfuller dtSal, reg noconst

Dickey-Fuller test for unit root                    Number of obs   =       230

                                 ---------- Interpolated Dickey-Fuller ----------
                    Test         1% Critical       5% Critical      10% Critical
                 Statistic           Value             Value            Value
------------------------------------------------------------------------------
 Z(t)            -13.698            -2.583            -1.950           -1.619
------------------------------------------------------------------------------

------------------------------------------------------------------------------
    D.dtSal |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
------------+-----------------------------------------------------------------
      dtSal |
        L1. |  -.9038615   .0659829   -13.70   0.000    -1.033873   -.7738503
------------------------------------------------------------------------------
```

(2) DF Test with constant (i.e. drift)

Table A.5. Dickey-Fuller test for absolute growth of salmon prices 2

```
. dfuller dtSal, regress

Dickey-Fuller test for unit root                    Number of obs   =       230

                                 ---------- Interpolated Dickey-Fuller ----------
                    Test         1% Critical       5% Critical      10% Critical
                 Statistic           Value             Value            Value
------------------------------------------------------------------------------
 Z(t)            -13.669            -3.467            -2.881           -2.571
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

------------------------------------------------------------------------------
    D.dtSal |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
------------+-----------------------------------------------------------------
      dtSal |
        L1. |  -.9039987   .0661331   -13.67   0.000    -1.034309   -.7736885
            |
      _cons |   .016344   .1239299     0.13   0.895    -.2278504    .2605383
------------------------------------------------------------------------------
```

(3) DF Test with constant (drift) and deterministic time trend

Table A.6. Dickey-Fuller test for absolute growth of salmon prices 3

```
. dfuller dtSal, reg trend

Dickey-Fuller test for unit root                    Number of obs   =       230

                                 ---------- Interpolated Dickey-Fuller ----------
                    Test         1% Critical       5% Critical      10% Critical
                 Statistic           Value             Value            Value
------------------------------------------------------------------------------
 Z(t)            -13.640            -3.997            -3.433           -3.133
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

