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HEDONIC PRICING FOR PRAWN AND SHRIMP IN THE PHILIPPINES

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Abstract

The prawn and shrimp industry in the Philippines is among the most lucrative industries both at the domestic and foreign perspective. This paper discusses the relevance of hedonic price analysis recognising that improving quality is a major issue in the global seafood market due to the increasing consciousness among buyers, who are becoming 'quality consumers' rather than 'quantity consumers'. This paper uses hedonic price model to measure the economic benefits from investing in the production of goods with preferred quantities of attributes or value-added features.

Using primary data based on observed and measured characteristics, we develop a log-linear model with combined continuous and dummy explanatory variables. The estimation results show significant implicit prices of attributes such as prawn tail length, product form, freshness, species, colour, size, ease of preparation, discolouration, protein and carbohydrate content. Specifically, longer tails and banana species are highly valued. Across sizes, large and average receive price premium. Processing by peeling and breading to ease preparation and add value obtains high premium. Freezing, although most practiced due to availability of technology and facilities, gets the highest discount among other forms of preservation.

Keywords: hedonic price model, quality, prawn and shrimp

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1. Introduction

Profitability and the depleting marine resources in the Philippines constitute the major factors for the increasing interest in prawn aquaculture, which accounts for 79.6% of total prawn and shrimp production (BAS 1995). While prawn and shrimp are among the traditional protein sources, the Philippine Bureau of Agricultural Statistics also reported that they are among the top ten agriculture-based exports of the country generating about 5.88 billion pesos annual average export earning, at an annual average export volume of 25,758mt from 1989-93. Shrimp and prawn account for more than half of the total export earnings of the fishery sector.

Technical and marketing literature support that the price of prawn and shrimp is affected by its quality. Quality in prawn and shrimp generally relates to having optimum 'quantities' of attributes such as freshness, size, colour, texture, taste and other aestetic and eating characteristics. In spite of the generally accepted relationship between price and quality, no attempt has been made to estimate the functional linkages between product price and such quality attributes.

Hedonic price analysis is closely intertwined with the concepts of product quality evaluation. Hedonic models estimate the influence of changes in quantities of attributes on product price. Changes in quantities of attributes reflect quality changes. The issues of improving food quality on top of increasing food quantity are among the thrust of major policy issues, not only in the Philippine seafood industry, but the global seafood markets. The relevance of hedonic price estimation is manifested through its capability to provide quantitative estimates useful for measuring economic benefits from investing in the production of goods with preferred quantities of attributes or value-added features associated with price premium.

Hedonic price analysis was developed by Court in 1939 and revived by Griliches in 1961. Since Rosen's theoretical work in 1974 and Lucas' in 1975, more abstractions and empirical studies followed. Ladd and Suvannunt (1976) extended the hedonic price concept based on consumer behaviour while Ladd and Martin (1976) developed the model on the producer's cost perspective. Petzel and Monke (1984) used the concept to evaluate market efficiency while in Brorsen, *et al.* (1984), hedonic pricing forms the basis for recommending the inclusion of quality in price indices.

Many prawn and shrimp attributes, such as colour, odour and tenderness are qualitative and are generally believed as determinants of seafood purchase behaviour, while flavour, freshness, ease of preparation and some sensory or attitudinal variables are among the determinants of demand for seafood. Other determinants include nutritional value, price, income level, region of residence, family size and presence of children in the family (Hanson *et al.*, 1995). However, food scientists emphasise the importance of chemical and microbiological aspects of traded seafood (Huss 1988, Whitfield *et al.* 1988 and Buchanan

1991). Some of the references useful for understanding and measuring qualitative seafood characteristics are Pearson (1970), Pearson and Dutson (1994), Shahidi and Botta (1994) and Hanson *et al.* (1995). Most hedonic models use categorical dummy variables in measuring the influence on price of qualitative attributes. Studies using hedonic models with categorical dummies include Ethridge (1982), Brorsen *et al.* (1984), Porter and Todd (1985), Unnevehr (1986), Bartik (1987), Williams (1989), Coelli *et al.* (1991), Goodwin and Espinosa (1991), Mullen and Wohlgenant (1991), Oczkowski (1994), Wilson (1994), and Mullen (1995).

Compilations of prawn and shrimp research abstracts in the Philippines by PCARRD (1985) and Marte (1993) focus on health and diseases, feeding technology and other aspects of pond care and maintenance. Economic research measured the benefits from improving yield and profitability of breeding, feeding, growing, processing, packaging, transport, preservation and other technologies. There is no hedonic pricing model estimated for prawn and shrimp in the Philippines. Recent literature evaluated the ecological and sustainability impact of prawn culture in the Philippines (Primavera 1992, 1993). One of the latest comprehensive study, intended to form the basis for policies concerning the Philippine prawn industry, was coordinated by Auburn University of the United States in 1993.

The main objective of this paper is to develop a hedonic price model for prawn and shrimp in the Philippines using primary data based on observed and measured product characteristics. The model aims to estimate the implicit prices of combined quantitative and qualitative attributes. This paper is structured as follows. The next section discusses the relevance of hedonic price models to prawn and shrimp in Philippine markets. The model is then presented, followed by the empirical results. The final section provides the conclusion and policy implications of the paper.

2. Relevance of hedonic price analysis to prawn and shrimp in Philippine markets

Table 1 shows the trend in production of prawn and and shrimp produced in the Philippines from 1989 to 1993. The aquaculture sector produced 79.6% of total production, followed by the municipal sector comprising 18% and by the commercial sector with 2.4%. Black tiger comprise 74.5% of total production, 97% of which comes from aquaculture. The other two species are endeavour and white prawn. Analysis showed that the percentage change in value, estimated at 25.4%, is greater than the change in volume (14.9%), suggesting an increasing unit price.

Table 1. Average annual prawn and shrimp production by species and sector, Philippines, 1989-93.

