Hedonic price analysis of shrimp: Quality Factors influencing Market price of Shrimp in Nha Trang, Vietnam

Nadarajah Suthamathy

Master Thesis in Fisheries and Aquaculture
Management and Economics
(30 ECTS)

The Norwegian College of Fishery Science
University of Tromso, Norway
&
Nha Trang University, Vietnam

May 2012

Abbreviations and Acronyms

ARGOINFO	Information Center for Agriculture and Rural Development
BMP	Better Management Practices
FAO	Food and Agriculture Organization
GAP	Good Aquaculture Practices
GSO	General Statistical Office
Ha	Hectare
NORAD	Norwegian Agency for Development Co-operation
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary least Square
VASEP	Vietnam Association of Seafood Exporters and Producers
VND	Vietnamese currency Unit (Dong)

Abstract

Purpose: The primary purpose of this study was to identify the various quality attributes of shrimp which influence on market price and evaluate the relationship between price and quality attributes. Secondly to point out the main quality characters of shrimp which influence consumer preference and demand in domestic market.

Theoretical framework – Based on Rosen (1974) proposed framework, simple linear form of hedonic price model of price dependent variable and combined continuous and dummy explanatory variables was developed to achieve the objectives.

Methodology and sampling - Seventy six shrimp observations were collected from a specific domestic market in Nha Trang and price and quality attributes were recorded. Variables used to estimate the model were adopted from previous literatures of seafood hedonic pricing. Hedonic model price was estimated by regressing price on quality attributes using OLS method in Shazam 10.0. A questionnaire survey was conducted using a convenience sample of 130 consumers in Nha Trang, Vietnam and data were analyzed using statistical tool Microsoft Excel 2003.

Findings – The results confirm the hypothesis that the market price remarkably influenced by the extrinsic quality attributes of shrimp including carapace length, weight, origin, species freshness, product form and preservation method. Longer carapace length and no discolored shrimp are highly valued. Freezing, although widely practiced, receives the discount among preservation method. Fully cleaned to product form obtains a high premium. Further more, study found that some of quality characteristics such freshness, origin, species and size are also considered by consumer beside price which are the attributes influence on the consumer preference and demand. Even though, favourite quality attributes of shrimp vary with consumer, the most of consumers prefer the medium sized, sea-caught and fresh whole shrimp for consumption.

Managerial implications - Practical implications drawn from this study are that fisherman should consider the mesh size of trawler to avoid very small size shrimp catching and preservation method. Farm operators have to maintain the optimum density to facilitate shrimp for attaining its maximum mature size by providing adequate nutrition, sanitation and spacing to individuals. Farm operators should also consider the consumer demanded species

during the selection of species for farming. Further, it can be suggested that preserving cultured shrimp in aerated water can during selling is a good practice to keep shrimp fresh. The shrimp seller can adapt this as a better method for cultured shrimp.

This research could contribute to understand about shrimp industry and marketing in Vietnam and to modify the possible quality attributes which would upgrade quality standard of shrimp and get better price in future through satisfying consumer preferences.

Limitations – This research was conducted by considering extrinsic quality parameters which easily identifiable by domestic consumer. Even though, intrinsic quality parameters of shrimp mainly nutritional content also have influence on the price. Future study should incorporate those nutritional attributes. The consumer survey was based on shrimp buyers from domestic markets in Nha Trang city which did not represent the whole consumers, thus the results could not be generalized to Vietnam as a whole.

Keywords: Hedonic analysis, shrimp, extrinsic quality attributes, market price and Vietnam.

Acknowledgement

With deep sense of gratitude, I express my wholeheartedly thanks to my internal supervisors Professor Øystein Myrland, Tromsø University Business School, University of Tromsø for his excellent guidance, tremendous encouragement, valuable advices given to me throughout the study and indeed for his patient supervision. I am forever grateful to my national supervisor Dr. Le Kim Long Nha Trang University, Vietnam for kind advices and invaluable assistance during the entire study period.

I wish to record my thanks with pleasure to Academic coordinators Dr. Siv Reithe, University of Tromsø and Prof. Nguyen Thi Kim Anh, University of Nha Trang who imposed a great effort to give the maximum privileges through out this master course. I offer my true and sincere thanks to administrative coordinators, Mr. Kristoffer Kockvold (UoT, Norway), Ms. My Hanh and Mr. Nguyen Ngoc Duy (NTU, Vietnam) for the facilities provided to complete the study successfully.

I gratefully acknowledge the financial support of the NORAD project.

I wish to say my thanks to Mr.Nguyen Phong Hai and Dr. Mo Le thi hong Mo lecturers Nha Trang University, Vietnam for their kind help and also the staff of Aquaculture laboratory of Nha Trang University for the kind cooperation during laboratory work.

I would like to express my thanks to all those who rendered help in numerous ways from the inception of the thesis and my grateful gratitude to my Vietnamese colleagues and friends for their enthusiasm, moral support and encouragement not only during study period and also during my stay at Nha Trang University, Vietnam

At last not least, I cordially express my everlasting love and deepest gratitude to my parents, brother and sister for their kind, encouragement given to complete this study successfully.

Nadarajah Suthamathy

TABLE OF CONTENTS

List of Appendix

List of Figures

List of Tables

CHAPTER 1
INTRODUCTION

1.0 Introduction

Price indices play a significant role in present's economy. An index which shows how average price of a unit of commodity changes over time is referred as "*Price index*" (Samuelson and Nordhaus, 2010). The term "*Hedonic price index"* is well known. Hedonic price is the implicit price of characteristic embodied in a commodity (Rosen, 1974). The core hypothesis is that goods are valued for their utility-bearing attributes or characteristic and goods price varies with the change in quantity of characteristic associated with it (Rosen, 1974). Hedonic price analysis is a kind of regression analysis which is widely used by economists to evaluate the influence of unit of quality changes on the price of a commodity.

Generally, prices of commodities vary in two distinct ways within markets. First one is due to the seasonal variation, where market situation influence more, mainly daily demand and supply of that commodity. Another is due to difference in the quality characteristic or external appearance of particular commodity at a given point of time (Waugh, 1928). For products such as raw material from either agricultural or fishery sectors, quality attributes remarkably influence the price itself because those are perishable edible products and whose characteristics heterogeneous in nature and evolve with time. Thereby physical characteristic of those commodities are considered during the grading and pricing of product (Berndt, 1991). Hedonic method has been recommended as reasonable procedure to formulate quality-adjusted price index (Brachinger, 2002). It has been long recognized that the market price consumer pay for the seafood product depends in the quality standard of product such as texture, taste, freshness, nutritional content and packaging material. There have been numerous studies that shows the price- quality attributes relationship (Oczkowski, 1994; Combris *et al*., 1997; Salayo *et al*., 1999; Angulo *et al*., 2000; McConnell and Strand, 2000; Carroll *et al*., 2001; Roheim *et al.,* 2007) using a hedonic price model. This present study intends to study about the relation between market price and extrinsic quality attributes of shrimp in Nha Trang, Vietnam using the hedonic price model.

1.1 Background of study

Fishery and aquaculture sectors are well known for its multifunctional role in nations' economy via providing nutritional food, income, employment, foreign exchange, livelihood and recreation. World aquaculture continues to grow to meet protein requirement of growing population with an annual growth rate of 8.3% and global food fish production from aquaculture was 52.5 million tones in 2008 (FAO, 2010). Nearly 81 percent (115 millions tones) of the total world production (142 million tones) in 2008 was used for human consumption, even as the balance was utilized for secondary purpose such as direct feeding in aquaculture and production of byproducts; fishmeal and fish oil, baits and pharmaceutical items (FAO, 2010). In Vietnam, both fishery and aquaculture are important sectors which play a key role in Vietnam's social and economic life. Vietnam has a great potential to develop it's seafood industry. In addition to the long coastline around 3260 km and one million square kilometer exclusive economic zone (EEZ), it has 12 lagoons, straits and bays, 112 estuaries, canals, thousands of small and big islands scattering along the coast and numerous river systems (Tuan, 2003). Vietnam is the third largest aquaculture producing country and it was reported that the growth rate of aquaculture sector of Vietnam was 22.1% during the period of 2000-2008 (FAO, 2010) as a result of both expansion of cultured area and sophisticated techniques. Based on the statistical data, it reveals that the nationwide fishery production was 5127.6 thousands tonnes in the year 2010. Of which caught and aquaculture productions were 2420.8 and 2706.8 thousands tones respectively (GSO, 2010a). Export value of fisheries was 5.034 billion US dollars in 2010 (VASEP, 2011) and total contribution of the fisheries sector to the GDP was 5.44% in year 2008 (ARGOINFO, 2009).

Seafood products are recommended to take a prominent position in the human diet due to their high nutrients content (e.g. proteins, vitamins A, D, E, Se, I, omega-3) and vital role in the prevention of chronic degenerative diseases (Mozaffarian and Rimm, 2006; Adams and Standridge, 2006). In Vietnam, Sea foods are used as a major source of protein in their diet and the per capita consumption of seafood was 40.8 kg in 2008 (Stanton *et al*., 2010). Shrimp is not only the highest value and quantity export aquatic product of Vietnam but has high consumer demand in domestic market also. In recent decades, shrimp farming has developed dramatically and become a popular aquaculture business in several parts of Vietnam. Shrimp industry in Vietnam is characterized by two sub- sectors such sea-caught and aquaculture. In

2008, caught and cultured shrimp productions were 3 percent and 9 percent of the total fishery production (4.6 million tones) respectively (Stanton *et al*., 2010)). White shrimp (*Penaeus merguiensis*), Pink shrimp (*Penaeus ensis*), Cat Tiger (*Paraenaeus sculptilis*), Yellow shrimp (*Metapenaeus joyneri*), giant fresh water shrimp (*Machrobrandchium rosenbergii*) are some of indigenous species has been traditionally cultured in Vietnam (www.seaminhhai.com). Even though, Black tiger shrimp (*Penaeus monodon*) and White leg shrimp (*Penaeus vannamei*) are dominated shrimp species cultured in modern farms of Vietnam (Thủy *et al.,* 2010; Tien and Griffiths, 2009).

Khanh Hoa Province is a coastal province of South Central Vietnam with the population around 1,167,700 persons (GSO, 2010c) and it is also a prominent area where the shrimp farming has expanded in recent years. Nha Trang is the central city of Khanh Hoa province with 251 km² area and it is famous for seafood products. Shrimp production in Khanh Hoa Province through aquaculture was around 7188 thousand tones (GSO, 2010b). *Penaeus monodon, Penaeus vannamei* and *Penaeus merguiensis* are shrimp species cultured in the majority of commercial shrimp farms in Nha Trang also. Mature size of shrimp varies with species and may be affected by the nutritional status of feeding (Chiba *et al.,* 2000) and the growing environment condition (Araneda *et al.,* 2008). The biodiversity of shrimp species in Nha Trang bay is vast range (Zdenek, 2007; Marin and Savinkin, 2007). Bottom trawling the most common method fishing techniques used by fisherman to capture shrimp in Nha Trang. The size of individual caught by trawling depends on the mesh size of trawler gear (MacLennan, 1992). Season and fishing ground are the other factors which cause for variation in species caught. Generally, individual size and species are two main factors consider by the fisherman and farmer either in landing place or farms during the grading of shrimp to fix the selling price per kilogram in addition to the cost of production and market factors.

1.2 Research issue and objectives

Increasing concern about healthy life has twisted the consumer interest to have a look on the quality standard of seafood product during purchasing rather than quantity. Food certification and eco-labeling procedure has become more popular in many countries. Nowadays producer and sellers aim to upgrade their seafood quality through identifying the attributes desired by consumer and offer the optimum units for maximizing their profit and to get a good position in the market. From last century, researchers who involve in seafood industry have interest in investigating the influences of quality attributes of seafood on price in various stage of value chain mainly in landing place or market (Houston *et al*., 1989; Williams and Longworth, 1989; Salayo *et al*., 1999; McConnell and Strand, 2000; Carroll *et al*., 2001). Research studies about seafood sector related with quality aspects are meaningful to promote perceive quality of seafood commodity in country like Vietnam because, seafood is one of ingredients in a meal in Vietnam. Numerous studies have been done related to the Vietnamese shrimp industry. Most of them have been mainly focused on the status of production, challenges in production, technical efficiency and marketing value chain (Tuan, 2003; Khang, 2008; Thuy, 2008; Ruiz, 2009; Huy, 2009; Akter, 2010; Thuy *et al*., 2010; Choung, 2011). Shrimp is one of demanded seafood product by consumer due to its delicious taste. In relation to shrimp marketing, it is interesting and essential to integrate and investigate the relationship between the price and quality attributes of shrimp for the market efficiency. Carroll *et al*., 2010 stated that the knowledge about product attributes relates to consumer preference is useful to managers for evaluating production, investment decision and market strategies. The present study emphasis the quality aspect of shrimp associated with price and consumer preference.

The main objectives of this study are,

I. To identify various quality characters of shrimp which affect the market price in addition to market factors.
II. To find out the relationship between market price and quality characters in terms of marginal effects and elasticity.
III. To point out the main quality characters which influence consumer preference and demand of shrimp in domestic market of Nha Trang, Vietnam.

In addition to the general market factors such as quantity of product in the market, domestic demand and concomitant presence of other seafood product, the market price of seafood products like fish or shrimp generally relates and varies with species, quality and physical factors; size, species, origin, preserved method, freshness, ect (McConnell and Strand, 2000;

Salayo *et al*., 1999). Those are used as criteria for grading of shrimp by sellers in domestic market and also considered by consumer during purchase. Some of these characters have significant influence on market price and can be alter through management techniques. Thus, evaluating the influence of quality characters on price may contribute to modify the characters which can improve the perceive quality of shrimp and get better price in future through satisfying consumer preferences. Consumption of seafood is affected by preference (Sabat *et al*., 2008), convenience (Olsen *et al.*, 2007), variation in lifestyle and consumer's experience (Myrland *et al*, 2000). Quality attributes such as falvour, freshness, product form, sensory variables have influence on the seafood purchasing behavior in additional to the general factors; price, income, household and market advance (Hanson *et al.,* 1995). Wessells *et al.,* 1999 found that species has effect on the choice of ecolabelled seafood product.

Due to the limit of time and laboratory facility for the proximate analysis, the research was conducted by considering extrinsic quality parameter which easily identifiable by domestic consumers. Even though intrinsic quality parameters of shrimp also have influence on the price mainly nutritional content such like protein and carbohydrate content (Salayo *et al.*, 1999). Attributes such as nutritional value, appearance, smell, taste, texture and storage capacity of shrimp may be affected by the quality of nutrition and feed provided during culture (Hasan, 2001). In shrimp production 50-60% of the total cost of production is covered by the feed cost alone (Ridler and Hishamunda, 2001).

1.3 Method

In order to estimate a model that describe functional relationship between price and qualitative attributes of shrimp, seventy six observations were collected at different prices from a specific domestic market in Nha Trang and quality characters were recorded. Variables used to estimate model were adopted from previous literatures of seafood hedonic pricing. A survey was conducted using convenience sample of 130 consumers to point out the quality attributes which influence on the consumer preference and demand of shrimp in domestic market in Nha Trang. All the collected data were subjected to statistical analysis using Shazam software package version 10.0 and Microsoft Excel 2003 and thereafter estimated model was employed to explain the functional relation ship between price and quality attributes. In this study, on the other hand to explain the difference in price due to seasonal variation and market surrounding, daily average price of shrimp was recorded in two different domestic markets during the study period.

1.4 Structure of thesis

Following the introduction in Chapter 1, Chapter 2 briefly introduces the theory of hedonic price analysis and related literature reviews on hedonic pricing of commodities. Methodology of this research is presented in Chapter 3; this section includes sample collection, measurement of quality characters, consumer survey, secondary data collection, functional form for the multiple regression analysis and data analysis procedures. Chapter 4 focuses on the empirical results and finding from the analysis. Chapter 5 discusses the influences of quality character on market price of shrimp. Finally, conclusion and suggestions for future research were described in last chapter.

CHAPTER 2
THEORETICAL FRAMEWORK

An index which shows how average price of a unit of commodity changes over time is referred to as "*Price index*" (Samuelson and Nordhaus, 2010). Price index plays a vital role in today's economics, thus it is crucial to construct realizable and practicable index in accurate manner. Hedonic price is the implicit price of characteristic embodied in a commodity (Rosen, 1974). Hedonic price index for various type commodities has been formulated in many countries. In order to carry out a hedonic pricing for a certain commodity, it is essential to understand the fundamental theory of hedonic pricing of commodity. Therefore, this chapter outlines the theoretical concept of hedonic pricing and review some of recent empirical studies of hedonic pricing have been done in various sectors especially in seafood industry.

2.1 Theoretical background of Hedonic price Analysis

Hedonic pricing method is widely used to evaluate the impact of quality attributes or characteristic of a commodity on its price (Bartik, 1987; Williams and Longworth, 1989; Combris *et al*., 1997; Angulo *et al*., 2000; Salayo *et al*., 1999; McConnell and Strand, 2000; Carroll *et al*., 2001; Roheim *et al.,* 2007; Selim, 2008 ; Şentürk and Erdem, 2010). It forms the basis for the measurement of quality change. "*Match model*" is the conventional procedure used for integrating quality changes into price indexes. The hedonic method provides an alternative procedure for deriving quality- adjusted price index. Any price index which is derived with the usage of hedonic function is termed as "*Hedonic price index*" and hedonic function is an association between price of different varieties of a product and characteristic of them (Triplett, 2006). The hedonic model shows the functional relationship between price and various characteristics of a particular commodity. The pioneer study of price – quality relation ship was conducted by Agriculture economist Frederick V. Waugh in 1928 (Berndt, 1991). The first hedonic price index was estimated by Court in 1939 for automobile, subsequently to his work, Zvi Griliches, 1961 rejuvenated the Court's hedonic multiple regression approach to construct hedonic price index for automobile (Triplett, 2006). The modern outstanding of numerous researches were the outcomes stimulated by the

Griliches's finding and his classical paper is well- known in economic literature and Griliches has honorably called as "*Father of modern hedonic price analysis"* (Berndt, 1991).