------------------------------------------------------------------------------
    D.dtSal |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
------------+-----------------------------------------------------------------
      dtSal |
        L1. |  -.9039946   .0662763   -13.64   0.000    -1.03459   -.7733991
     _trend |  -.0002345   .0018704    -0.13   0.900     -.00392    .0034511
      _cons |   .0434249   .2491848     0.17   0.862    -.4475861    .5344359
------------------------------------------------------------------------------
```

Comparing the test statistic $Z(t)$ with the critical value, we can reject the null hypothesis of non-stationarity for all the Dickey-Fuller specifications (1), (2) and (3) at 1% level. Therefore the tests indicate that the absolute growths of the price series are stationary.

C. List of seafood exchanges

Australia	Melbourne Fish Market, http://www.chsmith.com.au/fish-prices/index.htm
	Sydney Fish Market, http://www.sydneyfishmarket.com.au/
	Western Australian Fishing Industry, http://www.wafic.com.au/
Asia	Taiwan, http://www.tpg.gov.tw/ - Taiwan Area Fishery Broadcasting Station - Fish Market Prices.
	Hong Kong, http://www.fmo.org.hk/ Fish Marketing Organization
	China, http://www.21food.cn/news/price.jsp?product=%CF%BA&category=%CB%AE%B2%F
	China, Dalian Commodity Exchange, http://www.dce.com.cn/
	Japan, http://www.shijou.metro.tokyo.jp/ - Metropolitan Central Fish Market central wholesale seafood market.
	Japan, http://swr.ucsd.edu/fmd/sunee/salesvol/svw.htm - Wholesale Fish Prices and Sales Volume
	Japan, http://swr.ucsd.edu/fmd/sunee/twshrimp/tokyo.htm - Tokyo Wholesale Shrimp Prices
	Japan, Kansai Commodities Exchange, http://www.kanex.or.jp/index.html
	Japan, http://swr.ucsd.edu/fmd/sunee/twprice/jws.htm - Tokyo Wholesale Fish Prices
	Tsuikiji Fish Market, http://www.tsukiji-market.or.jp/tukiji_e.htm - Tokyo's
U.S.A	U.S.A, http://www.st.nmfs.gov/st1/market_news/index.html. - National Marine Fishery Service - Fulton Fish Market, New England Auction Prices, West Coast Shellfish, Boston Frozen Market, Fish Meal & Fish Oil Prices, New York Frozen Market, Gulf Coast Shrimp,
	U.S.A, http://swr.ucsd.edu/fmd/bill/mktsp.htm - San Pedro Fish Market Current Prices

	Bristol Seafood, http://www.bristolseafood.com/ - Portland, Maine, USA.
	Seafood Paradise Hawaii, http://www.hawaii-seafood.org/ - Honolulu Fish Auction.
	Suisan Fish Auction, http://www.suisan.com/market/auction.html - Fresh fish auction market.
	FoodService.com, http://www.foodservice.com/marketprices/seafood/ - Market prices of fish and seafood from Food Service
	Fish Landings and Average Ex-vessel Prices – USA, http://swr.ucsd.edu/fmd/sunee/fishlexv/jexv.htm Fish landings, average ex-vessel price
	Fish Meal Market Prices, http://www.st.nmfs.gov/st1/market_news/doc44.txt - Prices of fishmeal
	Fulton Fish Markets – USA, http://www.st.nmfs.gov/st1/market_news/doc21.txt
	La Nueva Viga – Mexico, http://www.economia-sniim.gob.mx/SNIIM-PESCA/e_lvini1.asp? Mexican fish market
	New England Auction Prices – USA, http://www.st.nmfs.gov/st1/market_news/doc31.txt
	Portland Fish Exchange – USA, http://www.portlandfishexchange.com/ Fish Exchange Portland