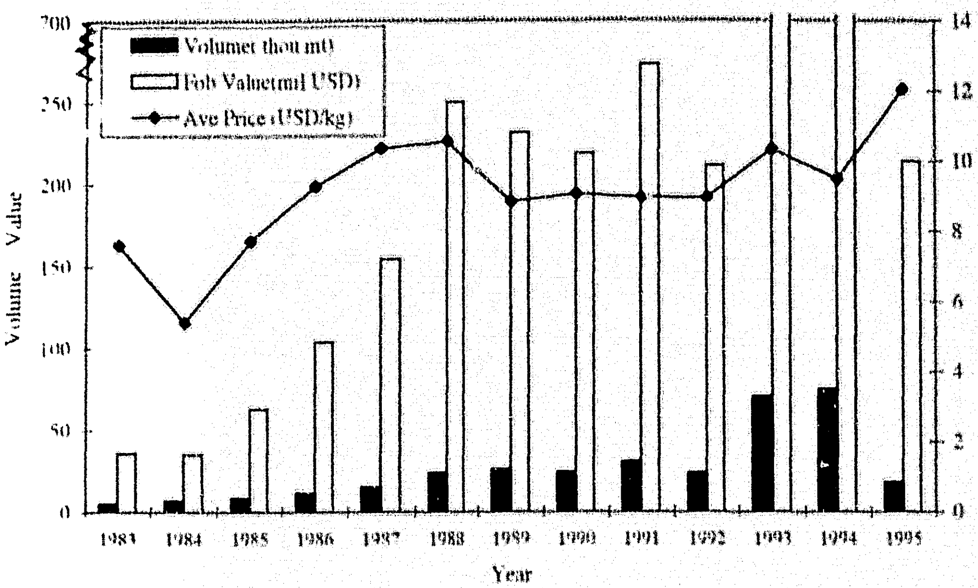
	Total	Tiger Prawn	Endeavour	White
Aquaculture				
Volume (mt)	65,499	59,793	4,372	1,334
Growth rate (%)	18.95	18.59	82.05	(49.23)
Share (%)	79.57	96.99	60.21	9.95
Municipal				
Volume (mt)	14,846	1,341	2,491	11,014
Growth rate (%)	8.21	(1.29)	14.36	8.22
Share (%)	18.03	2.17	34.31	82.15
Commercial				
Volume (mt)	1,973	516	388	1,059
Growth rate (%)	(36.12)	(72.95)	9.12	(36.49)
Share (%)	2.40	0.84	5.48	7.80
Total				
Volume (mt)	82,318	61,650	7,261	13,407
Growth rate (%)	14.96	16.77	44.79	(3.43)
Share (%)	100	100	100	100
Value (thou Pesos)*	11,940	10,523	377	105
% Change in value	25.36	24.64	339.59	0.79

* Estimated from brackishwater production only.
Source: BAS, 1995

Notwithstanding the supply and demand situation for prawn and shrimp, the general price level and other factors affecting such price increase, the observed increasing unit price could be evaluated against changes in product attributes. The growth in the prawn aquaculture sector has created impacts in terms of volume of production and product characteristics. The culture of prawn in controlled environment made available products with desired attributes.

The export market also showed large proportion of increases in value than in volume of trade (Figure 1). Although there are some price decreases, there is an overall increasing trend in price. This upward trend could be expected with the present interest among processors and traders to increase returns by adding value, that is, enhancing desirable attributes of the product. Since 1989, the country faces the threat of disease problems common in Southeast Asia affecting fluctuation in volume of production.

However, there is a question of which attributes are preferred, given the existing diversity in prawn and shrimp attributes in the domestic market. The wide range of attributes can be noted on the variety of species, marketable sizes, product forms and preparations, degree of freshness, methods of preservation, colour, packaging and other physically observable characteristics. However, diversity of product attributes prevails and is encouraged in the



Trend in volume, value and price of prawn and shrimp export from the Philippines 1983-95

Figure 1

Philippine domestic market to meet various consumer groups. Identification and estimation of relative implicit values[2] of various attributes desired by consumers, rather than standardisation, seem to be a more relevant objective in the domestic setting.

Throughout the years, the importance of hedonic pricing on prawn trade is becoming evident with increasing quality consciousness among buyers and consumers even in the domestic market. The twenty-first century consumers are evaluated as becoming 'quality consumers' rather than 'quantity consumers' (INFOFISH 1994). That is, consumers are after obtaining utilities from optimum quantities of positively-valued product attributes or minimum quantities of negatively-valued characteristics rather than from consuming optimum quantities or units of the product *per se*. Profit maximizing producers and middlemen are, therefore, expected to identify the attributes desired by consumers and offer the optimum quantities of attributes that would receive price premia and minimise those attributes that are expected to be discounted. The framework of hedonic price analysis caters to identify the market clearing price at which the consumers of 'marketable attributes' and sellers of 'marketable attributes' are satisfied.

[2] With the many attributes desired by heterogenuous domestic consumers, relative values or comparative implicit prices of attributes provides better information of what ranges and quantities of attributes should be available at market clearing prices.

This paper distinguishes quality as the state of having met a high level of acceptable standards, while attribute or characteristic refers to a positively or negatively-valued trait present or absent in a product in varying quantities. On the premise that quality improvement and value-adding processes either increases the quantity of desired attributes of a product, adds a new desirable attribute to a product, or minimises, if not eliminate, the undesirable attributes of a product, hedonic price models are important in estimating the implicit price associated with each process. Value-adding investments could focus on increasing the attributes receiving positive implicit price or on eliminating negatively valued attributes, either at the production, breeding or post-harvest stages. For instance, hedonic analysis estimates implicit prices of processing as peeled or breaded prawn. Similarly, losses due to soft shells, a negatively-valued attribute arising from harvest during intermoult or pre-moult stage, can be calculated.

3. The Model

Let P_i be the purchase price per kilogram[3] of prawn sample i, i =1, 2, ... 47, a sample i comprises a lot/bunch of prawn and shrimp pieces offered for sale in a market with a single tag price P_i. Price P_i constitutes the dependent variable in the proposed hedonic price model while the explanatory variables are categorised as (1) continuous, (2) dummy, and (3) dummy interaction variables[4]. Interaction variables are those which describe two attributes both exclusively present in a sample. Each sample is evaluated according to some characteristics such as weight, length, species, freshness, form and colour. Therefore, a linear price and attribute relationship can be expressed in the form:

$$(1) \qquad P_i = \alpha + \sum_{j=1}^{m1} \beta_j C_{ij} + \sum_{k=1}^{m2} \sum_{q=1}^{m3k} \gamma_{kq} D_{ikq} + \varepsilon_i , \qquad i = 1, 2, ..., 47$$

where m_1 is the number of continuous variables; m_2 is the number of qualitative variables; m_{3k} is the number of categories for the k^{th} qualitative variable; α is the autonomous trend

[3] The use of purchase price elliminates the limitations associated with the usual practice of imputing 'missing' price in hedonic regressions, especially for new products, as discussed by Feenstra (1995).

[4] The use of categorical scaled variables was also explored on attributes such as brokenness, odour and discolouration, that is, these categorical variables were scaled from 0 to 5. In this case, the coefficient estimate of the scaled variable represents a price change due to a unit change in the scaled category describing a certain level of characteristic. The results, however, are not significantly relevant to price changes due perhaps to some measurement errors associated with the use of categorical scaled variables. Hence, binary form of dummy variables is an alternative for such cases.

term; β_j's are the coefficients of the continuous variables, j=1, ... m_1; γ_{kq}'s are the coefficients of the dummy variables, q=1, ... m_{3k}; k=1, ... m_2,. The C_{ij}'s are the continuous variables; D_{ikq}'s are the dummy categories of the k^{th} qualitative variable; and ε_i is the error term. The number of dummy variables (m_{3k}) is one less than the number of categories of that qualitative variable because one category serves as the control dummy.