Hedonic hypothesis basically involves treating differentiated products of a particular commodity those differ in some specific characteristic even though, they posses many general attributes and those specific attributes are the reasons for reflection of heterogeneity. Theory of using hedonic pricing was developed by Rosen in 1974, who defined the hedonic price as "implicit prices of attributes and are revealed to economic agents from observed prices of differentiated products and the specific amount of characteristic associated with them." The core hypothesis is that goods are valued for their utility-bearing attributes or characteristic and goods price varies with the change in quantity of characteristic associated with it (Rosen, 1974). Consequently, theoretical approach has been studied and recently statistical theory of hedonic price index has demonstrated by Brachinger (Brachinger, 2002).

The fundamental theory of hedonic price explains the price (*P*) of a commodity as a function of its characteristic. The model assumption is that a product is composed of a variety of specific attributes that consumers valued independently. For any given commodity, let consider it characterized by the set of *j*-th specific attributes and are denoted as Z= (Z_1, Z_2, …, Z_j) and it is assumed that the preferences of the economic agents towards the commodity are determined by its corresponding characteristic vector alone. The functional relationship between its price *P* and characteristic vector **Z** given by,

$$P=f(\mathbf{Z}) \qquad (1)$$

This function specifies the hedonic relationship for a commodity. According to the functional relationship (1) the marginal price of the *j*-th characteristic, say Z_j is given by the partial derivative of hedonic function (1) with respect to Z;

$$\frac{\partial P}{\partial Z_j} = \frac{\partial f}{\partial Z_j} \quad (j = 1, 2, \ldots, m) \qquad (2)$$

The hedonic price $\partial P/\partial Z_j = \partial f/\partial Z_j$ indicates, how much the price *P* of a good changes if this good is endowed with an additional unit of the characteristic Z_j and all others be constant. It is important to understand that estimated hedonic price function typically identify neither demand nor supply functions (Rosen, 1974). In hedonic approach, different types of

functional form have been employed in the previous studies. The functional forms have a significant effect on the error terms in measuring marginal attribute of prices (Cropper *et al*., 1988). The simplest approach is the *ordinary linear* approach (3) given by:

$$P = \beta_0 + \sum_{j=1}^{m} \beta_j Z_j + \varepsilon \qquad (3)$$

Where the vector **Z** stands for a particular variable of a good considered; coefficient β_0 is the intercept; β_j is regression coefficient and ε is the random error term satisfying the classical regression assumption. The regression coefficient β_j indicates the marginal change of price with respect to a change of the *j*-th characteristic Z_j of the commodity, i.e how much the price *P* changes at a certain level if the *j*-th characteristic Z_j changes by one unit when all other marginal effects kept constant. The main pieces of information included in the estimated hedonic price equation are price of product, quantities of characteristic and implicit price of characteristic (Berndt, 1991).

$$ln\,(P) = \beta_0 + \sum_{j=1}^{m} \beta_j Z_j + \varepsilon \qquad (4)$$

$$P = \beta_0 + \sum_{j=1}^{m} \beta_j ln\,(Z_j) + \varepsilon \qquad (5)$$

$$ln\,(P) = \beta_0 + \sum_{j=1}^{m} \beta_j ln(Z_j) + \varepsilon \qquad (6)$$

Other functional forms are *log-linear,* (4) *linear-log* (5) *and log-log* (6). In *log-linear* approach (4), regression coefficients can be interpreted as *growth rates.* The coefficient β_j (j = 1, 2, …, m) indicates the rate at which the price changes at a certain level, given the characteristic **Z**. In *log-log* approach (6), the regression coefficients can be interpreted as *partial elasticity* β_j (j = 1, 2, …, m) indicates how many percent the price *P* changes at a certain level if the *j*-th characteristic Z_j changes by one percent. The term *elasticity* in hedonic approach also termed as *flexibility* (McConnell and Strand, 2000). In addition to above forms, quadratic function form has also been used in hedonic pricing (Cropper *et al*., 1988).

The choice of functional form can have an effect on the result and the conclusion reached (Halvorsen and Pollakowshi, 1981). Suited functional form is chosen on basis of *goodness-*

of-fit criteria (Cropper *et al*., 1988; Berndt, 1991) and *likelihood ratio tests* used to test the appropriateness of functional form (Halvorsen and Pollakowshi, 1981). The procedure named as Box-Cox or Box- Tidwell can be used to compare alternative functional form (Berndt, 1991).

In the hedonic approach, price is considered as dependent variable and specific attributes cause for variation among a particular commodity are generally considered explanatory variables categorized as main and dummy variable. Analytically hedonic price model is characterized by a continuous dependent variable and multiple explanatory variables representing the characteristics. In a model, variables are either perfectly correlated or uncorrelated with each of them variable (Berndt, 1991). Both relevant quantitative and qualitative measurable characters are taken into account to explain the whole variation in price. Even though, it is impossible to include all relevant quality attributes into hedonic price equation for some commodities such as computers (Berndt, 1991). Furthermore, in some case certain quality variables employed in hedonic regression equation are not in themselves measures of quality but are reassumed to be highly correlated with perceived quality of product. Examples for those variables in case of aquatic product are harvesting method, storage condition, package material, product form etc. In some other cases if a particular quality character required to enter into hedonic model but it is very difficult to obtain accurate measure of it by scale, however if such quality is associated with any factor then one could incorporate that variable into hedonic function by specifying dummy variable (Berndt, 1991). Most hedonic model use categorical dummy variable to evaluate the effect of qualitative attributes on price (Salayo *et al*., 1999; McConnell and Strand, 2000; Carroll *et al*., 2001; Roheim *et al.,* 2007). Normally irrelevant variable are omitted from the analysis and the omission of relevant variable can result to biased model estimation. Therefore, care should be taken during the selection of variable to avoid problems often occur in statistical analysis such irrelevant variable, omitted variable problem, collinearity, etc.

2.2 Literature review: Hedonic pricing of various commodities

a. Seafood products

The concept of seafood hedonic pricing is similar to the concepts of hedonic pricing of housing (Bartik, 1987; Selim, 2008), computer (Şentürk and Erdem, 2010) or wine (Oczkowski, 1994; Nerlove, 1995; Combris *et al*., 1997; Angulo *et al*., 2000). It is well known from empirical studies cited in the literature of hedonic pricing of seafood products that seafood quality attributes have relevance during pricing of seafood products (Williams and Longworth, 1989; Salayo *et al*., 1999; McConnell and Strand, 2000; Carroll *et al*., 2001; Roheim *et al.,* 2007). A large number of quality attributes were included in earliest studies, such as species, size; weight and length, physical appearance; color, shape and freshness, nutritional quality; fat content and protein content, method of handlings, market condition, grade, brand, product form etc where some of the attributes had remarkable explanatory power on price.

Tuna is one of important seafood traded among countries. Hedonic pricing of tuna has been carried out in some countries; one of the earlier studies was done in Japan by Williams and Longworth (1989) about the Coral tuna fishery. Williams and Longworth (1989) analysis was based on auction price of yellow-fin and big-eye tuna and attributes such as meat color, freshness, condition, origin, dressed weight and auction time were taken into consideration. Williams and Longworth (1989) separately analyzed the data on yellow-fin and big-eye tuna and found that meat color was the primary determinant of value. Other attributes also had influence; in case of big-eye tuna carcass weight, auction time day of sale and origin, while for yellow-fin tuna, condition and freshness had remarkable influence on price.

Similar study on tuna has been done in Hawaii. McConnell and Strand, (2000) considered species, whole fish weight, manner of harvesting, method of handling, appearance, fat content and grade as explanatory variables. McConnell and Strand, 2000 considered fish as common goods and selected species as one attributes, McConnell and Strand (2000) found that yellow fin and big eye tuna had higher price premium than albacore which reveals species has influence on price of fish. Furthermore, McConnell and Strand (2000) reported that the bigger size attracted higher price. This study shows in addition to the grade and species, physical characteristic of fish determine the ex-vessel price of tuna mainly size and method of handling in Hawaii (McConnell and Strand, 2000).

Carroll *et al*., (2001) reported that the price of fresh bluefin tuna significantly was influenced by the quality attributes of fish such as fat content, color, shape and freshness. Recently a study of hedonic analysis of retail frozen fish in the UK using scanner data was undertaken by a group of scholars (Roheim *et al.,* 2007). The finding of Roheim *et al*., (2007) study shows that frozen fish product price also relevant with the embodied attributes of product like fresh fish such as species, brand, product form, package size and processed form.

Seafood is a board term which includes a vast range of fish, mollusks and crustacean. Shrimp is also one of the important traded seafood products among nations. Salayo *et al*., (1999) study is good evidence that shrimp attributes includes species, physical characteristics, nutritional contents and some other attributes such as mode of sale, store/seller type and ease of preparation have significant influence on market price. Similar to fish, species, size, freshness and nutritional content had high influence in shrimp price also. Salayo *et al*., (1999) found that the combination of attributes linked with the perception of quality have remarkable positive implicit price (i.e., either live, longer tail banana species or easy to clean or easy to prepare, ready to cook forms).

b. Agricultural product

It has long been recognized and evaluated that the quality characters of agricultural products have remarkable influence on its market price (Waugh, 1928: Ethridge and Davis, 1982; Estes, 1986; Espinosa and Goodwin, 1991; Ahmadi-Esfahani and Stanmore, 1994; Oczkowski, 1994; Kajikawa, 1998; Angulo *et al*., 2000; Carew, 2000; Combris *et al*., 1997; Nerlove, 1995). The first well known pioneering empirical work relating price and quality attributes of vegetables was done by Waugh in 1928, who conducted the study in three various type of vegetable such Asparagus, tomato and hot-house cucumber and considered physical characters such size, colour, package material, growing place and condition. Waugh (1928) found that those physical characters had significant influences on market price when price as dependent variable was regressed on various characters. It is revealed in Waugh's work that quality factors which have high influence on price vary with product. Subsequently with the development of hedonic approach frame work, hedonic price indexes for many agricultural raw products such as apple (Kajikawa, 1998; Carew, 2000), pepper (Estes, 1986), semi- processed product; wheat (Espinosa and Goodwin, 1991; Ahmadi-Esfahani and

Stanmore, 1994); cotton (Ethridge and Davis, 1982) and processed product; wine (Oczkowski, 1994; Nerlove, 1995; Combris *et al*., 1997; Angulo *et al*., 2000) were constructed in past years. Quality characters are normally considered during grading of product considered as relevant variable in most of the empirical work. The results from those studied also revealed that relevant variables have significant influence on market price. In case of raw material, physical characteristics; size, color, texture, variety, growing region, condition, package material, freshness and nutritional content; water, protein and acid content were the quality attributes considered during the hedonic pricing (Waugh, 1928; Estes, 1986; Kajikawa, 1998; Carew, 2000). For processed product (eg; Wine) quality characters such as grape variety, growing region, grape vintage, vintage (Oczkowski, 1994 and Angulo *et al*., 2000) and sensory characteristic (Combris *et al.*, 1997) were identified as quality attributes which have significant influence on market of wine price. Most of the hedonic pricing studied carried out by considering price and embodied characteristic of commodity, although Nerlove in 1995 derived the hedonic equation for wine using consumer demand (quantity sold).

C. Other commodities

Hedonic approach is also used in other commodity like industrial goods; computer (Şentürk and Erdem, 2010), housing (Bartik, 1987; Selim, 2008) and medicine (Robst, 2006). Further, Komarova (2009) applied the hedonic pricing method for housing market of Moscow in order to assess the effect of air pollution on housing price.

CHAPTER 3
METHODOLOGY

An evaluation of quality attributes that influence on the market price of shrimp in Nha Trang, Vietnam was carried out with a Hedonic price model. The procedures of the questionnaire, sample collection, model, consumer survey and data analysis are discussed in this chapter. The present study follows the established methodology of previous studies on hedonic pricing of seafood cited in literature including Salayo *et al*., 1999; McConnell and Strand, 2000; Carroll *et al*., 2001; Roheim *et al.,* 2007. In the present study of the hedonic pricing of shrimp, we deal with two issues. The first issue concerns to the empirical content of hedonic price model of shrimp. What are the extrinsic characteristics that influence on the market price of shrimp and what are marginal values of these characteristics? The second relates to the consumer preference of shrimp. Which quality characteristics are commonly considered by consumer during choosing and purchasing of shrimp? in Nha Trang, Vietnam.

3.1 The basic information collection

The basic information (Appendix A and B) for the study about shrimp capture and shrimp culture were collected through direct discussion with fisherman in Vinh Luong fishing port, Nha Trang and shrimp farm operators in Ninh Hoa, Khanh Hoa province respectively.

3.2 Hedonic pricing of shrimp

Quality of seafood generally relates to having optimum quantity of some specific quality characters such as freshness, size, colour, texture, taste and nutritional content. Those quality attributes of seafoods are generally assumed to be the basis for grading and tagging market price. Market price would accurately reflect the end-use quality standard of a commodity, if there is an effective grading system operated for a commodity in marketing environment. Quality attributes of seafood are also considered as determinants for seafood purchase behaviour and consumer preference of seafood in addition to market and social factors such as price of product, income level and household size (Hanson *et al.,* 1995 and Wessells et al., 1999). Even though, generally consumers mainly consider some extrinsic characteristic to

judge the quality of seafood themselves during purchasing in market. Therefore, in this analysis extrinsic characteristics were mainly considered such as size, species, origin, freshness, stored condition or preservation method and product form. These are could be the possible extrinsic quality parameters could be considered by consumers during choosing and purchasing of shrimp which is sold in Nha Trang, Vietnam.

3.2.1 The model

As discussed in Chapter 2.1, the hedonic price is the implicit price of attributes embodied in a commodity (Rosen, 1974). The fundamental theory of hedonic price explains the price (*P*) of a commodity as s function of its characteristics. For shrimp, the hedonic model can be written in its general form as

$$P_i = f(\mathbf{Z}_j) \qquad (7)$$

Where P_i is the market price per kilogram of shrimp observation *i,* where *i*=1, 2, …, *n*, with *n* being the number of observation. $\mathbf{Z}_j$ is a vector of quality attributes that influence on the price of shrimp, *j*=1,2, …, *m* and *m* is the number of quality attributes considered and *f* is the function that relates price P_i to the quality attributes Z_j.

Based on the theory developed by Rosen, 1974, the hedonic price function for a commodity is constructed by regressing price on characteristics and the marginal value of the characteristics is given by the partial derivatives. According to the theory of Rosen, 1974, hedonic equation for shrimp which is subject to the regression analysis using simple linear form is written as:

$$P_i = \beta_0 + \sum_{j=1}^{m} \beta_j Z_j + \varepsilon \qquad (8)$$

Where coefficient β_0 is the intercept; β_j is regression coefficient and ε_i is the random error term. The regression coefficient β_j is the marginal value of the characteristics, indicates change of price with respect to a change of the *j*-th characteristic Z_j of the shrimp, i.e how much the price *P* changes at a certain level if the *j*-th characteristic Z_j changes by one unit.

Most of the quality attributes considered in this present study are qualitative attributes expressed as dummy variable and only two are quantitative attributes expressed as continuous variable. We would transform the data on continuous variable in to its natural logarithm value

while transform the data on dummy variable logarithm value is impossible, because those values denoted as 1 when the character present and 0 when that particular character absent. Therefore, we concentrated on linear form of hedonic model for shrimp. Even though, the double log form was also pre-tested and finally linear form hedonic model was selected.

3.2.2 Variable description

The hedonic price model for shrimp is illustrated by price as dependent variable and quality attributes as independent variables (Equation 8). In this study, both quantitative and qualitative extrinsic attributes of shrimp are considered for the hedonic price estimation. The quantitative attributes are expressed as continuous variables and qualitative attributes are expressed as dummy variables. All the variables and its corresponding description listed in Table 1. The dependent variable is the price per kilogram of shrimp in domestic market in Vietnam dong (VND). There are two continuous variables such as weight of shrimp and carapace length of shrimp and five qualitative attributes represented as dummy variables such as species, origin, freshness, preservation method and product form are considered – encompassing a total of nineteen quality attributes.

Size is an important attributes of seafood taken into account during pricing of product and which is normally considered a criteria when sort outing of seafood. In this study, size was measured in terms of weight and carapace length of shrimp. Carapace length; measurement from base of the eye notch to the posterior mid-dorsal edge on the carapace has been adopted as the standard measurement in many studies of shrimp (Cole and Mistqkidis, 1953). Weight was the whole shrimp weight.

Generally qualitative characteristics of seafood are included as categorical dummy variable into model to measure the influence of qualitative attributes on price (Salayo *et al.*, 1999; McConnell and Strand, 2000; Carroll *et al*., 2001; Roheim *et al.,* 2007). Qualitative attributes represented as dummy variables are listed in Table 1 included biological factor such as origin and species, organoleptic factor such as freshness, attributes relates to convenience such as product form, attributes that link with handling method of shrimp during selling such as storage or preservation method. Attributes are similar those identified by Williams and Longworth, 1989; McConnell and Strand, 2000; Carroll *et al*., 2001; Roheim *et al.,* 2007 as

factors has significant influence on the market price of seafood, and especially most of them are similar to those identified by Salayo *et al*., 1999 in price of shrimp and prawn.