	San Pedro Market Fish – USA, http://swr.ucsd.edu/fmd/bill/mktsp.htm Market price for seafood
	Seafood Report – USA (FoodService.com), http://www.foodservice.com/marketprices/seafood
	Weekely Boston Frozen Market Prices – USA, http://www.st.nmfs.gov/st1/market_news/doc32.txt
	Weekly Ex-Vessel Gulf Fresh Shrimp Prices & Landings – USA, http://www.st.nmfs.gov/st1/market_news/doc42.txt - shrimp prices and landing

	Weekly Fish Meal & Oil Prices – USA, http://www.st.nmfs.gov/st1/market_news/doc44.txt Fish oil and fishmeal prices
	Weekly Gulf Finfish Prices – USA, http://www.st.nmfs.gov/st1/market_news/doc43.txt Finfish market price indicator
	Weekly New England Auction Summary – USA, http://www.st.nmfs.gov/st1/market_news/doc33.txt
	Weekly New York Frozen Prices – USA, http://www.st.nmfs.gov/st1/market_news/doc22.txt
Europe	Italy, http://www.pesca.ismea.it/mnuAgenzie/agenzia.asp - ISMEA Fish & Aquaculture
	Germany, http://www.fischauktion.de/ - Bremmerhavener Fish Auction
	EU Fish Quotas, http://www.irishmarine.com/fishing.html - Courtesy of Irish Marine
	Spain, http://www.fish1.com/FishPrices.html - Spanish Fish Market Prices
	Mercabarna Market – Spain, http://www.mercabarna.es/cgi-bin/treu.cgi
	Göteborgs Fiskauktion – Sweden, http://www.gfa.se/
	Billingsgate Market – UK, http://www.billingsgate-market.org.uk/
	Fishgate (Hull Fish Auction Ltd.) http://www.fishgate.co.uk/ - Kingston upon Hull, UK.
	Grimsby Fish Market, http://www.grimsbyfishmarket.co.uk/ - Current Fish prices and auction site in Grimsby, England.
	Hanstholm Fish Auction, http://www.hanstholmfiskeauktion.dk/default.asp?V_LANG_ID=7&RND=40 -
	Peterhead Fish Market – UK, http://www.caley-fisheries.co.uk/prices.htm

	Scrabster Fishmarket – Scotland, http://www.scrabster.co.uk/
	Skagen Fiskauktion, http://www.skagenfiskeauktion.dk/ - Danish fish auction. Danish language site with current fish prices.
See Also:	MGE, Black Tiger Shrimp Daily Charts and Prices, (not trading anymore) http://exchanges.barchart.com/intra/mgex/mgest.htm
	Salmon Prices http://www.intrafish.com/engelsk/prices/ from IntraFish Daily up-to-date Salmon market prices in Japan, France and Usa.
	Source: http://www.sea-ex.com/trading/market.htm

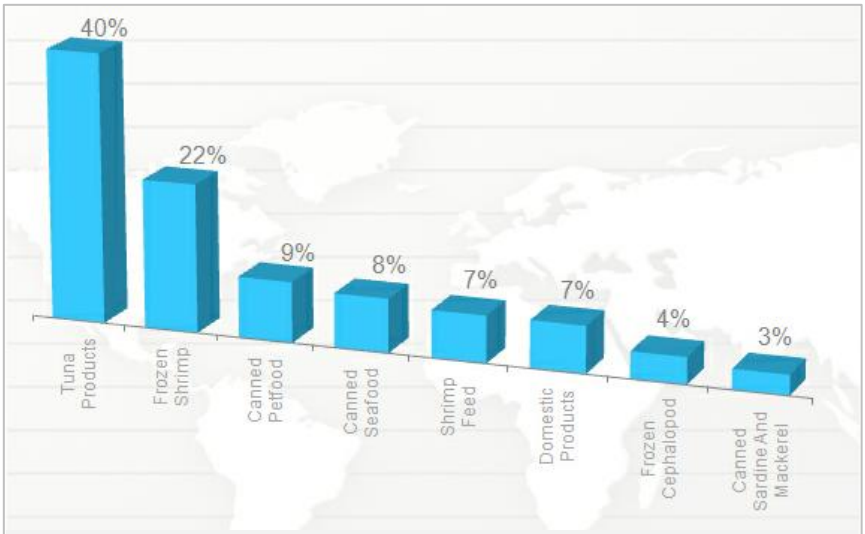
D. Profiles of some shrimp producers

ASIA

Thai Union Group http://www.thaiuniongroup.com/home/intro.html

The predecessor of Thai Union Group PLC, Thai Union Manufacturing Co.,Ltd was established as early as 1973. The group was formed in 1988 and was listed on Stock Exchange of Thailand since 1994 and remains one of the biggest seafood producer in Asia and in the world. In 2010, the Group made 71.5 billion Thai Baht in Sales[28], which is equivalent to $2.3 billion at an exchange rate of 1.00 USD, = 31.60 THB. Figure C.1 and Figure C.2 gives the breakdown of sales by products and by regions in the same year. 22% of the consolidated sales is represented by frozen shrimp, with a value of $506 million.

Figure C.1. Sales breakdown by products –TU, 2010

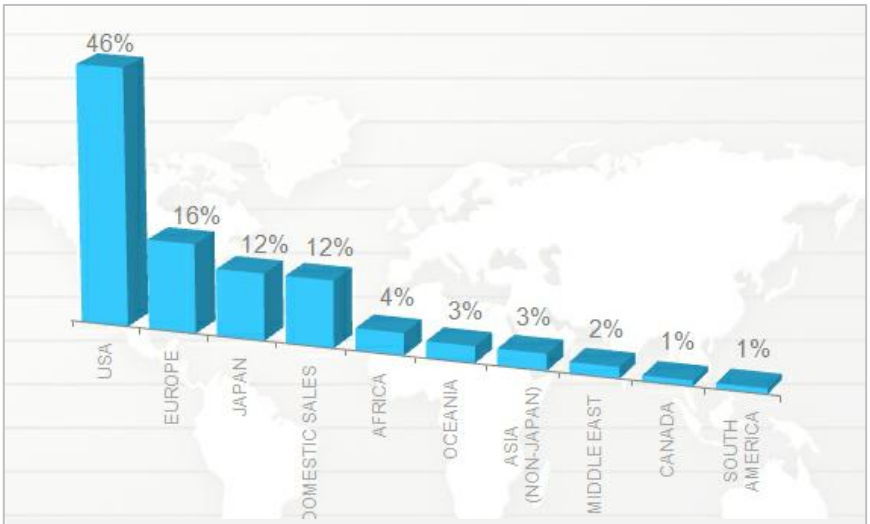


Source: http://www.thaiuniongroup.com/home/Investor_Relations/index.php