The constant α is interpreted as the price relevant to all attributes represented by the control or benchmark category of each qualitative variable and when the quantities of the continuously measurable variables C_{ij}'s are zero. The coefficients γ_{kq}'s denote the price associated with the presence of the qualitative attribute represented by the k^{th} dummy variable D_{ikq}. The coefficient β_j manifest the sensitivity of price changes to a unit change in quantities of each continuously measurable attribute C_{ij}, highlighting the importance of minimizing measurement errors. This study attempted to estimate a hedonic function with the assumption that the observed attributes are measured to the best possible means, acknowledging that there is an evolving science of sensory, and chemical and physical assessment of quality in seafood[5].

Homogeneity of attributes[6] is assumed within a sample i since sorting of prawn and shrimp according to some characteristics C_i or D_{kq}, is generally practiced in all markets included in the study. Although in some cases, for instance, with assorted species offered for sale under one price tag, the homogeneity assumption is violated. In such a case, the variation is noted and is considered as another characteristic.

Admittedly, this assumption of homogeneity within a sample can be a setback on the use of continuous variables and potential source of measurement errors discussed by Williams (1989). For instance, a continuous variable C_i such as average weight of a piece representing a sample i may be an approximation of the actual weight of each piece in sample i, especially if sorting is not rigid and precise. Hence, a system of dummy variables encompassing ranges of average weights, with each range taking a dummy, may be an error-minimizing alternative.

The log-linear version of the hedonic price model (1) takes the form,

$$(2) \qquad \ln P_i = \alpha + \sum_{j=1}^{m1} \beta_j \ln C_{ij} + \sum_{k=1}^{m2} \sum_{q=1}^{m3k} \gamma_{kq} D_{ikq} + \varepsilon_i$$

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[5] York and Sereda (1994) reviewed the development of sensory assessment procedures for seafood and proposed for the recognition of sensory analysis as being analogous to chemical and physical procedures of quality assessment.

[6] The assumption of homogeneity within a sample should not be confused with product heterogeneity assumed for the domestic market. Anderson (1995) asserts that the exceptional heterogeneity of seafood is a major reason for the recent interest in marketing and demand analysis for the seafood industry.

where $\ln P_i$ and $\ln C_{ij}$ are the logarithmic transformation of the price and continuous variable series. While the dummy variable D_{ikq} remain untransformed in Equation (2), its coefficient γ_{kq} require antilogarithmic transformation to derive the relevant percentage impact on price of the presence of the qualitative attribute. The percentage impact is computed as $(e^{\gamma_{kq}} - 1) \times 100$.

The use of dummy variables to represent qualitative attributes confines the choice of functional form of the hedonic price model to either linear or log-linear. While hedonic price functions are reduced form equations (Williams, 1989), the choice between the linear and log-linear forms of the model in this study was generally influenced by the relevance and ease of interpretation, nature of the data and the objective of minimum specification error. Logarithmic transformation was used as stabilizing measure for variable series that show wide fluctuations in their original form, especially with price and attributes of heterogenuous products.

While plots of alternative transformations of a series and their corresponding relationships provided bases for establishing the functional form of the model, diagnostic tests for specification error are instrumental in defining the structural part of reduced form models. A review of such procedures as applied to linear and logarithmic models was documented by Godfrey et al. (1987), which provided a discussion and application of the Ramsey's regression specification error test (RESET) to select between the linear and log-linear alternative forms of hedonic price models. Equation 3 specifies the RESET test for a linear regression while Equation 4 shows the test for a log-linear model.

$$(3) \qquad P_i = \alpha + \sum_{j=1}^{m1} \beta_j C_{ij} + \sum_{k=1}^{m2} \sum_{q=1}^{m3k} \gamma_{kq} D_{ikq} + \sum_{r=2}^{c} \varphi_{0r} (\hat{P}_i)^r + \varepsilon_i$$

$$(4) \qquad \ln P_i = \alpha + \sum_{j=1}^{m1} \beta_j \ln C_{ij} + \sum_{k=1}^{m2} \sum_{q=1}^{m3k} \gamma_{kq} D_{ikq} + \sum_{r=2}^{c} \varphi_{1r} (\ln \hat{P}_i)^r + \varepsilon_i$$

where $\hat{P}_i$ is the predicted value of P_i in the linear model while $\ln \hat{P}_i$ is the predicted value of $\ln P_i$ in the log-linear model; r is the power at which the predicted value is raised, r=2,...c. For the linear model, RESET(c) evaluates if H_0: $\varphi_{02} = \varphi_{03} = \ldots = \varphi_{0c} = 0$ and is distributed as $F(c-1, N-k-c)$, where φ_{0r} denotes the coefficient of the residual of the linear model (3) raised to the power r. Similarly, for the log linear model, RESET (c) tests if $\varphi_{12} = \varphi_{13} = \ldots = \varphi_{1c} = 0$ and is distributed as $F(c-1, N-k-c)$ as in Equation 4. The rejection of H_0 at any RESET(c) suggests the problem of specification error and the formulation of an alternative form of the model is required.

4. Empirical Results

Collection and Observation of Samples

Forty seven prawn and shrimp samples were purchased from selected markets in Metro Manila and peripheral consumption centres. The measurable length and weight-related attributes listed in Table 2 comprise the quantitative explanatory variables. The organoleptic factors, such as colour and odour, and the market-related product characterisation, such as grades according to size, product form or species constitute the qualitative attributes described as dummy variables (Table 3). Many of the attributes observed are similar to those identified by Hanson *et al.* (1995) as determinants of seafood purchase behaviour.

Recognising the nutritional importance of gourmet prawn and shrimp, this paper attempted to include proximate component variables such as percent moisture, protein, fat, carbohydrate, fibre and ash content.[7] These nutritional characteristics that cannot be detected in normal consumption, but whose effect may or may not come later, comprise the 'credence' qualities of goods (Wills and Harris 1994). For instance, ash content, the organic residue after burning the organic matter, can be regarded as a general measure of quality and often useful for identiying a food (Pearson 1970).

Table 2. Comparison of the means, variances and coefficients of correlation between price and each quantitative variable, 47 prawn and shrimp samples, Philippines, July 1995.

Variable	Variable Notation[1]	Mean	Variance	Max	Min	Correlation w/ price (r)
Price (Peso/kg)	P_i	253.3	20515.4	689.0	30.0	
Tail length (cm)	C_{i1}	8.51	11.63	15.4	1.7	0.735
Head-on shell-on length (cm)	C_{i2}	11.88	26.09	24.8	2.2	0.619
Meat weight (gm)	C_{i3}	13.85	228.86	70.85	0.05	0.741
Head-on shell-on weight (gm)	C_{i4}	23.97	961.28	150.0	0.05	0.635
Number of pieces/kg	C_{i5}	689.3	8461388	19685	8.3	-0.302

[1] Notation follows Equation (1) where a continuous variable is denoted by C_{ij}, where the subscripts denote quantitative attribute *j* in sample *i*.