Table 1: Description of variables included in the Hedonic Model -1 Estimation

Variables	Description	Number of observation
PRICE	Market price per kilogram of shrimp (in 1000 VND / kg)	76
WGT	Weight of shrimp (g)	76
CL	Carapace length (mm)	76
Origin		
OR1	1 if sea-caught shrimp, 0 otherwise	39
OR2	1 if cultured shrimp, 0 otherwise	37
Species		
SP1	1 if *Penaeus merguiensis,* 0 otherwise	7
SP2	1 if *Penaeus vannamei,* 0 otherwise	14
SP3	1 if *Metapenaeus ensis,* 0 otherwise	19
SP4	1 if *Penaeus monodon,* 0 otherwise	4
SP5	1 if *Penaeus indicus,* 0 otherwise	6
SP6	1 if *Metapenaeus intermedius,* 0 otherwise	6
SP7	1 if *Parapenaeus fissuroides,* 0 otherwise	11
SP8	1 if *Trachypenaeus longipes,* 0 otherwise	9
Preservation method		
PM1	1 if Shrimp stored in aerated water, 0 otherwise	15
PM2	1 if Shrimp stored in water with ice cube, 0 otherwise	61
Product form		
PF1	1 if Whole shrimp, 0 otherwise	73
PF3	1 if fully cleaned and ready to cook, 0 otherwise	3
Freshness		
DC1	1 if there is no discolouration, 0 otherwise	50
DC2	1 if there is slight discolouration, 0 otherwise	20
DC3	1 if there is remarkable discolouration, 0 otherwise	6

Shrimp from both capture fishery and aquaculture are sold in the domestic markets of Nha Trang, thus sea-caught and culture categories are considered as the origin for shrimp in this study. Species is another important characteristic of shrimp which considered by fisherman during sorting of shrimp and pricing of shrimp in shrimp landing places. There are eight prominent species are considered all together from both origin. The selection of these prominent eight species was done after the periodical field visit to the major domestic markets in Nha Trang during the study period. Seafoods are perishable product, degree of freshness change with time and vary with the handling method practiced. Freshness of seafood is the main factor consider by consumer during purchasing. Normally consumers

judge fresh condition by colour or texture changes and odor. In this study, freshness condition of shrimp was assessed in term of the discoloration of shrimp which was categorized into three dummy variables (Table 1) in this study. Most of the sellers of shrimp either from sea or culture sources practice the method of storing shrimp in water with ice cube. While, some of sellers store cultured shrimp in container with aerated water to keep shrimp alive and very fresh and water is aerated artificially using motor. Product forms considered in this study are whole shrimp i.e head-on and fully cleaned i.e head-less and peeled. Even though, the most common form of shrimp sold in Nha Trang is whole shrimp.

3.2.3. Data collection

A domestic market named Vinh Hai was randomly selected for the observations of this study. Vinh Hai is a domestic market, located on 2-4 street, north suburb of Nha Trang city and it supplies food i.e., fish, vegetable, fruit and other essential to the public. Seventy six shrimp observations were collected for the study. A batch of shrimp comprised of five to ten shrimp individuals tagged with a single price and was considered as one observation. Thus, seventy six shrimp batches at different prices were purchased from Vinh Hai market during the period of 6th February to 21thof March, 2012. Batches were processed according to their quantitative and qualitative extrinsic parameters listed above such as weight, carapace length, species, origin, freshness, preservation method, and product form. Shrimps' weight and carapace lengths were measured using an electronic weight and Vanier's caliper respectively available in the Aquaculture laboratory at Nha Trang University Vietnam. The shrimp weight for one observation was estimated by averaging all of the individual weights in one batch of single tag price and the average weight was considered as the weight of the shrimp which belongs to the particular price. The same procedure was followed for the carapace length. Other qualitative parameters were assessed and recorded in the market at the time of purchase (Appendix C). Table 2 specifies the summary statistics for the variable included in the hedonic pricing of shrimp. Among all 76 observations, market price of shrimp, the highest and the lowest price per kilogram of shrimp observed in Vinh Hai market, Nha Trang are 350,000 VND and 50,000 VND respectively. The weight of shrimp, the maximum weight of individual shrimp is 95.53g and the minimum weight of individual shrimp is 0.53g. The carapace length of the shrimp ranges from 13mm to 71mm (Table 2). Of the seventy six observations, 51.3% shrimp batches are sea-caught and 48.7% are cultured shrimp batches.

Table 2: Summary Statistics of Variables Used for Hedonic Model -1 Estimation

Variables [1]	Frequency (%)	Minimum	Maximum	Mean	Standard Deviation
PRICE		50.00	350.00	121.973	62.477
WGT		0.53	95.53	10.791	12.876
CL		13.00	71.00	31.232	9.057
Origin					
OR1	51.3	0.00	1.00	0.513	0.503
OR2	48.7	0.00	1.00	0.487	0.503
Species					
SP1	9.2	0.00	1.00	0.092	0.291
SP2	18.4	0.00	1.00	0.184	0.390
SP3	25.0	0.00	1.00	0.250	0.436
SP4	5.3	0.00	1.00	0.053	0.225
SP5	7.9	0.00	1.00	0.079	0.271
SP6	7.9	0.00	1.00	0.079	0.271
SP7	14.5	0.00	1.00	0.145	0.354
SP8	11.8	0.00	1.00	0.118	0.325
Preservation method					
PM1	19.7	0.00	1.00	0.197	0.401
PM2	80.3	0.00	1.00	0.803	0.401
Product form					
PF1	96.0	0.00	1.00	0.960	0.196
PF2	4.0	0.00	1.00	0.039	0.196
Freshness					
DC1	65.8	0.00	1.00	0.658	0.478
DC2	26.3	0.00	1.00	0.263	0.443
DC3	7.9	0.00	1.00	0.079	0.271

[1] All the notations follow Table 1

3.3 Consumer survey

Another part of methodological is consumer survey to point out the main quality attributes which influence on the consumer preference and demand of shrimp. It was conducted with consumers in randomly selected six domestic markets in Nha Trang, Vietnam with predefined questionnaire (Appendix D). First, the English version of the questionnaire was developed then Vietnamese version was derived by direct translation from the English version. The questionnaire was pre tested using convenience sample of approximately 10 consumers in Vinh Hai market, Nha Trang. Then questionnaire consist English and Vietnamese version together was used for the survey. With few exceptions, the social research concerns about consumer demand and preference of a particular commodity, the first part of the data collection is the socio-economic variables such like house hold size, income, age, gender, education, religion or race. Many studies have been revealed and it is

undoubtedly that some specific socio-economic factors have significant impact on the consumption pattern and demand of seafood (Mullen and Wohlgenant, 1991; Hanson *et al.,* 1995 and Wessells *et al*., 1999). In this study, on the other hand we have omitted those socio-economic factors and consider only the extrinsic quality attributes and evaluate how various quality attributes influence on consumer preference and consumption demand of shrimp.

In first part of the questionnaire, information on price, quantity of shrimp that the respondent brought on the day of interview and family weekly consumption were collected. Then respondent asked about choosing situation and their preferred quality attributes of shrimp with a series of questions. The survey respondents were shown a laminated sheet of coloured photographs of shrimp to selected their preferred size and species of shrimp. For the size selection, size was categories in to four grades such as big, medium, small and very small which were noted as G1, G2, G3 and G4 respectively (Appendix E). Table 3 specifies the measurement range weight and carapace length of each grade considered in survey. The question concerning the species selection, consumers asked to select the preferred species of shrimp in term of the colour of shrimp. Common shrimp species which available to consumer for purchasing in Nha Trang are grouped in to four categories based on its colour such as white, black, pink and brown (Appendi F). The species considered as Black is balck tiger shrimp (*Penaeus monodon)*, as White are white leg shrimp (*Penaeus vannamei)*, banana shrimp (*Penaeus merguiensis)* and Indian white prawn (*Penaeus indicus*), as Pink are Neptune rose Shrimp (*Parapenaeus fissuroides*) and En-longlegged rough shrimp (*Trachypenaeus longipes*) and as Brown are Graesyback shrimp (*Metapenaeus ensis)* and Middle shrimp *(Metapenaeus intermedius)*. In additional to the information about consumer preference on attributes, idea about the nutritional quality of shrimp also asked with respondents.

Table 3: Weight and carapace length of shrimp included in grades categorizes

Grade	weight	Carapace length
Big size (G-1)	29.65 ± 9.25	46.72 ± 4.13
Medium size (G-2)	10.45 ± 2.99	33.51 ± 3.17
Small size (G-3)	5.06 ± 0.68	26.41 ± 2.21
Very small (G- 4)	2.72 ± 1.09	20.55 ± 3.07

Value represents mean ± standard deviation

Finally, consumers requested to provide the information about quality attributes of shrimp indicated in the questionnaire that he/she purchased on the day of interview. Information collected via consumer survey about the preferred quality attributes of shrimp was analysis using descriptive statistical tools and another hedonic model referred as hedonic model 2 was estimated using the data on the price of shrimp and quality attributes of shrimp that the consumer purchased. Hedonic model 2 was estimated using OLS method; all the variables were expressed in dummy variables. Table 4 specifies the variables description and summary of statistical of variable used in hedonic model 2. Correlation matrix of variables is given in Appendix J.

Table 4: Description of variables included in the Hedonic Model -2 Estimation

Variables	Description	Mean	Standard deviation
PRICE	Market price per kilogram of shrimp (in 1000 VND / kg)	141.65	63.945
Size			
G1	1 if Big size shrimp, 0 otherwise	0.231	0.423
G2	1 if Medium shrimp, 0 otherwise	0.584	0.495
G3	1 if Small shrimp, 0 otherwise	0.169	0.376
G4	1 if Very small shrimp, 0 otherwise	0.015	0.124
Origin			
O1	1 if sea-caught shrimp, 0 otherwise	0.562	0.498
O2	1 if cultured shrimp, 0 otherwise	0.438	0.498
Species /colour			
C1	1 if White colour shrimp, 0 otherwise	0.392	0.490
C2	1 if Black colour shrimp, 0 otherwise	0.092	0.290
C3	1 if Pink colour shrimp, 0 otherwise	0.253	0.437
C4	1 if Brown colour shrimp, 0 otherwise	0.246	0.432
Freshness			
F1	1 if shrimp is alive 0 otherwise	0.154	0.362
F2	1 if shrimp is very fresh 0 otherwise	0.300	0.460
F3	1 if shrimp is fresh 0 otherwise	0.531	0.501
F4	1 if shrimp is acceptable fresh 0 otherwise	0.031	0.173
Preservation method			
S1	1 if stored with ice cube, 0 otherwise	0.715	0.453
S2	1 if stored in aerated water can, 0 otherwise	0.238	0.428
S3	1 if stored in water only, 0 otherwise	0.046	0.211
Product form			
P1	1 if whole shrimp, 0 otherwise	0.885	0.320
P2	1 if partially cleaned shrimp , 0 otherwise	0.069	0.255
P3	1 if fully cleaned shrimp, 0 otherwise	0.046	0.211

3.4 Daily price recording of shrimp

Daily average price and supply of shrimp (Appendix G) in two different domestic markets were recorded during the study period 9th of January to 19th February to explain other market factors which influence on the price of shrimp such like seasonal variation and market surrounding.

3.5 Data analytical procedures

Data analysis procedures were done using the econometric and statistical package SHAZAM version 10.0 and Microsoft Excel 2003. First aim of this study is to drive the hedonic function which illustrate the functional relationship between shrimp price and quality characteristic, for that correlation matrix between all grouped qualitative attributes as well as between continuous variable and with price were calculated to find out the degree and direction of relationship. Then hedonic model price was estimated by regressing price on characteristics using Ordinary Least Square (OLS) method. Estimated model was employed to explain the functional relation ship between price and quality attributes. Consumer survey data were analysis descriptive statistical tools.

The coming chapter 4 of the thesis presents the result of data analysis and summary information collected from various actors; fisherman, farm operators and consumers.

CHAPTER 4
EMPIRICAL RESULTS

This section consists of four parts. In the first one, we would briefly discuss information collected from fishing port and shrimp farm about the present status shrimp production in Nha Trang, Vietnam. The next part is the main part of study that concerns the econometric estimates of hedonic regressions of shrimp and the third part presents about the consumer preference of shrimp. Last part briefly illustrate the daily average price of shrimp and supply amount of shrimp in two different markets such as Vinh Thou and Vinh Hai, Nha Trang, Vietnam.

4.1 Overview of shrimp production in Nha Trang, Khanh Hoa Province

Shrimp industry in Khanh Hoa Province is characterized by two sub- sectors such as the capture fishery and the aquaculture. Thus shrimp sellers in domestic market get shrimp for their business via middle man from two different sources such as sea-caught and farmed shrimp. The fisheries of Nha Trang is characterized by multiplicity of species, shrimp is one among major component of catch. Bottom trawling is the harvesting method practiced by fisherman in Nha Trang with mesh size of code end ranges from 10-15mm. Average catch per trawl varies and depends on the number of fishing days and is around 20-30kg/trawler/overnight trip, 100kg/trawler/3days trip, 150kg/trawler/5days trip and 200 kg/trawler/7days trip. One over night trip is most commonly practicing even though some fisherman fishing for 3-5 days with higher engine power. The biodiversity of shrimp in Nha Tran Bay is vast range and the dominant shrimp species caught are those listed in Table 5. Species and size are the major criteria considered by fisherman for grading and fix the selling price of shrimp. Shrimps are preserved in plastic baskets with ice cube. Normally fisherman sells very small shrimp which has little or no consumer demand (i.e. shrimp bycatch) to aquaculture farm as feed.

Another source of shrimp production in Khanh Hoa is shrimp farming using aquaculture technique. Khanh Hoa province is a prominent area where the shrimp farming has expanded in recent years. Both mono and mixed culture farming system are practiced by farmers in Ninh Hoa. Some farmers practice shrimp farming in large scale nearly 7 ha and some farmers in small scale 0.3 – 1 ha. The major cultured species are Black tiger shrimp (*Penaeus*

monodon) and White leg shrimp (*Penaeus vannamei*) in Ninh Hoa, Khanh Hoa province. Most of the farmers culture Black tiger shrimp as one crop/year and some farmers practiced 2 crops per year. The duration for maturity of black tiger shrimp is around five months. In case of white leg shrimp, it is around two and half months to three months. Consequence of its short duration, the farmers practice 2- 3 crops per year. Crab or fish is grown with shrimp in mixed farming system. The average production of black tiger shrimp around 1.5 - 2 ton/ha in monoculture and 0.3 – 1 ton/ha in mixed farming system. Mean while white leg shrimp production is around 1.5- 3 ton/ha, since white leg shrimp can be cultured in much higher density compared to black tiger shrimp (white leg shrimp: 100 individuals/m^2 and black tiger shrimp : 30 individuals/m^2). Size is the main factor considered by farmers to sort out the shrimp and other factors are colour, texture of skin, eye colour. Based on the number of shrimp in one kilogram, they fix the price considering of the cost of production. Marketing of shrimp is mainly via middle man to market seller.

Table 5: Major shrimp species in Nha Trang Bay

Scientific name	Common name
Penaeus monodon Fabricius, 1798	Giant tiger prawn
Penaeus indicus H. Milne- Edwards, 1837	Indian white prawn
Metapenaeus intermedius Kishinouye, 1900	Middle shrimp
Penaeus latisulcatus Kishinouye, 1896	Western king prawn
Metapenaeus ensis de Haan, 1850	Graesyback shrimp
Trachypenaeus longipes Paulson, 1875	En-longlegged rough shrimp
Parapenaeus fissuroides Crosnier, 1986	Neptune rose Shrimp
Atypopenaeus stenodactylus (Stimpson,1860)	periscope shrimp
Pontonia sp	Fan clam shrimp
Parapenaeopsis tenella (Bate, 1888)	Smoothshell shrimp

After the discussion with fisherman and shrimp farm operators, it was understood that size of shrimp is an important factor considered by them to fix the market price of shrimp and knowledge of high consumer demanded species with the experience also play a significant role for pricing. In Nha Trang, length of shrimp is the measurement parameter considered by fisherman to assess the size while farm operators assess the size of shrimp in term of number

of shrimp in one kilogram. Based on the number of individuals in one kilogram, they categories the shrimp into two or three grade and fix the selling price.

4.2 Hedonic Price Equation and Marginal Value of Attributes of Shrimp

The model was estimated using OLS method of regression analysis. The choice of functional form for illustrating hedonic price is a difficult task. Initially linear and double log form were tested for this study and based on the preliminary results, we concluded that linear form behaves well for the set of data. The Durbin-Waston procedure was used to test whether the expected autocorrelation was present. All correlation matrixes of variable considered in Hedonic model 1 are given in Appendix H. The estimated model for hedonic price function of shrimp named Model 1 consists of all variables in Table 1 except the default variable OR2, SP3, PM2, PF2 and DC3 and variables indicating qualitative attributes such origin, species, freshness, preservation method and product form should be interpreted as the increase or decrease over the default case. In this hedonic price study we have treated shrimp as differentiated product of generic good, all 76 observations are pooled in the same model and influence of attributes such as origin and species estimated. Another approach would be to estimate hedonic price function for a particular species of shrimp or would be to estimate hedonic price function for sea –caught shrimp or cultured shrimp.

The statistical results derived from regression analysis of shrimp hedonic price model 1 are shown in Table 6. Most of OLS coefficient had expected signs and high t-value. The price flexibilities of variables were calculated from mean values. This model of 76 observations on shrimp price explains 85.56% of the variation in price. The parameter estimates represent the results shown in Table 6 indicated that most of the considered variable have significant influence on market price of shrimp. Three of fifteen variables in the model are significant at the 1% level, implying a high level of confidence about the coefficient and attributes represented by those three variables are carapace length, freshness and product form. While the coefficient of variable representing attributes such as origin, species and preservation method are significant at 5% significant and coefficient of weight is significant at 10% level. The constant term $\beta_{0,}$ non significant, is estimated as 1.5605. The influence of each quality attributes are described briefly in turn below.