Accounting for almost $\frac{1}{60}$ or 1.6% of the world total shrimp trade value, Thai Union is absolutely one of the most important shrimp producers in the world, possessing great power in directing the market.

[28] Thai Union Annual Report, 2010, http://tuf.listedcompany.com/misc/ar/ar2010_en/ar2010_enindex.htm

Figure C.2. Sales breakdown by markets – TU, 2010



Source: http://www.thaiuniongroup.com/home/Investor_Relations/index.php

Allied Pacific http://www.alliedpacificfood.com

Allied Pacific GROUP is the leading seafood processor and exporter in Dalian, China. With two large seafood processing plants, APG has the capacity to produce over 20,000 tons of seafood annually. Products are mainly exported to US, Canada, Japan, Korea, Australia, Singapore, Malaysia and Europe.

Charoen Pokphand Thailand http://www.cpthailand.com

Charoen Pokphand Foods Public Company Limited is a Thailand-based company engaged in the operation of agro-industrial and integrated food businesses. The businesses are divided into two segments: livestock business, which comprises of chicken, duck and pigs and aquatic business, which consists of shrimp and fish. The two main businesses are vertically integrated, sourcing raw materials for animal feed production, breeding animals, farming animals for commercial purposes, processing meat, producing ready-to-eat food products, and selling products to both domestic and overseas markets. The Company's products include animal feed, animal farm products, such as animal breeder, live animal and meat, and processed foods and ready meals. Its subsidiaries include Bangkok Produce Merchandising Public Company Limited, Bangkok Agro-Industrial Products Public Company Limited,

Bangkok Food Products Co., Ltd. and Charoen Pokphand Northeastern, among others.[29]

PT Charoen Pokphand Indonesia Tbk http://cp.co.id/

In 2011, Charoen Pokphand Indonesia made a net sales of 18 trillion Indonesian rupiahs, which is approximately $1.9 billion.[30] But over 99% is from poultry feed and poultry processing. Less than 1% is from the remaining business including other feeds, machinery etc. Unlike Charoen Pokphand Thailand, it seems that Charoen Pokphand Indonesia does not focus its business on shrimp business.

SOUTH AMERICA

OMARSA http://www.omarsa.com.ec/

Since 1977 OMARSA has been engaged in farming, processing and shipping of frozen vannamei shrimp. The company boasts its strict quality control and high standards products. The operation is vertically integrated includes three hatcheries, three shrimp farms and a processing plant. It is among the top 5 shrimp exporting companies in Ecuador with diversified brands and markets.

Promarisco http://www.promarisco.com/

The Promarisco Group is a vertically integrated company specialized in growing and selling the Ecuadorian Vannamei. The hatcheries produce over 2 billion larvae per year. The feed mill produces 40,000 tons per year and the shrimp farm covers an area of 4,500 hectares, which appears to be using non-intensive farming technologies.

Pesca Fina S.A. http://www.cevichepescafina.com/