[7] Proximate component analysis is done by an accredited private laboratory, the SGS Philippine Testing and Control Services, Inc., Makati City, Philippines.

Table 3. Definition of dummy variables and proportion of samples having such attribute, (n=47)

Attribute	Variable Notation[1]	Definition[2]	Proportion of samples (%)
Number of prawn pieces per kilogram (D_{i1q}, q=1, ... 5)			
• ≤ 15 pieces	D_{i11}	assumes 1 if there are 15 or less prawn pieces per kilogram, otherwise 0	8.51
• 16-35 pieces	D_{i12}	assumes 1 if there are 16 to 35 prawn pieces per kilogram, otherwise 0	12.76
• 36-110 pieces	D_{i13}	assumes 1 if there are 36 to 110 prawn pieces per kilogram, otherwise 0	44.68
• 111-999 pieces	D_{i14}	assumes 1 if there are 111 to 999 prawn pieces per kilogram, otherwise 0	27.66
• ≥ 1000 pieces	D_{i15}	assumes 1 if there are 1000 or more prawn pieces per kilogram, otherwise 0	6.38
Protein content (D_{i2q}, q=1, 2)			
• ≥ 15%	D_{i21}	assumes 1 if the protein content of the sample is greater than or equal to 15%, assuming that this range of percentage protein is a desirable attribute, otherwise 0	87.23
• < 15%	D_{i22}	assumes 1 if the protein content of the sample is less than 15%, assuming that this range of percentage protein is an undesirable attribute, otherwise 0	12.77
Carbohydrate content (D_{i3q}, q=1, 2)			
• ≥ 1.6%	D_{i31}	assumes 1 if the carbohydrate content of the sample is greater than or equal to 1.6%, assuming that this range of percentage carbohydrate is a desirable attribute, otherwise 0	38.30
• < 1.6%	D_{i32}	assumes 1 if the carbohydrate content of the sample is less than 1.6%, assuming that this range of percentage carbohydrate is an undesirable attribute, otherwise 0	61.70
Discolouration (D_{i4q}, q=1, 2)			
• present	D_{i41}	assumes 1 if the discolouration of the sample is equal to 3, 4, or 5 in a scale of 0 through 5 where 0 is without discolouration while 5 has the most discolouration, otherwise 0	27.66
• nil	D_{i42}	assumes 1 if the discolouration of the sample is equal to 0, 1 or 2 in a scale of 0 through 5, otherwise 0	72.34
Mode of sale (D_{i5q}, q=1, 2)			
• retail sale	D_{i51}	assumes 1 if the sample was purchased by retail sale, otherwise 0	76.60
• wholesale	D_{i52}	assumes 1 if the sample was purchased by wholesale, otherwise 0	23.40
Ease of preparation (D_{i6q}, q=1, 2)			
• easy to prepare	D_{i61}	assumes 1 if the sample is easy to prepare or requires no preparation, otherwise 0	82.98
• difficult	D_{i62}	assumes 1 if the sample is difficult or cumbersome to prepare, otherwise 0	17.02

Table 3. Con't.

Attribute	Variable Notation[1]	Definition[2]	Proportion of samples (%)
Store/seller type (D_{i7q}, q=1, 2, 3)			
• farm or wet market	D_{i71}	assumes 1 if the sample was purchased either from a farm or a wet market, otherwise 0	48.94
• supermarket	D_{i72}	assumes 1 if the sample was purchased from a supermarket, otherwise 0	31.92
• processing plant	D_{i73}	assumes 1 if the sample was purchased from a prawn processing factory, otherwise 0	19.15
Species or type (D_{i8q}, q=1,... 6)			
• black Tiger	D_{i81}	assumes 1 if the sample is a black tiger prawn, otherwise 0	29.79
• ocean, sea, king, green flower tiger	D_{i82}	assumes 1 if the sample is an ocean, sea, king, green or flower tiger prawn, otherwise 0	12.77
• white, banana	D_{i83}	assumes 1 if the sample is a white or banana prawn, otherwise 0	23.40
• freshwater	D_{i84}	assumes 1 if the sample is a freshwater prawn, otherwise 0	4.26
• endeavour	D_{i85}	assumes 1 if the sample is a endeavour prawn, otherwise 0	21.28
• assorted species	D_{i86}	assumes 1 if the sample comprise a combination of species, otherwise 0	8.51
Degree of freshness (D_{i9q}, q=1,... 4)			
• live	D_{i91}	assumes 1 if the sample comprise live prawn, otherwise 0	4.26
• chilled raw	D_{i92}	assumes 1 if the sample comprise chilled raw prawn, otherwise 0	80.85
• frozen	D_{i93}	assumes 1 if the sample comprise either block or individually quick frozen (IQF) raw prawn, otherwise 0	8.51
• dried/cooked	D_{i94}	assumes 1 if the sample comprise dried or cooked prawn, otherwise 0	6.38
Product form/ Extent of Processing (D_{i10q}, q=1,... 4)			
• head-on	D_{i101}	assumes 1 if the sample comprise head-on shell-on prawn, otherwise 0	68.08
• headless	D_{i102}	assumes 1 if the sample comprise headless shell-on prawn, otherwise 0	17.02
• headless peeled	D_{i103}	assumes 1 if the sample comprise either headless peeled tail shell-on or completely peeled prawn, otherwise 0	8.51
• headless breaded	D_{i104}	assumes 1 if the sample comprise breaded headless peeled tail shell-on prawn, otherwise 0	6.38
Colour during purchase (D_{i11q}, q=1,... 4)			
• orange	D_{i111}	assumes 1 if the sample comprise orange coloured prawn, otherwise 0	14.89
• black	D_{i112}	assumes 1 if the sample comprise black coloured prawn, otherwise 0	31.91
• white	D_{i113}	assumes 1 if the sample comprise white coloured prawn, otherwise 0	19.15
• grey	D_{i114}	assumes 1 if the sample comprise grey coloured prawn, otherwise 0	34.04

Table 3. Con't.