Table 6: Estimation Results for the Hedonic Price Model -1

Variables [1]	Coefficient Estimate	t-ratio	P- Value	Elasticity at means
CONSTANT	1.5605	0.0478	0.962	0.0128
WGT	1.2010	1.848	0.069	0.1063
CL	4.0089	4.325	0.000	1.0265
OR1	-28.932	-2.140	0.036	-0.1217
SP1	-34.174	-2.358	0.022	-0.0258
SP2	-15.927	-1.416	0.162	-0.0241
SP4	-4.4250	-0.2184	0.828	-0.0019
SP5	18.705	1.238	0.221	0.0121
SP6	35.102	2.169	0.034	0.0227
SP7	10.079	0.5939	0.555	0.0120
SP8	-34.054	-2.181	0.033	-0.0331
PM1	22.012	2.011	0.049	0.0356
PF1	-53.338	-3.121	0.003	-0.4200
DC1	56.569	3.164	0.002	0.3051
DC2	43.340	2.600	0.012	0.0935

[1] All the notations follow Table 1

No observation = 76
Final prediction error (FPE) = 829.59
Sum of Squared errors (SSE) = 42264
Generalized cross validation (GCV) = 863.22
$R^2 = 0.8556$
Rice (1984) criterion = 918.77
Adjust $R^2 = 0.8225$
Durbin-Waston Value = 1.9341
$F_{mean} = 25.824$

4.2.1 Size

From the direct interviews with fisherman and farm operators, it can be suggested that the quality of shrimp is multidimensional of size and species and freshness. Market price of particular shrimp is determined based on these quality attributes of shrimp in additional to cost of production and the results shown in Table 6 confirm the conclusion reached as expected after the direct interviews. Size is the main key factor determinant of market price during the consideration of quality factors. There were numerous studies revealed that size of

seafood has significant influence on it's price (Salayo *et al*., 1999; Williams and Longworth, 1989; Carroll *et al*., 2001; Roheim *et al.,* 2007). In this study, effect of size on price was evaluated using two parameters such as weight and carapace length of shrimp. It can be seen in the results, that both parameter coefficient are significant. While, among those two parameter estimate, the length estimates is highly significant than weight. The coefficient estimate for weight is 1.2010, significant at 10% level and coefficient estimate for carapace length is 4.0089, significant at 1% level. The price elasticity is also termed as price flexibility in hedonic model, i.e. percent changes in the price of shrimp from a 1 % changes in particular characteristic Zj, are calculated as $\left(\overline{Z_j} / \overline{P}\right) \partial Pi/\partial Z_j$ where the bars indicates means for the attributes or price. It was observed in the results that price is more elastic to carapace length of shrimp than shrimp weight. That is 10% increase in carapace length would have effect of 10.28% increase in price and 10% in weight would have 1.06% increase in price at mean level. This positive implicit price suggested that larger the size of shrimp obtain proportionately higher price.

Parameter considered for the representative for size: weight and carapace length of shrimp are correlated factors and consequently weight is depended factor of carapace length. The correlation between carapace length and weight of shrimp sample considered in this study is 0.901 (Appendix H). Even though, when we included both variable into hedonic model and the result shows that both have significant influence on price. It can be seen in Appendix H that carapace length and weight are positively related with price as expected. Thus a model was estimated to evaluate the relation ship between weight and carapace length of shrimp, and it is illustrated graphically in Figure 1. The estimation of the regression results in the parameter values are given in Table 7. It was clearly revealed that the weight and carapace length have non-linear relationship between them.

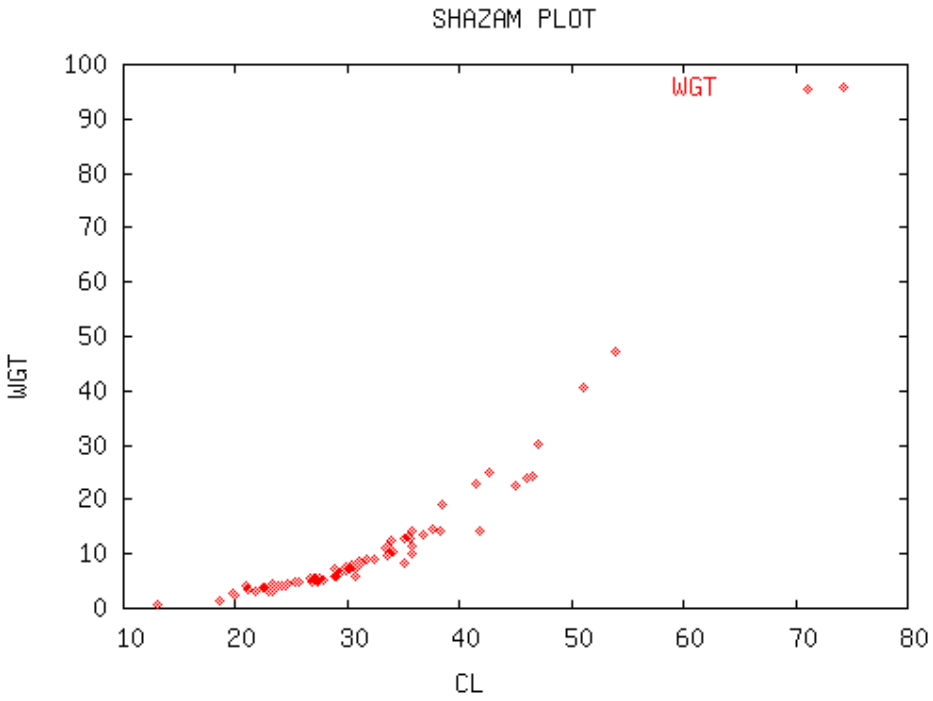
Table 7: Parameter estimates for the weight- carapace length relationship

Variables	Coefficient Estimate	t-ratio	P-value	Elasticity at means
CONSTANT	14.464	8.772	0.000	1.3403
CL	-1.2543	-13.94	0.000	-3.6303
CL^2	0.033608	28.94	0.000	3.2900

No observation = 76 R^2 = 0.9849 Adjusted R^2 = 0.9845 F_{mean}= 2388.630

Sum of Squared errors (SSE) = 187.15 Generalized cross validation (GCV) = 2.6691

Rice (1984) criterion = 2.6736 Final prediction error (FPE) = 2.6649



WGT: Weight of shrimp (g) CL: Carapace length (mm)

Figure 1: Relationship between carapace length and weight of shrimp

4.2.2 Origin

The hedonic price coefficient of categorical characteristic indicates the price difference over the default case of category not included into model. Among the biological factor, origin is first categorical characteristic and variable OR2 represent cultured shrimp was default variable. The results for shrimp (Table 5) suggest that the price discount for sea-caught

shrimp relative to cultured shrimp. Sea-caught shrimp on average sells for 28,932 VND lesser than cultured shrimp.

4.2.3 Species

Species is another important characteristic of shrimp which considered by fisherman during sorting of shrimp and pricing of shrimp in shrimp landing places. It has been studied that the species of seafood has remarkable influence on market price (Salayo *et al*., 1999; McConnell and Strand, 2000; Roheim *et al.,* 2007).

Among the eight species considered in this study, three species have positive coefficient, even though only SP6 coefficient estimate significantly differed from zero. Similarly, four species have negative coefficient and two of four coefficient estimate such as SP1 and SP8 are significant at 5% level indicate price discount relative to the species SP3. To explain, the coefficient on SP6 represents the increase in market price by 35,102 VND paid for one kilogram of *Metapenaeus intermedius* over *Metapenaeus ensis*. The coefficients on SP1 and SP8 have the interpretation; that is price per kilogram of *Penaeus merguiensis* and *Trachypenaeus longipes* discounted by 34,174 VND and 34,054 VND over price of per kilogram of *Metapenaeus ensis* respectively.

4.2.4 Storage condition or preservation method

Perishable product such like shrimp should be stored in a good condition to keep product freshly. PM variable represents the stored condition or preservation method of shrimp in domestic market. The default storage method is store in water with ice cube. The coefficient PM1 implies that price per kilogram for shrimp stored in aerated water is higher by 22,012 VND than default case.

4.2.5 Freshness

Normally perishable products undergo physical appearance; colour texture changes with time. Normally, in case of fish consumer use gill colour change to judge freshness and in case of shrimp whole body thereby in this whole body colour change was consider as indicator for freshness. The freshness of shrimp shows up in the coefficients DC1 and DC2 and the default

case is remarkable discoloration. The coefficients show increment in price per kilogram of shrimp over the remarkable discoloration category. When there is no discoloration, the shrimp gets a price premium of 56,569 VND per kilogram and when there is slightly discoloration price increases by 43,340 VND per kilogram over the shrimp which got remarkable discoloration.

4.2.6 Product form

The "PF" variables represent the influence of product form on the price of shrimp. This attributes relates to the convenience. The coefficient on PF1 illustrates that the market price paid for whole shrimp is lesser by 53,338 VND for one kilogram than paid for one kilogram of over the fully cleaned (i.e head-less and peeled).

All the attributes discussed above indicated that price of shrimp is influenced by various attributes which may either directly or indirectly relates with quality parameters.

4.3 consumer survey

As discussed earlier, there are some specific quality factors of shrimp which are considered by consumer during the purchasing in domestic market. Consumption pattern also varies with consumer attitudes. Finding of the consumer survey about the preferred shrimp quality attributes is presented in turn below. In additional to hedonic price model 1 described in section 4.2, there was another hedonic model named Model 2 was estimated with data collected in consumer survey.

4.3.1 Consumption pattern and consumer preference of shrimp

The survey was conducted from February 29 until 16th of March in 2012 and convenience samples of 130 respondents were interviewed in randomly six selected markets; Vinh Hai, Vinh Thuo, Dam, Vinh Trung, Xom and Vinh Thanh in Nha Trang for the data collection. The average price of shrimp per kilogram paid by consumer was 141,653 VND with a standard deviation of 63,944 VND and ranged from 50,000 to 350,000 VND. The average weekly consumption of shrimp per respondent family was 0.75 kg (std. dev 0.56 kg).

During the interview, if a respondent answer more than one option for one question she/ he request to prioritize the option and the first ranked option was selected for the statistical analysis. Of 130 respondents, who consume shrimp most of consumers (63.8%) choose shrimp to purchase because of their favorite and 21.5% respondents purchase occasionally. Consumers choose shrimp rarely when they fate up with fish and consumer choose shrimp when its price is cheap were 10.8% and 4.6% of total respondents respectively. It was observed that most of consumers consider both price and quality standard of shrimp during purchasing of shrimp, it was around 72% of total consumers interviewed, while 28% of them consider only quality standard of shrimp. It reveals that consumer concern the quality attributes in additional to price of shrimp. Among the six quality characters considered, freshness was the first ranked factor of most consumers and others; origin, size and species were also to some extend. Figure 2 illustrates the percentage of consumers who have given the first priority to each attributes.

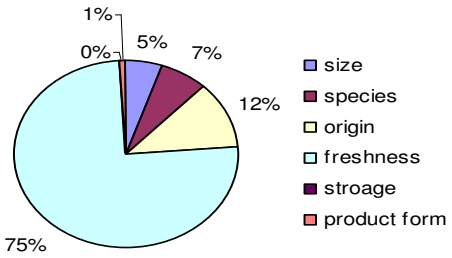


Figure 2: Percentage of consumers who consider the each attributes as the main factor during choice of shrimp

Consumption of seafood is affected by the preference (Sabat *et al*., 2008) and quality attributes such as falvour, freshness, product form, sensory variables have influence on the seafood purchasing behavior in additional to the general factors; price, income, household and market advance (Hanson, 1995). Table 8 shows the descriptive statistical summary of the preferred shrimp quality. It can be seen that the preferred quality of shrimp vary from individual to individual, it is real in nature. It was observed that medium size is favorite size of most of consumers (58.5%) followed by small size is favorite of 21.5% of total consumers. Most of consumers prefer the shrimp from ocean than cultured shrimp. In case of species, it was assessed in term of colour in this survey, white and brown colour species are selected as

favorite species among four categories, while black and pink also favorite of consumer that's a depended factor of consumer attitudes. Freshness of edible things is important and increasing concern about healthy eating, consumers more care of freshness. It was reveled from this study, the consumers expect that shrimp to be either very fresh or fresh and some consumers wish it to be alive. The most common method of preservation of seafood in domestic market is keep in iced condition, consumer also like that method and whole shrimp is the most favourite product form of consumer.

Table 8: Consumer favorite quality of shrimp, Nha Trang, Vietnam

Main attributes	Categories	Frequency (%)
Size	Big size	17.7
	Medium	58.5
	Small	21.5
	Very small	2.3
Origin	Ocean	66.2
	Culture	33.8
Species (Colour)	White	40.8
	Black	15.4
	Pink	15.4
	Brown	28.4
Freshness	Alive	23.8
	Very fresh	26.9
	Fresh	43.9
	Acceptable fresh	5.4
Preservation method	With ice cube	61.5
	In aerated water can	29.2
	In water only	9.3
Product form	Whole shrimp	85.4
	Partially cleaned	6.2
	Fully cleaned and ready to cook	8.4

In the next part of questionnaire, there were some information asked to consumer about the taste consideration and nutritional idea about shrimp. It was found that more than 80%

consumer consider the taste of shrimp. Of 105 respondents who consider the taste, most of them (65.7%) always choose specific shrimp species based on the previous experience and some of them (19%) choose different species with previous experience and fewer consumers (10.4%) choose randomly to test the taste quality. It was observed that 80% of 130 respondents have idea about nutritional quality of shrimp and can either judge well or to some extend.

4.3.2 Estimation of Hedonic model 2

In final part of survey, the quality attributes of shrimp that the respondent purchased on the day of interview were collected. The data on the price of shrimp and quality attributes of shrimp were used to estimate another hedonic model, named as hedonic price model 2. Hedonic model 2 was estimated using OLS method; all the variables were expressed in dummy variables.

Table 9: Estimation Results for the Hedonic Price Model -2

Variables[1]	Coefficient Estimate	t-ratio	P- Value	Elasticity at means
CONSTANT	57.314	1.413	0.160	0.4046
G1	149.600	5.216	0.000	0.2437
G2	62.383	2.231	0.028	0.2575
G3	19.459	0.6901	0.492	0.0232
O1	7.2692	0.7282	0.468	0.0288
C1	12.772	1.466	0.145	0.0354
C2	48.916	3.738	0.000	0.0319
C3	-16.238	-1.467	0.145	-0.0291
F1	36.046	1.631	0.106	0.0391
F2	21.947	1.284	0.202	0.0465
F3	-1.6409	-0.0996	0.921	-0.0061
S1	14.651	0.8669	0.388	0.0740
S2	-13.762	-0.6421	0.522	-0.0232
P1	-18.504	-1.114	0.268	-0.1156
P2	-21.989	-1.054	0.160	-0.0107

[1] All the notations follow Table 4

No observation = 130 $R^2 = 0.6932$ Adjust $R^2 = 0.6558$

Sum of Squared errors (SSE) = 0.16185E+06 $F_{mean} = 18.556$

Final prediction error (FPE) =1569.8 Rice (1984) criterion = 1618.5

Generalized cross validation (GCV) = 1590.9 Durbin-Waston Value = 1.7528

The parameter estimates of the hedonic model 2 are summarized in Table 9. The adjusted R^2 for the fit of model to the data was 0.6558. The estimated model for hedonic price function of shrimp named as Model 2 consists of all variables in Table 4 except the default variable G4, O2, C4, F4, S3 and P3. All independent variables were expressed in dummy form; therefore attributes should be interpreted as the increase or decrease over the default case. In this hedonic price study, of 130 total shrimp data collected from consumers in six different markets have pooled together in the same model and influence of attributes on price were estimated. It was assumed that all six markets are homogeneous but in reality, the price of shrimps have same quality standard might differ because of the transport cost difference.

Some of the attributes considered in this model significantly affect the price such as size and species. Size was indicated in terms of grade, the defaulted variable was very small size. One kilogram of shrimp receiving the highest grade for size such as big was expected to sells on average 149,600 VND higher over the very small sized shrimp and when the shrimp was medium size, the price of one kilogram of shrimp increase by 62,383 VND over the default case.

The influence of species was evaluated in term of colour of shrimp; the reason was answering the favourite shrimp in term of colour might easy to consumer. It can be seen from the results that species have significant influence on price. The coefficient of C2 illustrates that the market price paid for black colour shrimp is higher by 48,916 VND for one kilogram than the price paid for one kilogram of brown colour shrimp. The coefficient of origin, storage method, freshness and product form were not significant.

4.4 Shrimp daily price records

Daily average price and supply of shrimp were recorded in two different domestic markets such as Vinh Thou and Vinh Hai during the study period 9th of January to 19th February. Figure 3 and 4 show the average daily price of shrimp in Vinh Thou and Vinh Hai respectively and Y bar indicates the standard deviation. The systemic variation in price of shrimp due to the season variation can see in Figure 3 and 4. It can observed during the period near to the Vietnam Lunar New Year, especially one week near to January 23rd average price was high in both markets. During the period 23rd of January to 26th of January the markets were closed for the special occasion. Thereafter, the trend shows the usual fluctuation in prices.

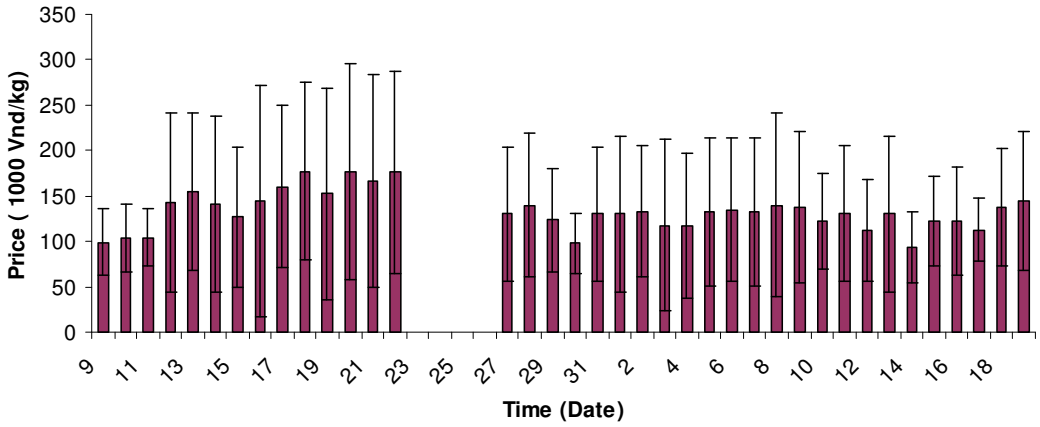


Figure 3: Average daily shrimp price during the period of January 9th to February 19th in Vinh Thou market, Nha Trang, Vietnam

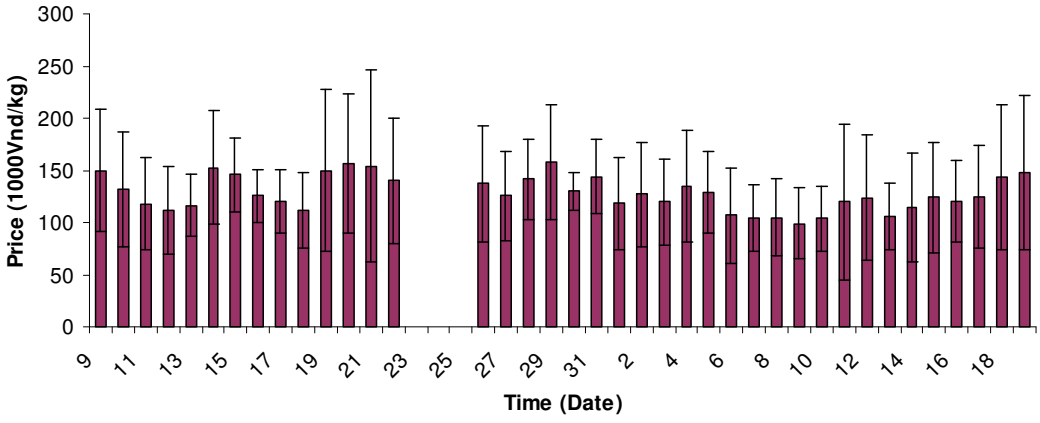


Figure 4: Average daily shrimp price during the period of January 9th to February 19th in Vinh Hai market, Nha Trang, Vietnam

In additionally, the supplied amount of shrimp to both markets was recorded separately. Amount of supply fluctuates with week and weekend days, supply was high in weekend days in both markets, the reason might be in weekend days the demand is high and normally most of consumers who are employees purchase the vegetables and fish during weekend days. Vinh Hai market is larger than Vinh Thuo market in scale, there by the supply was higher in Vinh Hai than another.