Pesca Fina is a privately owned company and has has been in the seafood business for over 60. It operates its own fishing boats and became an established source of employment in the fishing community in Panama. In 2008 it established an

[29] Thomson Reuters, http://www.reuters.com/finance/stocks/overview?symbol=CPOKY.PK

[30] Charoen Pokphand Indonesia Annual Report, 2011, http://cp.co.id/wp-content/uploads/2012/04/annual-report-cpin-2011.pdf

importing and distribution Company in Miami, Florida operating as Ceviche Pesca Fina, LLC. Its distribution Company services hotels, restaurants, deli-markets and fish markets. The products are FDA approved and HACCP certified and comply with the highest food safety regulations.

Cartagena Shrimp Company http://www.cartacua.com/

Cartagena Shrimp Company was founded in 1983 in the colonial city of Cartagena de Indias, Colombia. It is dedicated to aquaculture and the production of shrimp (Penaeus Vannamei specie).[31] Products are exported to U.S., Mexico, Colombia, France, Spain, United Kingdom and Holland. Operation in Cartagena is vertically integrated from hatchery, farm and processing. Cartagena Shrimp farms its shrimp on a field of 800 hectares using an entirely intensive system. They grow between 35 to 45 shrimp per square meter in ponds equipped with individual aerators. The average production is approximately 4.500 kg per hectare, and 2.6 harvests a year per pond. The estimated production for this year is approximately 10,000 tons. At the present time the farm employs some 300 workers, most of which are native dwellers of the area.

Expalsa http://www.expalsa.com/

Expalsa is specialized in producing and exporting agricultural and aquaculture products since 1973. The shrimp farm covers an area of 50,000 hectare with integrated production in Guayaquil, Ecuador. From the size of the farms, Expalsa appears to be quite big compared to its peers in South America.

Groppon Farallon Aquaculture http://www.gfarallon.com/index.php/es/

Farallon Aquaculture, SA is a Panamanian company founded in 1993 dedicated to larval production, cultivation and marketing of shrimp. The group's headquarter is located in Panama City and employes over 1,000 employees across the region. The

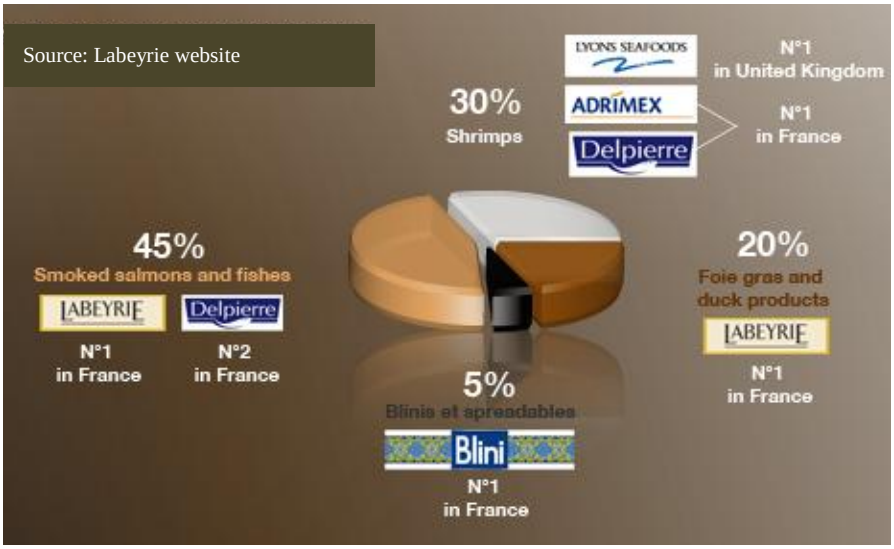
[31] Cartagena Shrimp company website, 2012 http://www.cartacua.com/synergy/docs/BDBinDoc.asp?Id=%7BC05A81B3-AAA8-4D30-BE57-9031CA14736D%7D

operation includes seven larval production centers located in Panama, Mexico, Honduras, Nicaragua, Ecuador, Venezuela, and two packaging plants located in Panama and Nicaragua.

EUROPE

Labeyrie (France) http://www.labeyrie.com/

Labeyrie is a subsidiary of ALFESCA, a French-Icelandic group which is the European leader of festive food. Its main activities are in four markets: smoked salmons and fishes; shrimps; foie gras and duck products; blinis and spreads. The company has €221 million in turnover in 2008 and the main segments are summarized in the figure below. 30% of the revenues are generated by shrimps, representing €66.3 million.



Accounting for about 0.2% of the world total shrimp trade value, Labeyrie can be considered quite important, especially in the European market.