Attribute	Variable Notation[1]	Definition[2]	Proportion of samples (%)
Moisture content (D_{i12q}, q=1, 2)			
• 76-80% for wet samples or 44-55% for dried samples	D_{i121}	assumes 1 if the moisture content of the sample is between 76-80% for wet samples or 44-55% for dried samples, assuming that each range of percentage moisture is a desirable attribute, otherwise 0	63.83
• not within 76-80% for wet samples or 44-55% for dried samples	D_{i122}	assumes 1 if the moisture content of the sample is not within 76-80% and 44-55% ranges for wet and dried samples, respectively, otherwise 0	36.17
Fat content (D_{i13q}, q=1, 2)			
• ≤ 3.5%	D_{i131}	assumes 1 if the fat content of the sample is less than or equal to 3.5%, assuming that this range of percentage fat is a desirable attribute, otherwise 0	95.74
• > 3.5%	D_{i132}	assumes 1 if the fat content of the sample is greater than 3.5%, assuming that this range of percentage fat is an undesirable attribute, otherwise 0	4.26
Fibre content (D_{i14q}, q=1, 2)			
• 0% fibre	D_{i141}	assumes 1 if the fibre content of the sample is zero, assuming that zero fibre content is a desirable attribute, otherwise 0	89.36
• fibre present	D_{i142}	assumes 1 if the fibre content of the sample is not zero, assuming that a non-zero fibre content is an undesirable attribute, otherwise 0	10.64
Ash content (D_{i15q}, q=1, 2)			
• ≤ 1.8%	D_{i151}	assumes 1 if the ash content of the sample is less than or equal to 1.8%, assuming that this range of percentage ash is a desirable attribute, otherwise 0	85.11
• > 1.8%	D_{i152}	assumes 1 if the ash content of the sample is greater than 1.8%, assuming that this range of percentage ash is an undesirable attribute, otherwise 0	14.89
Foul odour (D_{i16q}, q=1, 2)			
• present	D_{i161}	assumes 1 if the odour of the sample is equal to 4 or 5 in a scale of 1 through 5 where 1 is without any foul odour while 5 has the most foul odour, otherwise 0	17.02
• nil	D_{i162}	assumes 1 if the odour of the sample is equal to 1, 2 or 3, otherwise 0	82.98
Brokenness (D_{i17q}, q=1, 2)			
• present	D_{i171}	assumes 1 if the brokenness of the sample is equal to 2, 3, 4 and 5 in a scale of 0 through 5 where 0 is without any broken shell or parts as head, swimrets and tail, while 5 has the most broken structures, otherwise 0	59.57
• nil	D_{i172}	assumes 1 if the brokenness of the sample is equal to 1 or 2, otherwise 0	40.43

Table 3. Con't.

Attribute	Variable Notation[1]	Definition[2]	Proportion of samples (%)
Percent shell refuse ($D_{i,18,q}$, q=1, 2)			
• substantial	$D_{i,18,1}$	assumes 1 if percent shell refuse is 43-47% of total weight, assuming that this range is a desirable attribute, otherwise 0	21.28
• nil	$D_{i,18,2}$	assumes 1 if percent shell refuse is not within 43-47% of total weight, assuming that this range is an undesirable attribute, otherwise 0	78.72
Source or type of production ($D_{i,19,q}$, q=1, 2)			
• cultured	$D_{i,19,1}$	assumes 1 if the sample is aquacultured, otherwise 0	40.43
• sea-caught	$D_{i,19,2}$	assumes 1 if the sample is sea-caught, otherwise 0	59.57

[1] Notation follows Equation (1) where a dummy variable is denoted by D_{ikq}, where the subscripts denote category q of qualitative attribute k in sample i.

[2] Assumptions and approximations on desirable ranges of percentage composition of the edible portion of prawn and shrimp are based on: Pearson (1970) stating that cooked prawns has 70% water, 1.8% fat and 21.2% protein while cooked shrimp has 62.5% water, 2.4% fat and 22.3% protein. Floyd (1985) cited that protein content of most fish species varies from 15 and 20% while fat varies positively with protein at a wider range from 0.3 to 20%, depending on species and season. Kraus (1975) reported 1.7g of carbohydates per 4 ounces of raw prawn meat (equivalent to 1.4%) and 4.7g per whole raw prawn (1.04%), frozen raw breaded prawn has 19.93% carbohydrates while fired breaded has 20.11%

Analysis of Data

In an empirical hedonic analysis of commodities such as prawn and shrimp, it is not surprising to obtain a wide-range data set due to diversity in product form, species, freshness and other attributes in a domestic market. Inevitable large variation in quantitative continuous variables, such as number of pieces per kilogram $C_{i,5}$ was stabilised by forming dummy categories that represent grades according to size that prevails in the domestic market[8] (see $D_{i,1,1...5}$ in Table 3). The variation within each dummy category is more stable and the diversity of product attribute is maintained. Transforming continuous quantitative variables into groups of dummy variables also reduces the measurement errors discussed by Williams (1989).

For variables such as price and length-related attibutes, logarithmic transformation stabilises the variances. Log transformation also facilitates ease of interpretation of estimation results (Kennedy 1989). Therefore, the log transform which accounts as the variance stabilizing

[8] The size categories under the number of pieces/kg $D_{i,1,q}$, q=1,... 5 is a modification of the standard ranges in international prawn and shrimp trade where there are about 10 to 15 categories (see INFOFISH Tradenews forthnightly publication, Kuala Lumpur, Malaysia). In this paper, the five categories suit the domestic market where buyers and sellers generally classify prawn and shrimp in less stringent categories as 'very small', 'small', 'average', 'medium' and 'large'.

measure, will be preferred and used in proposing a hedonic price model. Below, statistical analysis justifies the use of logarithmic variables in the model.

Estimation of the hedonic price model

The estimates derived from regressing price againsts each quantitative and qualitative variable provided a basis for identifying potential explanatory variables. An attribute is considered as an explanatory variable when the signs and the significance of the estimates lends theoretical and realistic interpretation of each price and attribute relationship. An attribute that is believed preferred by consumers, such as more meat weight per piece $C_{i,8}$, has a significant positive coefficient estimate (0.35) while an undesirable attribute, such as foul odour, $D_{i,16,1}$, has a significant negative coefficient estimate (-0.93).

On the choice of continuous predictor variable, tail length $C_{i,1}$ was chosen because length-related attributes are directly observable during purchase than weight-related attributes. Also, fourteen of the 47 prawn samples were headless. Tail length also represents all other length- and weight-related attributes as it showed high correlation with other attributes.

Initial estimation of equation (2) revealed that only 20 of the listed variables in Table 3 are significant. We re-estimated equation (2) with those 20 variables and the results are presented in column 2 of Table 4. That is, logarithmic price $\ln P_i$ is regressed against the continuous variable tail length together with all the qualitative attributes represented as dummies. Results showed that eight variables with t-values less than 1.0 have to be omitted from the Model 1 to improve estimation results. This Unrestricted Model will be used later to test the efficiency of the final model. Several estimations were performed before arriving at the Restricted Model 2 estimates listed in column 4 of Table 4, which presents the significant influence of 12 explanatory variables on price.

The model selection criteria in Table 4 compare the effect of omitting insignificant variables. The improvements mainly arise from the significance of more estimates and higher degrees of freedom manifested with higher adjusted R^2 and F value for Model 2 than for the Model 1. Except for Shibata, Akaike information criterion (AIC) and log-AIC which favour Model 1 but are not very different from the coefficients associated with the Restricted Model 2, all other selection criteria validates the efficiency of Model 2.