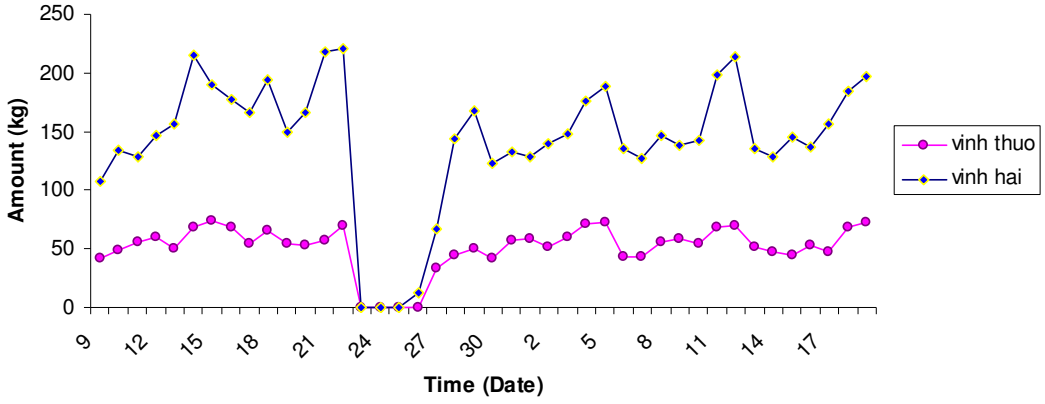


Figure 5: Supplied amount of shrimp to different markets in Nha Trang, Vietnam

CHAPTER 5
DISCUSSION AND FINDING

5.1 Discussion

Statistical results derived from the fitted model suggested that the extrinsic quality attributes of shrimp have significant influence on the market price. There are two models that were estimated in this study. The model developed for the empirical purpose is hedonic model 1. In model 1, the quantitative attributes were measured accurately using scientific standard scale and were expressed as continuous variable and the qualitative attributes were assessed with proper indicator to represent the real value and hence were expressed as dummy variables. Model 2 is the empirical hedonic price model derived using of data from consumer survey. In model 2, the same attribute which are included in Model 1 were measured using dummy variables but the data were the answers from consumer. The reason for the use of categories variables for all attributes in the survey was to format the answerable questionnaire to the consumer because it would be difficult to collect the data on attributes in scale value from the consumer. All observations of hedonic model 1 were from one specific market, while the survey covered six different markets and it was assumed that all six markets are homogeneous but in reality they might be heterogeneous. Regression parameter estimates of all attributes shows that most of the attributes included in Model 1 (Table 6) have significant influence on price, while in Model 2 only two attributes coefficient were significantly different from zero, and other attributes coefficients were not significant (Table 9). However the main attributes such as size and species coefficient were found significant in both models. The hedonic model 1 of 76 observations on shrimp price explains 85.56% of the variation in price and Model 2 explains 69.32% of the variation in price. The hedonic pricing model for shrimp is therefore, best represented by Model 1 which comprises two quantitative variables and five groups of dummy explanatory variables for estimating implicit price of shrimp attributes in Nha Trang domestic market.

The impact of each attributes on price is described in section 4.2 of chapter 4. The presence of consumer demanded attributes whether genetically or created deserve price premium, which have to be investigate further in future. Result of the consumer survey shows that shrimp is a favourite seafood of Vietnamese. Nearly 63.8% choose the shrimp to purchase because of their a favorite and quality standard of shrimp is taken into account by all of people either next to price or alone. It was around 72% of total consumer interviewed

considered both price and quality standard of shrimp and 28% of them consider only quality standard of shrimp.

Among the continuous variables; carapace length and weight significantly affected price and are associated with positive coefficient (marginal implicit price), carapace length has flexibility more than one which reveals that price is more elastic to length than weight. One issue is the influence of the size of shrimp on market price, as shrimp carapace length gets larger, the equilibrium price per kilogram rises. In nature, the height and the body weight of organism are correlated. During the growth phase of the organism, it grows in all part of the body and the intrinsic growth rate of an organism depends on genetic and environment factor like climatic and nutritional condition. To investigate this relationship, weight was regressed on carapace length and carapace length squared and it was found that weight and carapace length have a non-linear relationship (Table 7). Therefore, one can conclude that both variables could be included in the final model. In case of size, small size shrimp was less valued and consumer survey results of preferred size also indicated that consumer dislike small size, suggested that small sized shrimp has less consumer demand. The most preferred size of shrimp are big and medium and consumer may don't want to take the risk of consuming much time for cleaning in small sized shrimp. Price for the medium sized shrimp would be optimum and could economic viable to consumer, this fact also be the reason for the higher demand to medium size shrimp. Size can be a modifiable attributes and results suggest that producer have to consider size of shrimp produce to supply preferred sized shrimp for domestic consumption. Capturing and culturing large enough size shrimp would make business more effective.

Understandably, one can infer that most of consumers prefer sea-caught shrimp than cultured one, the reason might be believes of consumer that sea-caught is healthier than cultured shrimp. Because it is well known that the number of drugs and antibiotic are used in shrimp farming and some time disease outbreak also occurred in farming. But, the second finding of hedonic model 1 is that cultured shrimp are more valued than sea-caught shrimp. However, these result, can be interpreted with some caution related to the cost of production. The cost of production of shrimp in shrimp farming is high compare with harvesting cost of the shrimp fishing. Feed cost constitutes more than 60 percent of cost of production (Ridler and Hishamunda, 2001) and during the discussion with farm operator, they answered that only

feed they use is shrimp mass and hand feeding is practiced. Most of the farmer use aerator for the circulation of water.

Species and product form also exerted high impact on shrimp prices relative to their benchmarks. Some species receives price premium and some have price discount. Price of a specific species depends on its demand to some extend. The results of the consumer survey indicated that favourite species of consumer varies among consumers and it was measured in terms of colour of shrimp. It was observed that most consumers preferred white shrimp followed by brown shrimp. The species considered as white are white leg shrimp (*Penaeus vannamei)*, banana shrimp (*Penaeus merguiensis)* and Indian white prawn (*Penaeus indicus*) and as brown are Graesyback shrimp (*Metapenaeus ensis)* and Middle shrimp *(Metapenaeus intermedius)*. The favourite species is a correlated factor of consumer attitude and experience of the taste. One could discuss the favourite species of consumer with the result of the taste consideration and selection of species in the consumer survey. The finding of taste consideration showed that taste is one organoleptic factor considered by consumer, nearly more than 80% consumers consider the taste of shrimp. Choice of shrimp species based on taste vary with consumer wish. Of 105 respondent who consider the taste, most of them (65.7%) always choose specific shrimp species based on the previous experience and some of them (19%) choose different species with previous experience and less consumers (10.4%) choose randomly to test the taste quality. The species which is the favourite of most consumers become a higher demanded species and receive higher value than less demanded one. This suggest that investigating the species that has high consumer demand could be useful to producer, mainly farm operators.

In case of product form, fully leaned product (i.e. headless-peeled form of shrimp) that is more convenient for cooking received high price premium than whole shrimp (benchmark). It was noticed during market visit that sea-caught small shrimp are mainly processed to this cleaned form. It suggests that processed form selling could be more profitable in case of seller when they receive small sized sea-caught shrimp. Even though, the whole shrimp is the favourite of most consumers and that is the most common form of shrimp sold in Nha Trang domestic markets also. It might be the reason of consumers' attitude that they can judge it freshness condition with peel colour and appearance when it is a whole shrimp.

As expected, price of shrimp is affected by freshness, in this study freshness assessed in term of disclouration. As mentioned earlier freshness is the main factor considered by consumers in the market to ensure quality standard. The consumer study also supported the statement, the first important attribute considered by most consumers is freshness, nearly 75% of total respondents interviewed. Furthermore, most of consumers prefer the shrimp to be in good fresh condition (alive or very fresh or fresh). When shrimp get discolored this means reduced freshness; the taste would be abnormal because of hydroxylation of nutrients and deterioration all together lead to reduction in quality thus brought to less freshness. Regression result (Table 6) shows that Shrimp which is either no discoloration or slight discoloration of body part; head and shell were more valued in relation to those have remarkable discolouration. Aggregated results of regression and consumer survey reveal that lower the freshness lesser the market value of shrimp and reduce the demand for shrimp. Discoloration occurs after the harvesting if the perishable product is not properly stored with its suited low temperature. As noted earlier shrimp is a perishable product that would discolour, if didn't preserved properly. Hence, the all factors in shrimp production and marketing chain including fishermen and farmers after harvesting, middle man during transportation should prevent the product from discolouration and seller also have to maintain the fresh condition during bussiness. Furthermore, it was noticed in survey, around 80% of 130 respondents have an idea about nutritional quality of shrimp and can either judge this well or to some extend. This shows that the consumers are more concern on health aspects of food product. This freshness attributes can be interpreted with storage method. As described earlier, In Vietnam, shrimp stored with ice cube (freezing) is the most common method used to preserve sea-caught shrimp in all stage of the marketing chain. Most of the sellers are also practicing the same method for both originated shrimp while some cultured shrimp seller used a technical method (i.e storing shrimp in aerated water). The shrimp stored in that method seems alive or very fresh and valued high than iced shrimp. This suggests that storing shrimp in condition which longer the shelf-life of shrimp would upgrade the market value of shrimp.

The daily price of shrimp records from two different markets shows (Figure 3 and Figure 4) that the price of shrimp varies with some market factors. It was observed that price of shrimp increased during the period near to the Vietnamese Launa New Year. It well known that the price of a commodity is normally increases during the special seasonal occasion and generally demand of most of essential commodity is high the normal days. It also noted that

in a specific day the average price for kilogram of shrimp vary from market to market. The transport cost and demand of shrimp might be the reasons. Day of week, seasonal occasion, and market situation are the noticed market factors influence on price of commodity in this study. Secondly, it was found that amount of supply fluctuates with week and weekend days, supply was high in weekend days in both markets, the reason might be in weekend days the demand is high and normally most of consumers who are employees purchase the vegetables and fish during weekend days. Vinh Hai market is larger than Vinh Thuo market in scale, there by the supply was higher in Vinh Hai than another.

The summarized finding of the study, beside the market factors, the extrinsic quality attributes of shrimp have significant impact on its market price. Among those attributes, size, species and freshness are very most important attributes. Shrimp is the favorite of most of people due to its delicious taste. Next to price, quality attributes of seafood which represent the quality standard are considered by the consumer mainly freshness of shrimp. Further more, the preferred quality attributes of shrimp differ among consumers. Even though, some specific characters are favourite of most consumers i.e., medium sized, sea-caught white fresh whole shrimp.

5.2 Managerial and theoretical implications

The seafood marketing sector is a diversified sector. Shrimp is an important seafood in Vietnam. Study about the shrimp production and evaluating the quality attributes influence on market price is meaningful for future shrimp production and marketing in Vietnam.

The implications of this study suggest to three various actors in shrimp industry including fishermen, farm operators and market sellers. Mesh sizes of trawler gear is one factor which determines the sizes of individual caught during trawling (MacLennan, 1992), selectivity improvement would improve the future shrimp catch. The practical implications that can be drawn from the study are that fisherman should consider the mesh size of bottom trawler to avoid catching very small sized shrimp. The results from the study show that larger size shrimp has high value and most of the consumers prefer either medium or big size shrimp. Thus small size shrimp are lower value and some time which used as feed for aquaculture farm. While the only preserved method of sea-caught shrimp is store with ice cube in plastic basket thereby when the time duration of fishing day long, there is possibility to reduce

freshness of shrimp. Therefore fisherman have to consider preservation method because the freshness is a depended factor of preservation and freshness is first most quality attributes of seafood consider by consumers.

Farm operators have to maintain the optimum density to facilitate shrimp for attaining its maximum mature size by providing adequate nutrition, sanitation and spacing to individuals. Mature size of shrimp vary with species and may be affected by the nutritional status of feeding (Chiba *et al.,* 2000) and the growing environment condition (Araneda *et al.,* 2008). Attributes such as nutritional value, appearance, smell, taste and texture may be affected by the quality of nutrition and feed provided during culture (Hasan, 2001). Farm operators should also consider the consumer demanded species during the selection of species for farming.

Further, it can be suggested that preserving cultured shrimp in aerated water can during selling is a good practice to keep shrimp fresh. The shrimp seller can adapt this as a better method for cultured shrimp.

This research could contribute to understand about shrimp industry and marketing in Vietnam and to modify the possible quality attributes which would upgrade quality standard of shrimp and get better price in future through satisfying consumer preferences. One also could suggested from the result of different modeling that evaluating the influence of quality attributes on a seafood, its best to employ the model with data by collecting seafood sample and record accurately than data collect from consumer.

5.3 Limitations and future research

This research was conducted by considering extrinsic quality parameter which easily identifiable by domestic consumer due to the limit of time and laboratory facility for the proximate analysis. Even though intrinsic quality parameters of shrimp mainly nutritional content also have influence on the price. Future study it would be better to include those nutritional attributes. The consumer survey was based on shrimp buyers from domestic markets in Nha Trang city which did not represent the whole consumers, thus the results could not be generalized to Vietnam as a whole.

CHAPTER 6
SUMMARY AND CONCLUSSION

This study aimed to analyze the variation in market price of shrimp relates to quality changes through identifying the various quality attributes of shrimp which influence on market price and evaluate the relationship between price and quality characters in terms of marginal effects and elasticity. Secondly aimed to point out the main quality characters which influence consumer preference, which quality characteristics are commonly considered by consumer during choosing and purchasing of shrimp? in Nha Trang, Vietnam. To achieve the first objective a simple linear form of hedonic price model incorporating both quantitative and qualitative attributes was developed in this study and a consumer survey was conducted in six domestic markets using a convenience sample of 130 respondents to full fill the last objective of the study. The theoretical background of this study is related to the hedonic pricing, which is widely applied for explaining price variations of differentiated commodity proposed by Rosen (1974). Shrimp was treated as differentiated product of a general good. The variable used were either taken or adapted from previous literature of seafood hedonic pricing. Seventy six shrimp observations collected from a specific domestic market in Nha Trang for empirical analysis. Extrinsic quality attributes such carapace length, weight species, origin, freshness, preservation method and product form were identified and measured. All measured data were subjected to statistical analysis in Shazam 10.0 and simple linear form of hedonic model was estimated using OLS method. Influence of quality attributes on shrimp prices reflected by the marginal implicit price i.e coefficient of explanatory variables such as continuous and dummy variables. Positive coefficient means that a quality attribute positively valued by consumer and receive price premium and negative coefficient means vise versa, suggest that price discount for those attributes.

The continuous variable “carapace length” was reported to be a desirable quality attributes receiving a price premium and price was more elastic to carapace length than weight. The characteristic “no discoloration” valued more than other form of freshness. Removing head and peel i.e. fully cleaning raises the value of shrimp. The valuation of species was varied among consumers. Some species have high consumer demand in domestic market. The attribute “preservation method” was also tested and it influenced on consumer valuation of shrimp quality. Further more, consumer survey results indicated that the consumers consider

quality attributes of shrimp including freshness, species, origin and size which have influence of consumer preference. The hedonic estimation results showed that combination of desired attributes that related with perception of best quality standard would value high in domestic market.

Day of week and cultural occasion were noticed as market factors lead to price fluctuation with in market. Like wise, market situation was noticed one of reason for price variation of shrimp between markets in this study. Supply also varied with scale of market.

Direct visit to shrimp landing place and farming, interviews with various actors in shrimp production and marketing and statistical analysis, all imply that extrinsic quality attributes are also determinant of market price in additional to market factors and differentiation in quality standard causes for the variation in price with in market. In particular, "carapace length" expresses the size and no dicolouration represent the freshness in this study are the primary determinants of value. Vietnam consumers select shrimp on the basis of their preference and quality standard of product.

It is recommended that future study have to incorporate the intrinsic quality characteristic and some other attributes to explain the whole variation in price of shrimp in domestic market due to the differentiation in quality attributes.

REFERENCE

Adams, S and J. Standridge (2006). What should we eat? Evidence from observational studies. *Southern Med J*, Vol. 99, pp. 744-748.

Ahmadi-Esfahani, F. Z and R .G. Stanmore (1994). Quality premiums for Australian Wheat in the growing Asian markets *Australian Journal Agricultural Economics* Vol. 38(3), pp. 237-250.

Akter, S. (2010). Effect of Financial and Environmental Variables on the Production Efficiency of White Leg Shrimp Farms in Khan Hoa Province, Vietnam, *Master thesis* Fisheries and Aquaculture Management and Economics, University of Tromso, Norway.

Angulo, A. M., J. M. Gil., A. Gracia and M. Sanchez (2000). Hedonic prices for Spanish red quality wine. *British Food Journal*, Vol. 102 (7), pp. 481-493.

Araneda, M., E. P. Pérez and E. Gasca-Leyva (2008). White shrimp *Penaeus vannamei* culture in freshwater at three densities: Condition state based on length and weight. *Aquaculture*, Vol. 283, pp. 13–18.

ARGOINFO (2009). Report on "Vietnam fishery sector in the first quarter, 2009" (In Vietnamese). Release date: June 25th, 2009. Published by Information Center for Agriculture and Rural Development (ARGOINFO). Institute of Policy and Strategy for Agriculture and Rural Development. Ministry of Agriculture and Rural Development, Vietnam.

Bartik, T. J. (1987). The Estimation of Demand Parameters in Hedonic Price Models *Journal of Political Economy*, Vol. 95, No. 1, pp. 81-8.

Berndt, E. R. (1991). The Measurement of Quality Change. In: *The Practice of Econometrics*: Classic and Contemporary, Addison-Wesley Publishing Company, Inc.,Reading, MA New York. Pp; 105-132.

Brachinger, H.W. (2002). Statistical Theory of hedonic Price Indices. (e. FERN) Finance, Economy and Risk Network.

www.unifr.ch/dqe/papers/files/wp0001.pdf

Carew, R. (2000). A Hedonic analysis of apple prices and product quality characteristics in British Columbia. *Canadian Journal of Agricultural Economics* 48: 241–257.

Carroll, M.T., J. L Anderson and J. Martinez-Garmendia (2001). Pricing U.S.North Atlantic bluefin tuna and implications for management. Agribusiness, ABI/INFORM Global, 17(2); 243-253.

Chiba, S., S. Goshima1 and T. Mizushima (2000). Factors affecting the occurrence of early maturing males in the protandrous pandalid shrimp *Pandalus latirostris. Marine Ecology Progress Series,* Vol. 203, pp. 215–224.

Choung, B. P. T. (2011). Value chain of White leg shrimp exported to U.S market in Khanh Hoa province, Vietnam. *Master thesis,* Fisheries and Aquaculture Management and Economics, University of Tromso, Norway.

Cole, H. A and M. N Mistqkidis (1953). A Device for the quick and accurate measurement of carapace length in prawn and shrimp , *ICES Journal of Marine Science*, Vol. 19 (1), pp. 77-79.

Combris, P., S. Lecocq and M. Visser (1997). Estimation of a Hedonic Price Equation for Bordeaux Wine: Does Quality Matter? *The Economic Journal*, Vol. 107, No. 441. pp. 390-402.

Cropper, M. L., l. B. Deck and K. E McConnell (1988). On the Choice of Functional Form for Hedonic Price Functions, *The Review of Economics and Statistics*, Vol. 70 (4), pp. 668-675.

Espinosa, J. A and B. K. Goodwin (1991). Hedonic Price Estimation for Kansas Wheat Characteristics. *Western Journal of Agricultural Economics,* Vol. 16(1), pp. 72-85.

Estes, E. A. (1986). Estimation of Implicit Prices For Green Pepper Quality Attributes Using a Hedonic Framework. *Journal of Food Distribution Research*, pp. 5-15.

Ethridge, D. E and B. Davis (1982). Hedonic price estimation for commodities: An application to cotton. *Western Journal of Agricultural economics*, Vol. 7(2), pp. 293-300.

FAO (2010). The State of World Fisheries and Aquaculture. Food and Agriculture Organization of the United Nations. Rome. Italy.

GSO (2010a). Statistical Hand book of Vietnam. General statistical office of Vietnam, Vietnam. P.148.

GSO (2010b). Statistical Year book of Vietnam. General statistical office of Vietnam, Vietnam. P.416.

GSO (2010c). General statistical office of Vietnam. http://www.gso.gov.vn/default_en.aspx?tabid=467&idmid=3&ItemID=11726

Halvorsen, R and H. O. Pollakwoshi (1981). Choice of functional form for hedonic price equation. *Journal of Urban Economics,* Vol. 10, pp. 37-49.

Hanson, G. D., R. O. Herrmann and J. W. Dunn (1995). Derterminants of Saefood purchase behavior: Consumers, restaurants and Grocery stores. *American journal of Economics, Vol*. 77, pp. 1301-1305.

Hasan, M.R. (2001). Nutrition and feeding for sustainable aquaculture development in the third millennium. In R.P. Subasinghe, P. Bueno, M.J. Phillips, C. Hough, S.E. McGladdery and J.R. Arthur, (eds). Aquaculture in the Third Millennium. Technical Proceedings of the Conference on Aquaculture in the Third Millennium, Bangkok, Thailand, 20-25 February 2000. pp. 193-219. NACA, Bangkok and FAO, Rome.

http://www.fao.org/DOCREP/003/AB412E/ab412e10.htm

Houston, J. C., A. E Nieto., H. Li and G. W. Lewis (1989). Factors affecting landing prices of shrimp landing. *Marine Resource Economics*, Vol.6, pp. 163-172.

Huy, D. H. Z (2009). Technical efficiency analysis for commercial Black Tiger Prawn (*Penaeus monodon*) aquaculture farms in Nha Trang city, Vietnam, *Master thesis* Fisheries and Aquaculture Management and Economics, University of Tromso, Norway.

Kajikawa, C. (1998). Quality level and price in Japanese apple market *Agribusiness,* Vol 14(3), pp. 227-234.

Khang, P. V. (2008). Challenges to Shrimp Production in the Bentre Province, Vietnam, *Master thesis* in Fisheries and Aquaculture Management and Economics, University of Tromso, Norway.

Komarova, V. (2009). Valuing Environmental Impact of Air Pollution in Moscow with Hedonic Prices. *World Academy of Science, Engineering and Technology* Vol 57, pp. 319-326.

MacLennan, D. N (1992). Fishing gear selectivity: An Overview. *Fisheries Research,* Vol. 13, pp. 201-204.

Marin, I. N and O.V. Savinkin (2007). Further records and preliminary list of pontoniine (Caridea: Palaemonidae: Pontoniinae) and hymenocerid (Caridea: Hymenoceridae) shrimps from Nhatrang Bay, In Britayev, T. A and D. S Pavlov(eds) *Benthnic fauna of the Bay of Nha Tran Southern Vietnam*, Joint Vietnamese-Russian Tropical Research and Technological Centre, KMK Scientific Press, Moscow. Pp 175.

McConnell, K. E and I. E. Strand (2000). Hedonic Prices for Fish: Tuna Prices in Hawaii. *American Journal of Agricultural Economics*, Vol. 82 (1), pp. 133-144.

Mozaffarian, D and E. Rimm (2006). Fish intake, contaminants, and human health evaluating the risks and the benefits. *J Am Med Assoc*, Vol. 296, pp. 1885- 1899.

Mullen, J. D and M. K. Wohlgenant (1991). The willingness of consumer to pay for the attributes of lamb. *The Australian Journal of Agricultural Economics*, Vol. 35, No. 3, pp. 247-262.

Myrland, O., T. Trondsen., R. S. Johnston and E. Lund (2000). Determinants of seafood consumption in Norway: lifestyle, revealed preferences, and barriers to consumption, *Food Quality and Preference*, Vol.11, pp. 169-188.

Nerlove, M. (1995) Hedonic price functions and the measurement of preference: The case of Swedish wine consumers. *European Economic Review* Vol. 39, pp. 1679-1716.

Oczkowski, E. (1994). Hedonic price function for Australian Premium Table wine *Australian Journal Agricultural Economics,* Vol 38(1), pp. 93-110.

Olsen, S.O., J. Scholderer., K. Brunso and W. Verbeke (2007). Exploring the relationship between convenience and fish consumption: A cross-cultural study. *Appetite*, Vol. 49, pp. 84-91.

Ridler, N and N. Hishamunda (2001). Promotion of sustainable commercial aquaculture in Sub- Saharan Africa. *FAO fisheries Technical paper*, Policy Frame work. FAO, Rome, Italy. Vol 1, Pp 9.

Robst, J. (2006). Estimation of hedonic pricing model for medigap supplemental insurance. *Health Service Research* Vol. 41.No.6. pp. 2097-2113.

Roheim, C. A., L. Gardiner and F. Asche. (2007). Value of brands and other attributes: Hedonic of retail frozen fish in the UK. Marine Resource Economics Vol.22, pp. 239-253.

Rosen, S. (1974). Hedonic Price and Implicit Market: product Differentiation in Pure Competition, *The Journal of Political Economy*, Vol .82 (1), pp. 34-55.

Ruiz, J. R. R. (2009). Economic analysis of Rural and Artisanal Aquaculture in Ecuador, *Master thesis,* Fisheries and Aquaculture Management and Economics, University of Tromso, Norway.

Sabat,S., A. Sharma and S. S. Salim (2008). Consumption pattern and consumption preference for the value- added fish and fish product in North zone of India. *Journal of Indian Fish Association* , Vol. 35, pp. 19-27.

Salayo, N. D., T. J. P Voon and S. Selvanthan (1999). Implicit price of Prawn and Shrimp attributes in the Philippine domestic market. *Marine Resource Economics,* Vol.14, pp. 65-78.

Samuelson, P. A and W. D. Nordhaus (2010). Economics, 19th edition. The Mc Graw- Hill Companies, Inc. India. Pp 869.

Selim, S. (2008). Determinants of house prices in the Turkey: A hedonic Regression model *Dogus University Journal*, 9 (1), pp. 65-76.

Şentürk, İ and C. Erdem. (2010). Factors Affecting the Notebook Computer Prices in Turkey: A Hedonic Analysis. *The Empirical Economics Letters,* Vol. 9(6), pp. 545-553.

Stanton, Emms and Sia. (2010). Future Opportunities in Vietnam's Market for Fish and Seafood. Agri-Food Trade Service, Agriculture and Agri-Food Canada

http://www.ats.agr.gc.ca/ase/5681-eng.htm

Thuy, H. T. (2008). Đánh giá hiệu quả kinh tế, xã hội nghề nuôi tôm sú giống tại tỉnh Khánh Hòa (Economic, social efficiency evaluation for breed Black Tiger Prawn -Penaeus monodon aquaculture- in Khanh Hoa province). *Master thesis*, Nha Trang University, Viet Nam.

Thủy,T. S. P. X., K.S. P. X. Yến., K.S. T. V. Liễn (2010). Technology transfer of seed production and white leg shrimp intensive cultivation (*Litopenaeus Vannamei*) for Quang Binh Province [Chuyển giao công nghệ sản xuất giống và nuôi thâm canh tôm hệ chân trắng (*Litopenaeus Vannamei*) cho tỉnh Quảng Bình] *Fishery Science and Technology Magazine* [Tạp chí Khoa học- Công nghệ Thủy sản],Nha Tran University [Trường Đại học Nha Trang] No -1 pp 42-52.

Tien, V. D and D. Griffiths (2009). Shrimp GAP and BMP in Vietnam: Policy, current status and future direction, Sustainable Development of Aquaculture, Fisheries Sector Programme Support Phase II. pp 1-21.

Triplett, J. (2006). Hand book on Hedonic Indexes and Quality Adjustments in Price Indexes: Special application to Information Technology products, OECD Publishing, Organization for Economic Co-operation and Development, Paris, France pp 45-46.

Tuan, L. A. (2003). Status of aquaculture and associated environmental management issues in Vietnam. Tropeca Working paper No.4. University of Fisheries, Nha Trang, Khanh Hoa, Vietnam.

VASEP (2011). Commercial Fisheries News (In Vietnamese). Release date: January 28th, 2011. Published by Vietnam Association of Seafood Exporters and Producers (VASEP).

Waugh, F. V. (1928). Quality Factors Influencing Vegetable Prices. *Journal of Farm Economics,* Vol. 10 No.2, pp. 185-196.

Wessells, C. R., R. J. Johnston and H. Donath. (1999). Assessing consumer prefernce for ecolabelled seafood: The influence of species, certifier and household attributes. *American Journal of Agricultural Economics* Vol.81 (5), pp. 1084-1089.

Williams, S. C and J. W. Longworth (1989). Factors influencing tuna prices in Japan and implication for the development of the Coral Sea fishery. European Journal of Marketing, 23; 5-24.

www.seaminhhai.com

Zdenek, D. (2007). Mantis shrimps (Crustacea: Stomatopoda) of Nhatrang Bay. In Britayev, T. A and D. S Pavlov(eds) *Benthnic fauna of the Bay of Nha Tran Southern Vietnam*, Joint Vietnamese-Russian Tropical Research and Technological Centre, KMK Scientific Press, Moscow. Pp 124.

Appendix A

A questionnaire used for information collection about sea-caught in shrimp landing place

Date: ……..

place (Address) .. …….

1. What are the common shrimp species captures in Nha Tran Bay?
2. How you grade the caught shrimp and what are the criteria you consider during grading?
3. How you fix the price per kilogram?
4. What is the method that you used to capture the shrimp?
5. What is the average catch per unit effort?
6. What is the mesh size of fishing gear that used for capturing shrimp?
7. What is average size of shrimp

Length weight

Grade 1 (large) …….

Grade 2 (medium) ……

Grade 3 (small) ……..

8. What is the usage of tinny/ very small sized shrimp?
9. Have you maintain any record for the expenditure, production and selling price?

Appendix B

A questionnaire used for information collection about shrimp culture

Date: ……..

place (Address) …….

1. What are the shrimp species that you culture in the farm?
2. What is the area of your production?
3. Method of culture (mono culture / mixed farming)?
4. what is the average production of those species (tons/ha or kg/m^2)
5. Duration of those species (age of harvesting)?
6. How you grade the shrimp and what are the criteria you consider during grading?

7. How you fix the price per kilogram?
8. What is average size of matured shrimp (for this I can take sample and record data, and secondary source also)?

1. Length weight/head

Grade 1 (large) ……..

Grade 2 (medium) …….

Grade 3 (small) ……..

02. How you marketing your product? (middle man/ market seller/…….)

10. Have you maintain any record for the expenditure, production and selling price?

Appendix C

Table format of quality attributes recording

NO	Price (vnd/kg)	Carapace length(cm)	weight	origin	Species	Preserved method	Freshness	Product form

Appendix D

Consumer survey questionnaire

Date:…… Consumer id:…… Market name:……

1. What is the price (Vnd/ kg) and amount of shrimp that you brought today?

……

2. Generally what amount (average in gram) you purchase in one time and how many times you purchase shrimp in a week?

……

3. In which situation you choice shrimp to purchase, (if your choice is more than one option, please indicate the order based on your priories)

a. I choose often because of my favorite
b. I choose occasionally
c. I choose rarely when I fate up with fish
d. I choose when it's price cheap
e. I choose shrimp when fish is unavailable

4. Which factor you consider during purchasing of shrimp? (if your choice is more than one option, please indicate the order based on your priories)

During purchasing of shrimp I consider,

a. Only the price
b. Only the quality standard of shrimp
c. Both price and quality standard of shrimp
d. I don't consider any of above factor
e. I don't have any idea

5. If you consider the quality standard of shrimp, what are the attributes you taken into account during choice of shrimp (if your choice more than one option, please indicate the order based on your priories)

a. Size b. species of my favorite
c. It's origin (sea-caught)/ culture d. Fresh condition
e Storage/ preservation condition f. Product form

Please tick you preferred quality character of shrimp in the following aspect

6. Size of shrimp (select from the photo)

a. Big size (G-1) b. Medium size (G-2) c. Small size (G-3) d. very small (G- 4)

7. Origin of shrimp

a. sea-caught shrimp b. Culture shrimp

8. Species / colour of shrimp (select from the photo)

a. White b. Black c. Pink d. Brown

9. Freshness

a. Alive b. Very fresh c Fresh d. acceptable fresh

10. Storage/ preservation method

a. with ice cube b. in aerated water can c. in water only

11. Product from

a. Whole shrimp c. Partially cleaned c. Fully cleaned and ready to cook

12. Do you consider the taste of shrimp when you choose particular kind of shrimp?

a. Yes a. No

13. If yes, how you choose

a. I choose randomly without any idea

b. I choose randomly to test the taste quality

c. I always choose specific shrimp species with my previous experience

d. I choose different shrimp species with my previous experience

14. Do you have any idea about the nutritional quality of shrimp?

a. yes b. No

15. Can you judge the nutritional quality of shrimp when you are purchasing?

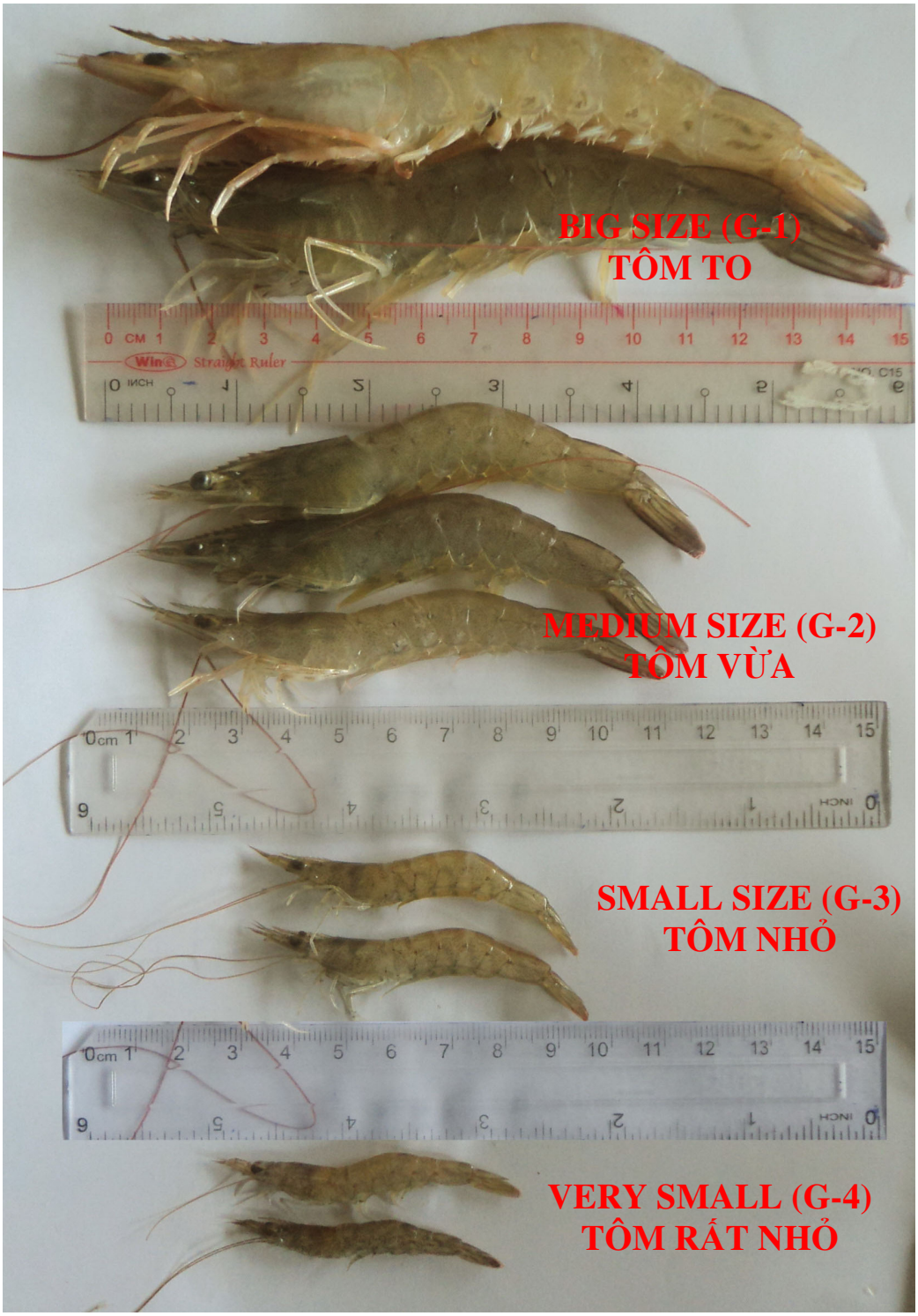
a. Yes I can well c. yes, I can to some extent b. No I can't