Using the F-test between the Unrestricted Model and the Restricted Model, this paper tests the hypothesis that the coefficient of the omitted variables are not significantly different from zero, that is, $\gamma_{12} = \gamma_{13} = \ldots \gamma_{18} = \gamma_{19} = 0$. The value of the F test statistics is 0.62, which is less than the critical value of 2.85. This confirms that Model 2 is preferable to Model 1.

The significance and percentage impact of each explanatory variable in Model 2 in Table 4 will be evaluated later in the discussion of empirical results.

Table 4. Estimated coefficients, regression statistics and model selection criteria (t-values are in parentheses).

Variables (1)	Model 1 (Unrestricted) Coefficient (2)	Model 2 (Restricted) Coefficient (3)	Model 2 (Restricted) Percentage Impact[1] (4)
Constant α_0	3.724 (3.861)*	4.160 (7.994)*	
Tail length C_1	1.305 (3.219)*	1.072 (5.976)*	107.2
Number of prawn pieces per kilogram			
• < 15 pieces $D_{1,1}$	0.376 (2.124)***	0.398 (2.678)**	48.88
• 16-35 pieces $D_{1,2}$ @			
• 36-110 pieces $D_{1,3}$	0.472 (2.366)**	0.395 (3.081)*	48.44
• 111-999 pieces $D_{1,4}$	0.300 (0.925)	0.087 (0.459)	9.10
• > 1000 pieces $D_{1,5}$	0.686 (0.862)	0.369 (0.814)	44.66
Protein content			
• > 15 percent $D_{2,1}$	-0.505 (-2.222)**	-0.464 (-2.444)**	(37.13)
• < 15 percent $D_{2,2}$ @			
Carbohydrate content[2]			
• > 1.5 percent $D_{3,1}$	-0.338 (-2.563)**	-0.274 (-2.753)**	(23.99)
• < 1.5 percent $D_{3,2}$ @			
Discolouration			
• present [scale 3, 4, 5] $D_{4,1}$	-0.351 (-1.972)***	-0.361 (-3.704)*	(30.29)
• nil [scale 0, 1, 2] $D_{4,2}$ @			
Mode of sale			
• Retail sale $D_{5,1}$	-0.339 (-1.414)	-0.348 (-2.019)***	(29.40)
• Wholesale $D_{5,2}$ @			
Ease of preparation			
• Easy to prepare $D_{6,1}$	0.291 (1.954)***	0.392 (3.623)*	47.98
• Difficult to prepare $D_{6,2}$ @			
Store/seller type			
• Farm or wet market $D_{7,1}$ @			
• Supermarket $D_{7,2}$	0.200 (1.093)	0.191 (1.595)	21.05
• Processing plant $D_{7,3}$	-0.308 (-0.976)	-0.281 (-1.215)	(24.48)

Table 4. Con't.

Variables	Model 1 (Unrestricted) Coefficient	Model 2 (Restricted) Coefficient	Model 2 (Restricted) Percentage Impact[1]
Species or type			
• Black Tiger D_{81} @			
• Ocean, sea, king, green, flower tiger D_{82}	0.652 (2.840)**	0.602 (2.981)*	82.64
• White, banana D_{83}	0.977 (3.680)*	0.882 (4.039)*	141.59
• Freshwater D_{84}	0.675 (2.181)**	0.684 (2.556)**	98.09
• Endeavour D_{85}	0.755 (3.411)*	0.712 (3.943)*	103.74
• Assorted species D_{86}	0.207 (1.045)	0.264 (1.565)	30.27
Degree of freshness			
• Live D_{91} @			
• Chilled raw D_{92}	-0.736 (-2.698)**	-0.686 (-3.443)*	(49.65)
• Frozen D_{93}	-1.846 (-4.454)*	-1.619 (-5.317)*	(80.20)
• Dried/cooked D_{94}	-1.032 (-1.497)	-0.866 (-1.772)***	(57.93)
Product form/ Extent of Processing			
• Head-on D_{101} @			
• Headless D_{102}	-0.431 (-2.817)**	-0.406 (-3.173)*	(33.40)
• Headless peeled D_{103}	1.250 (5.530)*	1.159 (6.115)*	218.77
• Headless breaded D_{104}	1.348 (2.759)**	1.089 (2.732)**	197.04
Colour during purchase			
• Orange D_{111}	-1.194 (-3.848)*	-1.039 (-5.083)*	(64.61)
• Black D_{112} @			
• White D_{113}	-1.223 (-4.084)*	-1.072 (-5.108)*	(65.76)
• Grey D_{114}	-0.682 (-2.821)**	-0.556 (-3.116)*	(42.68)
Moisture content			
• 74-80 % for wet samples and 44-55% for dried samples D_{121}	0.107 (0.700)		
• otherwise D_{122} @			
Fat content			
• <3.5% D_{131}	0.268 (0.905)		
• >3.5% D_{132} @			
Fibre content			
• 0% D_{141}	-0.086 (-0.565)		
• >0% D_{142} @			
Ash content			
• ≤1.8% D_{151}	-0.116 (-0.442)		
• >1.8% D_{152} @			

Table 4 Con't

Variables	Model 1 (Unrestricted) Coefficient	Model 2 (Restricted) Coefficient	Model 2 (Restricted) Percentage Impact[1]
Odour			
• present - scale 4, 5 D [illegible]	-0.083 (-0.036)		
• nil - scale 1, 2 D [illegible] @			
Brokenness			
• present [scale 2, 3, 4, 5] D [illegible]	0.002 (0.017)		
• nil [scale 1] D [illegible] @			
Shell refuse as percent of head-on weight			
• 43-47% D [illegible]	-0.069 (-0.517)		
• otherwise D [illegible] @			
Source or type of production			
• Cultured D [illegible]	-0.091 (-0.468)		
• Captured from wild D [illegible] @			
Regression Statistics:			
Sum of Squared Errors (SSE)	0.492[#]	0.696	
R^2	0.978[#]	0.969	
Adj R^2	0.916	0.929[#]	
$F_{computed}$	15.761	24.063[#]	
Degrees of freedom	12	20	
Model Selection Criteria[2]			
Final prediction error (FPE)	0.072	0.055[#]	
Generalized cross validation (GCV)	0.161	0.082[#]	
Rice (1984) criterion	-0.021	-0.099[#]	
Shibata (1981) criterion	0.026[#]	0.032	
Akaike (1974) information criterion (AIC)	0.046[#]	0.047	
Log-Akaike information criterion (Log-AIC)	-3.070[#]	-3.064	
Schwarz (1978) criterion (SC)	0.184	0.135[#]	
Log-Schwarz (1978) criterion (Log-SC)	-1.692	-2.001[#]	
Hannan and Quinn (1979) criterion (HQ)	0.078	0.070[#]	

@ denotes benchmark dummy variable. * Significant at 1%, ** Significant at 5%, *** Significant at 10%

[1] Percentage impact is relevant with dummy variables used in the model. The interpretation of dummy variables in semilog form was suggested by Halvorsen and Palmquist, and discussed by Gujarati (1988). Percentage impact is calculated as $((e^{\gamma_{kq}} - 1) \times 100)$, where γ_{kq} is the coefficient of the dummy variable. Figures in parentheses ( ) are negative impact or price discounts, otherwise, the figures are price premia.