16. Please circle the character of shrimp you purchase today

size	**origin**	**Species (Colour)**	**freshness**	**Product form**	**Preserved method**
Big (G1)	Sea-caught	White	Alive	Whole shrimp	with ice cube
Medium (G2)		Black	Very fresh	Partially cleaned	in aerated water
Small (G3)					
Very Small (G4)	Culture	Pink	Fresh	Fully cleaned and ready to cook	with normal water only
		Brown	Acceptable fresh		

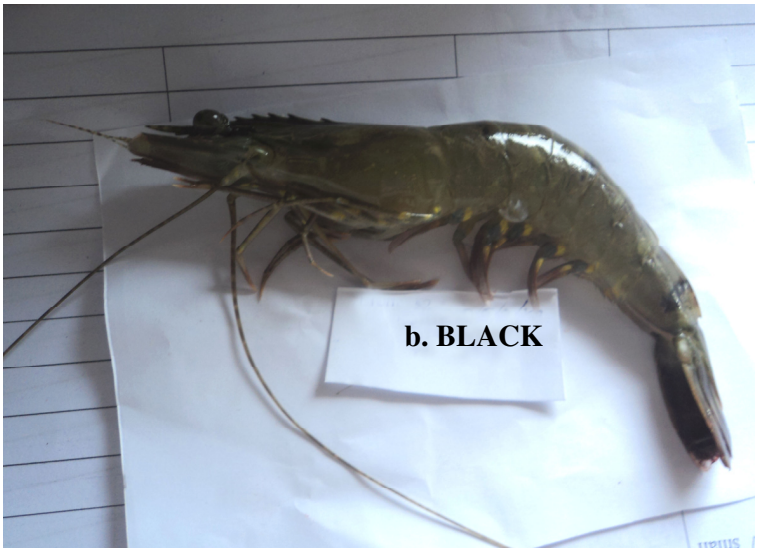
Appendix E

Size selection photograph



Appendix F

Species selection photographs




c. PINK


d. BROWN

Appendix G

Table format of daily shrimp price in Nha Trang domestic market recording during study period

Market name: Seller id:

Date	Price (vnd/kg)	Supply (amount of shrimp you bring to sell)	Demand (amount that you able to sell)

Appendix H

Shazam output of Data analysis : Correlation Matrix of variables

```
 Welcome to SHAZAM - Version 10.0 -  JUL 2004 SYSTEM=WIN-NT   PAR= 11000
 CURRENT WORKING DIRECTORY IS: D:\NOMA\DATAAN~1\SHAZAM
 |_* shrimp
 |_sample 1 76
 |_read no PRICE WGT CL OR1 OR2 SP1 SP2 SP3 SP4 SP5 SP6 SP7 SP8 PM1 PM2 PF1 PF2
DC1 DC2 DC3
   21 VARIABLES AND       76 OBSERVATIONS STARTING AT OBS       1

 |_FORMAT(F20.3)
 |_stat PRICE WGT CL / pcor cor= r
 NAME         N    MEAN        ST. DEV      VARIANCE    MINIMUM   MAXIMUM
 PRICE         76   121.97      62.477      3903.4      50.000     350.00
 WGT           76   10.791      12.876      165.80      0.53000    95.530
 CL            76   31.232      9.0567      82.024       13.000    71.000

  CORRELATION MATRIX OF VARIABLES -       76 OBSERVATIONS


 PRICE      1.0000
 WGT       0.78929       1.0000
 CL        0.76627      0.90124       1.0000
             PRICE        WGT          CL
 |_stat OR1 OR2 / pcor cor=r
 NAME         N    MEAN       ST. DEV     VARIANCE   MINIMUM      MAXIMUM
 OR1           76  0.51316     0.50315     0.25316    0.0000       1.0000
 OR2           76  0.48684     0.50315     0.25316    0.0000       1.0000

  CORRELATION MATRIX OF VARIABLES -       76 OBSERVATIONS


 OR1        1.0000
```

```
OR2       -1.0000       1.0000
             OR1           OR2
|_stat SP1 SP2 SP3 SP4 SP5 SP6 SP7 SP8  / pcor cor= r
NAME         N    MEAN      ST. DEV    VARIANCE     MINIMUM      MAXIMUM
SP1         76  0.92105E-01 0.29110    0.84737E-01   0.0000       1.0000
SP2         76  0.18421     0.39023     0.15228      0.0000       1.0000
SP3         76  0.25000     0.43589     0.19000      0.0000       1.0000
SP4         76  0.52632E-01 0.22478   0.50526E-01    0.0000       1.0000
SP5         76  0.78947E-01 0.27145     0.73684E-01  0.0000       1.0000
SP6         76  0.78947E-01 0.27145     0.73684E-01  0.0000       1.0000
SP7           76  0.14474     0.35417     0.12544    0.0000       1.0000
SP8           76  0.11842     0.32525     0.10579    0.0000       1.0000

 CORRELATION MATRIX OF VARIABLES -       76 OBSERVATIONS


SP1        1.0000
SP2      -0.15135       1.0000
SP3      -0.18389     -0.27435       1.0000
SP4      -0.75074E-01 -0.11200     -0.13608       1.0000
SP5      -0.93250E-01 -0.13912     -0.16903     -0.69007E-01   1.0000
SP6      -0.93250E-01 -0.13912     -0.16903     -0.69007E-01 -0.85714E-01
           1.0000
SP7      -0.13103     -0.19548     -0.23751     -0.96962E-01 -0.12044
         -0.12044       1.0000
SP8      -0.11674     -0.17416     -0.21160     -0.86387E-01 -0.10730
         -0.10730     -0.15077       1.0000
             SP1           SP2           SP3           SP4           SP5
             SP6           SP7           SP8
|_stat PM1 PM2 / pcor cor= r
NAME         N   MEAN        ST. DEV     VARIANCE   MINIMUM      MAXIMUM
PM1           76  0.19737     0.40066     0.16053   0.0000       1.0000
PM2           76  0.80263     0.40066     0.16053   0.0000       1.0000

 CORRELATION MATRIX OF VARIABLES -       76 OBSERVATIONS


PM1        1.0000
PM2       -1.0000       1.0000
             PM1           PM2
|_stat PF1 PF2 / pcor cor= r
NAME         N   MEAN       ST. DEV     VARIANCE    MINIMUM      MAXIMUM
PF1          76  0.96053     0.19601    0.38421E-01  0.0000       1.0000
PF2           76  0.39474E-01 0.19601     0.38421E-01 0.0000     1.0000
 CORRELATION MATRIX OF VARIABLES -       76 OBSERVATIONS


PF1        1.0000
PF2       -1.0000       1.0000
             PF1           PF2



|_stat DC1 DC2 DC3 / pcor cor= r
NAME         N    MEAN       ST. DEV    VARIANCE     MINIMUM     MAXIMUM
DC1          76  0.65789     0.47757    0.22807      0.0000       1.0000
DC2          76  0.26316     0.44327     0.19649     0.0000       1.0000
DC3          76  0.78947E-01 0.27145     0.73684E-01 0.0000       1.0000

 CORRELATION MATRIX OF VARIABLES -       76 OBSERVATIONS


DC1        1.0000
DC2      -0.82874       1.0000
```

```
DC3       -0.40600     -0.17496       1.0000
              DC1          DC2          DC3
|_print r / format
R
    8 BY     8 MATRIX - LOWER TRIANGLE PRINTED
              1.000
             -0.829
              1.000
             -0.406
             -0.175
              1.000
             -0.075
             -0.112
             -0.136
              1.000
             -0.093
             -0.139
             -0.169
             -0.069
              1.000
             -0.093
             -0.139
             -0.169
             -0.069
             -0.086
              1.000
             -0.131
             -0.195
             -0.238
             -0.097
             -0.120
             -0.120
              1.000
             -0.117
             -0.174
             -0.212
             -0.086
             -0.107
             -0.107
             -0.151
              1.000
|_stop
```

Appendix I

Shazam output of Data analysis - Shrimp Hedonic Model 1

```
 Welcome to SHAZAM - Version 10.0 -  JUL 2004 SYSTEM=WIN-NT   PAR= 11000
 CURRENT WORKING DIRECTORY IS: D:\NOMA\DATAAN~1\SHAZAM
 |_* shrimp
 |_sample 1 76
 |_read no PRICE WGT CL OR1 OR2 SP1 SP2 SP3 SP4 SP5 SP6 SP7 SP8 PM1 PM2 PF1 PF2
DC1 DC2 DC3
   21 VARIABLES AND       76 OBSERVATIONS STARTING AT OBS       1

 |_stat / all
 NAME         N    MEAN        ST. DEV      VARIANCE     MINIMUM      MAXIMUM
 NO            76   38.500      22.083      487.67       1.0000       76.000
 PRICE         76   121.97      62.477      3903.4       50.000       350.00
 WGT           76   10.791      12.876      165.80      0.53000       95.530
 CL            76   31.232      9.0567      82.024       13.000       71.000
 OR1           76  0.51316     0.50315     0.25316       0.0000       1.0000
 OR2           76  0.48684     0.50315     0.25316       0.0000       1.0000
 SP1           76  0.92105E-01 0.29110     0.84737E-01   0.0000       1.0000
 SP2           76  0.18421     0.39023     0.15228       0.0000       1.0000
 SP3           76  0.25000     0.43589     0.19000       0.0000       1.0000
 SP4           76  0.52632E-01 0.22478     0.50526E-01   0.0000       1.0000
 SP5           76  0.78947E-01 0.27145     0.73684E-01   0.0000       1.0000
 SP6           76  0.78947E-01 0.27145     0.73684E-01   0.0000       1.0000
 SP7           76  0.14474     0.35417     0.12544       0.0000       1.0000
 SP8           76  0.11842     0.32525     0.10579       0.0000       1.0000
 PM1           76  0.19737     0.40066     0.16053       0.0000       1.0000
 PM2           76  0.80263     0.40066     0.16053       0.0000       1.0000
 PF1           76  0.96053     0.19601     0.38421E-01   0.0000       1.0000
 PF2           76  0.39474E-01 0.19601     0.38421E-01   0.0000       1.0000
 DC1           76  0.65789     0.47757     0.22807       0.0000       1.0000
 DC2           76  0.26316     0.44327     0.19649       0.0000       1.0000
 DC3           76  0.78947E-01 0.27145     0.73684E-01   0.0000       1.0000
 |_* number PRICE WGT CL OR1 OR2 SP1 SP2 SP3 SP4 SP5 SP6 SP7 SP8 MS1 MS2 PM1
PM2 PF1 PF2 DC1 DC2 DC3
 |_stat OR1 OR2 / pcor
 NAME         N    MEAN        ST. DEV      VARIANCE     MINIMUM      MAXIMUM
 OR1           76  0.51316     0.50315     0.25316       0.0000       1.0000
 OR2           76  0.48684     0.50315     0.25316       0.0000       1.0000

  CORRELATION MATRIX OF VARIABLES -       76 OBSERVATIONS


 OR1         1.0000
 OR2        -1.0000       1.0000
               OR1           OR2
 |_stat SP1 SP2 SP3 SP4 SP5 SP6 SP7 SP8  / pcor
 NAME         N    MEAN        ST. DEV      VARIANCE     MINIMUM      MAXIMUM
 SP1           76  0.92105E-01 0.29110     0.84737E-01   0.0000       1.0000
 SP2           76  0.18421     0.39023     0.15228       0.0000       1.0000
 SP3           76  0.25000     0.43589     0.19000       0.0000       1.0000
 SP4           76  0.52632E-01 0.22478     0.50526E-01   0.0000       1.0000
 SP5           76  0.78947E-01 0.27145     0.73684E-01   0.0000       1.0000
 SP6           76  0.78947E-01 0.27145     0.73684E-01   0.0000       1.0000
 SP7           76  0.14474     0.35417     0.12544       0.0000       1.0000
 SP8           76  0.11842     0.32525     0.10579       0.0000       1.0000
```

```
CORRELATION MATRIX OF VARIABLES -       76 OBSERVATIONS

 SP1        1.0000
 SP2      -0.15135       1.0000
 SP3      -0.18389     -0.27435       1.0000
 SP4      -0.75074E-01 -0.11200     -0.13608       1.0000
 SP5      -0.93250E-01 -0.13912     -0.16903     -0.69007E-01   1.0000
 SP6      -0.93250E-01 -0.13912     -0.16903     -0.69007E-01 -0.85714E-01
            1.0000
 SP7      -0.13103     -0.19548     -0.23751     -0.96962E-01 -0.12044
          -0.12044       1.0000
 SP8      -0.11674     -0.17416     -0.21160     -0.86387E-01 -0.10730
          -0.10730     -0.15077       1.0000
              SP1          SP2          SP3          SP4          SP5
              SP6          SP7          SP8
 |_stat PM1 PM2 / pcor
 NAME         N    MEAN        ST. DEV      VARIANCE     MINIMUM      MAXIMUM
 PM1           76  0.19737     0.40066     0.16053       0.0000       1.0000
 PM2           76  0.80263     0.40066     0.16053       0.0000       1.0000

  CORRELATION MATRIX OF VARIABLES -       76 OBSERVATIONS


 PM1        1.0000
 PM2       -1.0000       1.0000
              PM1          PM2
 |_stat PF1 PF2 / pcor
 NAME         N    MEAN        ST. DEV      VARIANCE     MINIMUM      MAXIMUM
 PF1           76  0.96053     0.19601     0.38421E-01   0.0000       1.0000
 PF2           76  0.39474E-01 0.19601     0.38421E-01   0.0000       1.0000

  CORRELATION MATRIX OF VARIABLES -       76 OBSERVATIONS


 PF1        1.0000
 PF2       -1.0000       1.0000
              PF1          PF2
 |_stat DC1 DC2 DC3 / pcor
 NAME         N    MEAN        ST. DEV      VARIANCE     MINIMUM      MAXIMUM
 DC1           76  0.65789     0.47757     0.22807       0.0000       1.0000
 DC2           76  0.26316     0.44327     0.19649       0.0000       1.0000
 DC3           76  0.78947E-01 0.27145     0.73684E-01   0.0000       1.0000

  CORRELATION MATRIX OF VARIABLES -       76 OBSERVATIONS


 DC1        1.0000
 DC2      -0.82874       1.0000
 DC3      -0.40600     -0.17496       1.0000
              DC1          DC2          DC3
 |_* Relationship between weight and length
 |_genr CL2=CL*CL

 |_ols WGT CL CL2

 REQUIRED MEMORY IS PAR=      17 CURRENT PAR=   11000
  OLS ESTIMATION
        76 OBSERVATIONS     DEPENDENT VARIABLE= WGT
 ...NOTE..SAMPLE RANGE SET TO:      1,     76

  R-SQUARE =   0.9849     R-SQUARE ADJUSTED =   0.9845
 VARIANCE OF THE ESTIMATE-SIGMA**2 =   2.5637
 STANDARD ERROR OF THE ESTIMATE-SIGMA =   1.6012
 SUM OF SQUARED ERRORS-SSE=   187.15
```

```
 MEAN OF DEPENDENT VARIABLE =   10.791
 LOG OF THE LIKELIHOOD FUNCTION = -142.085

 MODEL SELECTION TESTS - SEE JUDGE ET AL. (1985,P.242)
  AKAIKE (1969) FINAL PREDICTION ERROR - FPE =      2.6649
     (FPE IS ALSO KNOWN AS AMEMIYA PREDICTION CRITERION - PC)
  AKAIKE (1973) INFORMATION CRITERION - LOG AIC =  0.98014
  SCHWARZ (1978) CRITERION - LOG SC =              1.0721
 MODEL SELECTION TESTS - SEE RAMANATHAN (1998,P.165)
  CRAVEN-WAHBA (1979)
     GENERALIZED CROSS VALIDATION - GCV =          2.6691
  HANNAN AND QUINN (1979) CRITERION =              2.7646
  RICE (1984) CRITERION =                          2.6736
  SHIBATA (1981) CRITERION =                       2.6570
  SCHWARZ (1978) CRITERION - SC =                  2.9216
  AKAIKE (1974) INFORMATION CRITERION - AIC =      2.6648

                     ANALYSIS OF VARIANCE - FROM MEAN
                       SS         DF            MS               F
 REGRESSION        12248.          2.        6123.8           2388.630
 ERROR             187.15         73.        2.5637            P-VALUE
 TOTAL             12435.         75.        165.80              0.000

                     ANALYSIS OF VARIANCE - FROM ZERO
                       SS         DF            MS               F
 REGRESSION        21098.          3.        7032.7           2743.131
 ERROR             187.15         73.        2.5637            P-VALUE
 TOTAL             21285.         76.        280.07              0.000


 VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED
ELASTICITY
   NAME    COEFFICIENT   ERROR      73 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
 CL        -1.2543     0.8995E-01  -13.94     0.000-0.853    -0.8823    -3.6303
 CL2       0.33608E-01 0.1161E-02   28.94     0.000 0.959     1.8313     3.2900
 CONSTANT   14.464      1.649       8.772     0.000 0.716     0.0000     1.3403

 |_graph WGT CL

 REQUIRED MEMORY IS PAR=      15 CURRENT PAR=   11000
       76 OBSERVATIONS
  SHAZAM WILL NOW MAKE A PLOT FOR YOU
 |_* Hedonic price model

 |_ols PRICE WGT CL OR1 SP1 SP2 SP4 SP5 SP6 SP7 SP8 PM1 PF1 DC1 DC2 / gf

 REQUIRED MEMORY IS PAR=      26 CURRENT PAR=   11000
  OLS ESTIMATION
       76 OBSERVATIONS     DEPENDENT VARIABLE= PRICE
 ...NOTE..SAMPLE RANGE SET TO:      1,     76

  R-SQUARE =   0.8556     R-SQUARE ADJUSTED =   0.8225
 VARIANCE OF THE ESTIMATE-SIGMA**2 =   692.85
 STANDARD ERROR OF THE ESTIMATE-SIGMA =   26.322
 SUM OF SQUARED ERRORS-SSE=   42264.
 MEAN OF DEPENDENT VARIABLE =   121.97
 LOG OF THE LIKELIHOOD FUNCTION = -348.035

 MODEL SELECTION TESTS - SEE JUDGE ET AL. (1985,P.242)
  AKAIKE (1969) FINAL PREDICTION ERROR - FPE =      829.59
     (FPE IS ALSO KNOWN AS AMEMIYA PREDICTION CRITERION - PC)
  AKAIKE (1973) INFORMATION CRITERION - LOG AIC =   6.7157
  SCHWARZ (1978) CRITERION - LOG SC =               7.1757
 MODEL SELECTION TESTS - SEE RAMANATHAN (1998,P.165)
```

```
  CRAVEN-WAHBA (1979)
     GENERALIZED CROSS VALIDATION - GCV =           863.22
  HANNAN AND QUINN (1979) CRITERION =               991.81
  RICE (1984) CRITERION =                           918.77
  SHIBATA (1981) CRITERION =                        775.61
  SCHWARZ (1978) CRITERION - SC =                   1307.3
  AKAIKE (1974) INFORMATION CRITERION - AIC =       825.25

                     ANALYSIS OF VARIANCE - FROM MEAN
                      SS         DF            MS                F
 REGRESSION       0.25049E+06     14.        17892.              25.824
 ERROR             42264.         61.        692.85             P-VALUE
 TOTAL            0.29275E+06     75.        3903.4               0.000

                     ANALYSIS OF VARIANCE - FROM ZERO
                      SS         DF            MS                F
 REGRESSION       0.13812E+07     15.        92079.             132.900
 ERROR             42264.         61.        692.85             P-VALUE
 TOTAL            0.14234E+07     76.        18730.               0.000


 VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED
ELASTICITY
   NAME    COEFFICIENT   ERROR      61 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
 WGT         1.2010     0.6499       1.848     0.069 0.230     0.2475     0.1063
 CL          4.0089     0.9269       4.325     0.000 0.484     0.5811     1.0265
 OR1        -28.932      13.52      -2.140     0.036-0.264    -0.2330    -0.1217
 SP1        -34.174      14.49      -2.358     0.022-0.289    -0.1592    -0.0258
 SP2        -15.927      11.25      -1.416     0.162-0.178    -0.0995    -0.0241
 SP4        -4.4250      20.26     -0.2184     0.828-0.028    -0.0159    -0.0019
 SP5         18.705      15.11       1.238     0.221 0.157     0.0813     0.0121
 SP6         35.102      16.18       2.169     0.034 0.268     0.1525     0.0227
 SP7         10.079      16.97      0.5939     0.555 0.076     0.0571     0.0120
 SP8        -34.054      15.61      -2.181     0.033-0.269    -0.1773    -0.0331
 PM1         22.012      10.95       2.011     0.049 0.249     0.1412     0.0356
 PF1        -53.338      17.09      -3.121     0.003-0.371    -0.1673    -0.4200
 DC1         56.569      17.88       3.164     0.002 0.375     0.4324     0.3051
 DC2         43.340      16.67       2.600     0.012 0.316     0.3075     0.0935
 CONSTANT    1.5605      32.64      0.4780E-01 0.962 0.006     0.0000     0.0128
 DURBIN-WATSON = 1.9341    VON NEUMANN RATIO = 1.9599    RHO =  0.03156
 RESIDUAL SUM =  0.25935E-12  RESIDUAL VARIANCE =   692.85
 SUM OF ABSOLUTE ERRORS=   1247.8
 R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.8556
 RUNS TEST:   32 RUNS,   35 POS,    0 ZERO,   41 NEG  NORMAL STATISTIC = -
1.5720
 COEFFICIENT OF SKEWNESS =   0.8762 WITH STANDARD DEVIATION OF 0.2756
 COEFFICIENT OF EXCESS KURTOSIS =   3.3719 WITH STANDARD DEVIATION OF 0.5448

 JARQUE-BERA NORMALITY TEST- CHI-SQUARE(2 DF)=   39.3084 P-VALUE= 0.000

      GOODNESS OF FIT TEST FOR NORMALITY OF RESIDUALS - 20 GROUPS
 OBSERVED  1.0  0.0  0.0  0.0  1.0  1.0  4.0  9.0 11.0 14.0 15.0  5.0  7.0  2.0
1.0  1.0  1.0  1.0  1.0  1.0

 EXPECTED  0.3  0.4  0.7  1.4  2.3  3.7  5.2  6.9  8.2  9.0  9.0  8.2  6.9  5.2
3.7  2.3  1.4  0.7  0.4  0.3

 CHI-SQUARE =   25.3849 WITH  3 DEGREES OF FREEDOM, P-VALUE= 0.000
 |_stop
```

Appendix J

Shazam output of Data analysis - Shrimp Hedonic Model 2

```
Welcome to SHAZAM - Version 10.0 -  JUL 2004 SYSTEM=WIN-NT   PAR= 11000
 CURRENT WORKING DIRECTORY IS: D:\NOMA\DATAAN~1\SHAZAM
 |_* shrimp
 |_sample 1 130
 |_read no PRICE G1 G2 G3 G4 O1 O2 C1 C2 C3 C4 F1 F2 F3 F4 S1 S2 S3 P1 P2 P3
   22 VARIABLES AND      130 OBSERVATIONS STARTING AT OBS       1

 |_stat / all
 NAME         N    MEAN        ST. DEV      VARIANCE     MINIMUM      MAXIMUM
 NO           130   65.500      37.672      1419.2       1.0000       130.00
 PRICE        130   141.65      63.945      4088.9       50.000       350.00
 G1           130  0.23077     0.42295     0.17889       0.0000       1.0000
 G2           130  0.58462     0.49469     0.24472       0.0000       1.0000
 G3           130  0.16923     0.37641     0.14168       0.0000       1.0000
 G4           130  0.15385E-01 0.12355     0.15265E-01   0.0000       1.0000
 O1           130  0.56154     0.49812     0.24812       0.0000       1.0000
 O2           130  0.43846     0.49812     0.24812       0.0000       1.0000
 C1           130  0.39231     0.49015     0.24025       0.0000       1.0000
 C2           130  0.92308E-01 0.29058     0.84436E-01   0.0000       1.0000
 C3           130  0.25385     0.43689     0.19088       0.0000       1.0000
 C4           130  0.24615     0.43244     0.18700       0.0000       1.0000
 F1           130  0.15385     0.36220     0.13119       0.0000       1.0000
 F2           130  0.30000     0.46003     0.21163       0.0000       1.0000
 F3           130  0.53077     0.50098     0.25098       0.0000       1.0000
 F4           130  0.30769E-01 0.17336     0.30054E-01   0.0000       1.0000
 S1           130  0.71538     0.45298     0.20519       0.0000       1.0000
 S2           130  0.23846     0.42779     0.18301       0.0000       1.0000
 S3           130  0.46154E-01 0.21063     0.44365E-01   0.0000       1.0000
 P1           130  0.88462     0.32072     0.10286       0.0000       1.0000
 P2           130  0.69231E-01 0.25483     0.64937E-01   0.0000       1.0000
 P3           130  0.46154E-01 0.21063     0.44365E-01   0.0000       1.0000
 |_* number PRICE G1 G2 G3 G4 O1 O2 C1 C2 C3 C4 F1 F2 F3 F4 S1 S2 S3 P1 P2 P3
 |_stat G1 G2 G3 G4 / pcor
 NAME         N    MEAN        ST. DEV      VARIANCE     MINIMUM      MAXIMUM
 G1           130  0.23077     0.42295     0.17889       0.0000       1.0000
 G2           130  0.58462     0.49469     0.24472       0.0000       1.0000
 G3           130  0.16923     0.37641     0.14168       0.0000       1.0000
 G4           130  0.15385E-01 0.12355     0.15265E-01   0.0000       1.0000

  CORRELATION MATRIX OF VARIABLES -      130 OBSERVATIONS


 G1          1.0000
 G2       -0.64979       1.0000
 G3       -0.24721     -0.53544       1.0000
 G4       -0.68465E-01 -0.14829     -0.56417E-01   1.0000
             G1           G2           G3           G4
 |_stat O1 O2/ pcor
 NAME         N    MEAN        ST. DEV      VARIANCE     MINIMUM      MAXIMUM
 O1           130  0.56154     0.49812     0.24812       0.0000       1.0000
 O2           130  0.43846     0.49812     0.24812       0.0000       1.0000

  CORRELATION MATRIX OF VARIABLES -      130 OBSERVATIONS

 O1          1.0000
 O2         -1.0000       1.0000
             O1           O2
 |_stat C1 C2 C3 C4 / pcor
 NAME         N    MEAN        ST. DEV      VARIANCE     MINIMUM      MAXIMUM
 C1           130  0.39231     0.49015     0.24025       0.0000       1.0000
```

```
C2          130  0.92308E-01 0.29058     0.84436E-01   0.0000       1.0000
C3          130  0.25385     0.43689     0.19088       0.0000       1.0000
C4          130  0.24615     0.43244     0.18700       0.0000       1.0000

 CORRELATION MATRIX OF VARIABLES -      130 OBSERVATIONS


C1         1.0000
C2       -0.25622       1.0000
C3       -0.46864     -0.18600       1.0000
C4       -0.45913     -0.18223     -0.33330       1.0000
             C1           C2           C3           C4
|_stat F1 F2 F3 / pcor
NAME         N    MEAN        ST. DEV      VARIANCE     MINIMUM      MAXIMUM
F1          130  0.15385     0.36220     0.13119       0.0000       1.0000
F2          130  0.30000     0.46003     0.21163       0.0000       1.0000
F3          130  0.53077     0.50098     0.25098       0.0000       1.0000

 CORRELATION MATRIX OF VARIABLES -      130 OBSERVATIONS


F1         1.0000
F2       -0.27915       1.0000
F3       -0.45350     -0.62899       1.0000
             F1           F2           F3
|_stat S1 S2 S3/ pcor
NAME         N    MEAN        ST. DEV      VARIANCE     MINIMUM      MAXIMUM
S1          130  0.71538     0.45298     0.20519       0.0000       1.0000
S2          130  0.23846     0.42779     0.18301       0.0000       1.0000
S3          130  0.46154E-01 0.21063     0.44365E-01   0.0000       1.0000

 CORRELATION MATRIX OF VARIABLES -      130 OBSERVATIONS


S1         1.0000
S2       -0.88716       1.0000
S3       -0.34874     -0.12309       1.0000
             S1           S2           S3
|_stat P1 P2 P3 / pcor
NAME         N    MEAN        ST. DEV      VARIANCE     MINIMUM      MAXIMUM
P1          130  0.88462     0.32072     0.10286       0.0000       1.0000
P2          130  0.69231E-01 0.25483     0.64937E-01   0.0000       1.0000
P3          130  0.46154E-01 0.21063     0.44365E-01   0.0000       1.0000

 CORRELATION MATRIX OF VARIABLES -      130 OBSERVATIONS


P1         1.0000
P2       -0.75515       1.0000
P3       -0.60907     -0.59992E-01   1.0000
             P1           P2           P3
|_* Hedonic price model

|_ols PRICE G1 G2 G3 O1 C1 C2 C3 F1 F2 F3 S1 S2 P1 P2/gf

REQUIRED MEMORY IS PAR=      42 CURRENT PAR=   11000
 OLS ESTIMATION
      130 OBSERVATIONS     DEPENDENT VARIABLE= PRICE
...NOTE..SAMPLE RANGE SET TO:      1,    130

 R-SQUARE =   0.6932     R-SQUARE ADJUSTED =   0.6558
VARIANCE OF THE ESTIMATE-SIGMA**2 =   1407.4
STANDARD ERROR OF THE ESTIMATE-SIGMA =   37.515
SUM OF SQUARED ERRORS-SSE=  0.16185E+06
```

```
 MEAN OF DEPENDENT VARIABLE =   141.65
 LOG OF THE LIKELIHOOD FUNCTION = -647.709

 MODEL SELECTION TESTS - SEE JUDGE ET AL. (1985,P.242)
  AKAIKE (1969) FINAL PREDICTION ERROR - FPE =      1569.8
     (FPE IS ALSO KNOWN AS AMEMIYA PREDICTION CRITERION - PC)
  AKAIKE (1973) INFORMATION CRITERION - LOG AIC =   7.3576
  SCHWARZ (1978) CRITERION - LOG SC =               7.6885
 MODEL SELECTION TESTS - SEE RAMANATHAN (1998,P.165)
  CRAVEN-WAHBA (1979)
     GENERALIZED CROSS VALIDATION - GCV =           1590.9
  HANNAN AND QUINN (1979) CRITERION =               1793.8
  RICE (1984) CRITERION =                           1618.5
  SHIBATA (1981) CRITERION =                        1532.3
  SCHWARZ (1978) CRITERION - SC =                   2183.1
  AKAIKE (1974) INFORMATION CRITERION - AIC =       1568.1

                     ANALYSIS OF VARIANCE - FROM MEAN
                       SS          DF            MS                F
 REGRESSION       0.36562E+06     14.        26116.               18.556
 ERROR            0.16185E+06    115.        1407.4              P-VALUE
 TOTAL            0.52747E+06    129.        4088.9                0.000

                     ANALYSIS OF VARIANCE - FROM ZERO
                       SS          DF            MS                F
 REGRESSION       0.29742E+07     15.       0.19828E+06          140.886
 ERROR            0.16185E+06    115.        1407.4              P-VALUE
 TOTAL            0.31360E+07    130.        24123.                0.000


 VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED
ELASTICITY
   NAME    COEFFICIENT   ERROR     115 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
 G1         149.60      28.68       5.216     0.000 0.437     0.9895     0.2437
 G2         62.383      27.96       2.231     0.028 0.204     0.4826     0.2575
 G3         19.459      28.20      0.6901     0.492 0.064     0.1145     0.0232
 O1         7.2692      9.983      0.7282     0.468 0.068     0.0566     0.0288
 C1         12.772      8.710       1.466     0.145 0.135     0.0979     0.0354
 C2         48.916      13.09       3.738     0.000 0.329     0.2223     0.0319
 C3        -16.238      11.07      -1.467     0.145-0.136    -0.1109    -0.0291
 F1         36.046      22.09       1.631     0.106 0.150     0.2042     0.0391
 F2         21.947      17.09       1.284     0.202 0.119     0.1579     0.0465
 F3        -1.6409      16.46     -0.9967E-01 0.921-0.009    -0.0129    -0.0061
 S1         14.651      16.90      0.8669     0.388 0.081     0.1038     0.0740
 S2        -13.762      21.43     -0.6421     0.522-0.060    -0.0921    -0.0232
 P1        -18.504      16.62      -1.114     0.268-0.103    -0.0928    -0.1156
 P2        -21.989      20.86      -1.054     0.294-0.098    -0.0876    -0.0107
 CONSTANT   57.314      40.56       1.413     0.160 0.131     0.0000     0.4046

 DURBIN-WATSON = 1.7528    VON NEUMANN RATIO = 1.7664    RHO =  0.11346
 RESIDUAL SUM =  0.41567E-12  RESIDUAL VARIANCE =   1407.4
 SUM OF ABSOLUTE ERRORS=   3417.8
 R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.6932
 RUNS TEST:   57 RUNS,   57 POS,    0 ZERO,   73 NEG  NORMAL STATISTIC = -
1.4334

 COEFFICIENT OF SKEWNESS =   0.7768 WITH STANDARD DEVIATION OF 0.2124
 COEFFICIENT OF EXCESS KURTOSIS =   2.2317 WITH STANDARD DEVIATION OF 0.4218

 JARQUE-BERA NORMALITY TEST- CHI-SQUARE(2 DF)=   36.6831 P-VALUE= 0.000
```

```
  GOODNESS OF FIT TEST FOR NORMALITY OF RESIDUALS - 20 GROUPS
 OBSERVED  1.0  0.0  0.0  0.0  2.0  5.0 10.0 13.0 21.0 21.0 14.0 18.0  9.0  6.0
0.0  5.0  0.0  1.0  2.0  2.0

 EXPECTED  0.5  0.6  1.3  2.3  4.0  6.3  9.0 11.7 14.0 15.3 15.3 14.0 11.7  9.0
6.3  4.0  2.3  1.3  0.6  0.5

 CHI-SQUARE =   32.1602 WITH  3 DEGREES OF FREEDOM, P-VALUE= 0.000
 |_stop
```