[2] See Judge *et al.* (1985, p.242) and Ramanathan (1992, p.167).

[#] The preferred model relevant to each criterion. Each criterion being the product of the error sum of squares (ESS) and penalty factor due to the loss of degrees of freedom with many predictor variables, the model with lowest coefficient is preferred with each criterion. The penalty factor varies with each criterion as summarized in Ramanathan 1992, p.169.

Choice of Functional Form

It was established earlier that the logarithmic transformation of each quantitative variable produced more constant variances and would be used throughout the paper. Initially, plots show the linear relationship of the logarithm of price and continuous explatory variables.

Table 5 summarises the results of Ramsey's regression error specification test (RESET) on the Restricted Model specified in Table 4. The test also showed that the the double-log form with continuous variable and log-linear with dummy variables is appropriate With the double-log form, Ramsey's RESET coefficients at levels 2 through 4, are not significant indicating absence of misspecification error. Furthermore, this form produced better predictive performance than the linear model, as shown by higher adjusted R^2 (0.929). In contrast, the linear form of the model showed significant RESET coefficients.

Table 5 Results of Ramsey's RESET specification test and summary statistics applied on the Restricted Model in Table 4

Functional Form	RESET values and other statistics	
Linear with all variables	RESET(2) = 16.213* ~ f(1, 19)	
	RESET(3) = 12.575* ~ f(2, 18)	
	RESET(4) = 8.082* ~ f(3, 17)	
	R^2 = 0.941	Adj. R^2 =0.864
	Ybar= 253.34	σ=52.87
	N= 47	D.F = 20
Double log with continuous variable and Log-linear with dummy variables	RESET(2) = 0.336 ~ f(1, 19)	
	RESET(3) = 1.676 ~ f(2, 18)	
	RESET(4) = 1.898 ~ f(3, 17)	
	R^2 = 0.969	Adj. R^2 =0.929
	Ybar= 5.342	σ=0.186
	N= 47	D.F = 20

* Significant at 1%. RESET test is based upon White's (1980) heteroscedasticity consistent covariance matrix and used in this study following Oczkowski's (1994) application to the Australian wine industry

Discussion of Empirical Results

The relevant hedonic price model for prawn and shrimp in the Philippine domestic market has a constant term, one quantitative variable and nine groups of dummy explanatory variables (Table 4). A constant term in the model is imperative as it denotes the implicit price of the combined attributes represented by the control or benchmark category for each group of dummy variables.[9] The coefficients of the dummies were presented as percentage impact of an attribute on price relative to the chosen control dummy category.

The constant is significant and estimated at 4.16 indicating that any prawn and shrimp having all the benchmark attributes are positively valued in the Philippine domestic market. That is, a live $D_{6,1}$ black tiger prawn $D_{8,1}$ at 16-35 pieces per kilogram $D_{1,2}$, with protein content less than 15% $D_{2,1}$, carbohydrate content less than 1.5% $D_{3,1}$, nil discolouration D_{4}, difficult to prepare $D_{6,2}$ with its head-on and shell-on $D_{10,1}$ and sold on wholesale terms D_{6} in a farm or wet market $D_{7,1}$ will be priced at 416 pesos per kilogram plus the implicit price due to its tail length C_1. Tail length is associated with a positive implicit price or a premium suggesting that those having longer edible tails obtain proportionately higher prices.

On the relative percentage impact of each q[th] category under each k[th] qualitative variable, product form, species, colour and degree of freshness are the attributes creating significant high percentage impact on prices relative to some benchmark characteristics. Specifically, the headless peeled tail shell-on or completely peeled product form D_{10} has the highest implicit price, estimated at 219% higher than the benchmark attribute head-on shell-on $D_{10,1}$. This suggests that investing in value-adding processes to obtain such forms that receive price premium is encouraged when value-adding processes are cost effective.

Protein content $D_{2,2}$ ≥15%, as per proximate content analysis, is significantly associated with 37% price discount relative to those with less than 15%, the benchmark dummy $D_{2,1}$.[10] Similarly, carbohydrate content $D_{3,2}$ ≥ 1.5% is significantly associated with 24% price discount relative to those with less than 1.5%. The implications are possibly associated with the concerns of seafood consumers who value the observable attributes of prawn, such as freshness and eating quality, but are consciously after moderate protein and carbohydrate intake.

Discolourations $D_{4,2}$ on the carapace and tail shell are significantly linked with 30% price discounts relative to samples without discolourations $D_{4,1}$. In a scale from 0 to 5, where 0 represents no discolouration and 5 has the most and worst, a rating from 3 to 5 will be associated with price discount. Discolourations appear in due time after harvest if proper temperature is not maintained. This implies that producers and middlemen should prevent their products from reaching such discolouration ratings to avoid price discounts.

[9] Unless the procedure and interpretation proposed by Suits (1984), but challenged by Kennedy (1986), will be followed. That is, all the categories in each dummy group of variables will be included in the regression, with a chosen constant added to the coefficient of each dummy variable, whose sum will be constrained to zero.

[10] Though this explanation needs further verification, too much protein content is undesirable. Protein content of seafood species often varies from 15 to 20%, and protein content increases with increasing fat content. Depending on the season, fat content ranges from 0.3 to 20% and as fat content increases, understandably an undesirable attribute for nutritional reasons, protein content also increases (Floyd 1985). Too much protein content, therefore, becomes an undesirable attribute receiving price discounts due to its positive proportionate linkage with fat content.

However, the lack of standard rating defining the extent of discolouration associated with each scaled rating needs prior attention from the industry.

Easy to prepare D_{61} shrimp and prawn with moderately textured shells or those that does not require cleaning and preparation receive price premium 48% higher than the benchmark attribute D_{62}. This implies the benefits from processing to ease and reduce preparation time. Avoiding harvest during moulting stage pays a premium since the shells are moderately textured and easy to detach, consequently reducing labour cost for processors. Innovations, such as breeding prawns with moderately textured shells, also implies positive implicit price if cost of such innovation proves reasonable.

The number of prawn pieces per kilogram, which represents size, is significantly affecting price. Large (≤15 pieces/kg) D_{11}, and average prawn (36-100 pieces/kg) D_{13} receive almost equal significant positive implicit price at 49 and 48%, respectively, relative to the benchmark medium-sized prawn (16-35 pieces/kg) D_{12}. Very small shrimp D_{14} and D_{15} are associated with positive but insignificant implicit price. The trend in the export market, where medium-sized prawn are most preferred, lends interpretation on the estimated implicit prices of various sizes in the domestic market. Such preference may have reduced the relative volume of medium-sized prawn in the local market and its price may be restrictively high, such that local buyers tend to value locally available smaller sizes. Since large prawn does not command good price relative to medium size in the discriminating export market, larger sizes would be available in domestic markets and obtain positive implicit prices among local buyers. For growers and fishers, the greatest benefit from significant positive implicit price due to size could be attained by harvesting at least at average sizes (36-100 pieces/kg), although significant implicit prices may also be gained from large and average-sized prawn in the domestic market.

All of the six local species are significantly linked with positive implicit price relative to the benchmark species black tiger prawn D_{81}. White or banana prawn D_{86}, received the highest implicit price at 142% followed by endeavour prawn D_{85} at 104% and freshwater D_{84} at 98%. Assorted species has positive but insignificant implicit price. The implications of the estimates and the relative percentage impacts on price are parallel with the general preferences and perception about each species in the Philippines. Black tiger prawn, often from aquaculture, is generally available and has gained notoriety both in the domestic and export market including Japan, Singapore and other Asian countries. Banana prawn with easy to remove shells than black tiger is generally harvested from off-shore deep-waters and may be preferred by some buyers because of the concept of purity, being void of chemicals used in aquaculture. Notwithstanding the refrigeration facilities on board most fishing vessels and hauling trucks, freshness could be its limitation compared with black tigers cultured in ponds proximate to markets. *M. endeavouri* or greasyback shrimp is the small-sized species common in local markets either fresh or prepared as dried, cooked or salted paste. Freshwater prawn is not commercially preferred due to its disproportionately big head and less edible meat. This species is generally intended for soup implying limited preparation styles.

As expected, live prawn is most preferred and obtains high price premium. With live prawn D_{q1} as the control dummy, other levels of freshness are linked with lower implicit price impacts. Dried or cooked D_{q4} and chilled raw prawn D_{q2} are associated 58 and 50% price premia, respectively. Frozen prawn D_{q3} received 80% discount. Therefore, once prawn and shrimp cannot be marketed live to obtain premium price, the alternatives are either to market them as chilled, add value by cooking or to process and prolong shelf-life by drying. Freezing is the last recommended option as this showed largest price reduction. Nevertheless, freezing remains the most common practice as this prolongs storage longest at least cost, arising from the more impressive improvement and availability of freezing technology than other preservation methods. Cooking and drying as value-adding procedures require substantial labour and other resources, hence, not as popular as freezing. Furthermore, cooked prawn, either boiled or steamed, are more susceptible to contamination and spoilage than frozen prawn.

Product forms representing substantial extent of processing to create distinct desirable attributes significantly influence price. Headless peeled prawn with or without tail shell $D_{[illegible]}$ creates the biggest implicit impact on price at 219% relative to the benchmark head-on shell-on form D_{pf1} which does not represent some processing. Processors substantiate these results explaining that head-on shell-on form is of highest level of freshness among all forms. Headless breaded form D_{pf4} follows with 197% relative impact on price. Although the headless shell-on form D_{pf2} represent some level of processing, it nevertheless is associated with 33% price discount as deheading do not substantially create additional desirable attribute to the product. Processors explained that headless shell-on or peeled forms are often products of down-graded head-on shell-on form with discolourations on the carapace, broken antennae and appendages or drooping head. Value-added breaded form, however, receives price premia because breading requires fresh raw prawn to avoid contamination and spoilage.

Colour during purchase significantly affect price. With black as benchmark variable, all other colours are associated with negative impact on price. Grey significantly receives the least price discount at 43%. White and orange are associated with 66 and 65% discounts, respectively. Colour varies from white, grey, bluish brown and black when uncooked. There are some species, such as pink and flower prawn, with orange bands when raw. But when cooked, orange is the common colour regardless of species. Orange discolourations also appear on the shell and meat of deteriorating uncooked prawn and is associated with discounts. These estimates suggest the high value imputed on raw black prawn. Black tiger may, therefore, be marketed raw with shell-on since its colour receive price premium. The impressive relative impact on price of black-coloured prawn is linked with the popularity and acceptability of black tiger species in the Philippines which comprise 75% of the total prawn and shrimp production in the country and is generally sourced fresh from aquaculture ponds (BAS).

5. Conclusion and Implications

This paper estimated a hedonic model recognising that attributes defining quality are among the primary determinants of prawn and shrimp prices. Using primary data collected through direct observation and laboratory test of product attributes, demand for prawn and shrimp attributes in the Philippine domestic market were derived from estimates of implicit prices.

The implicit price of continuous variable tail length together with qualitative attributes, such as product form, freshness, species, colour, size, ease of preparation, discolouration, protein and carbohydrate content, are conveniently presented as percentage impact on price relative to a benchmark category. Attributes that are generally linked with the concepts of quality significantly showed positive implicit price or premium while attributes that reduces level of quality are discounted.

Large (≤15 pieces/kg) and average (36-110) sizes get price premium relative to medium size (16-35). Processing to add value and ease preparation gets high premium. Some of the most valued forms include the peeled tail pieces with tail shell-on and the breaded forms. As expected, live prawn is valued higher than other levels of freshness. Freezing prawns without value-adding, although most practiced due to availability of reliable technology and facilities, gets the highest discount among other forms of preservation such as chilling, cooking and drying.

While all species are associated with positive implicit price relative to the abundant aquacultured black tiger, sea-caught banana prawn is most highly valued. Assorted species is not discounted but not significantly receiving premium. With black colour as benchmark, other colours are linked with discounts.

Among organoleptic attributes, discolouration gets significant price discount. Hence, postharvest efforts should focus on determining the appropriate measures and conditions to slow down the enzymes that influence discolouration. Odour and brokenness were also tested but they do not significantly affect price. Natural seafood smell and some forms of brokenness may be acceptable among less stringent local buyers.

Among the nutritionally important attributes, high levels of protein (>15% per gram) and carbohydates (>1.6% per gram) create price discounts. The implications are relevant to prawn breeders who should consider the changing concern of seafood consumers who savour the eating quality of prawn but are conscious about moderate nutrient intake.

In the hedonic price model, the use of dummy variables are inevitable for many attributes to reduce measurement errors. Combining log-transformed continuous variable with dummy variables in a hedonic price model served to compensate the information lost when some attributes are transformed into dummy categories to stabilize variances and to minimize measurement errors. Since many prawn attributes are qualitative in nature, definition of technically sound and reliable assumptions while considering a balance between minimizing measurement errors and loss of information when assigning dummy variables are crucial limiting procedures.

Overall, the model suggest the alternative value-adding procedures where prawn and shrimp producers, processors and researchers could focus their effort and investment. The percentage impact on price created by each attribute in quantities defining today's consumers' quality standards manifest their willingness to pay for attributes. In lucrative, yet high-investment domestic prawn and shrimp industry in the Philippines, and elsewhere, identifying consumers' demand for product attributes facilitate effiency in resource use. A hedonic price analysis has the advantage of quantifiying implicit prices of product attributes in desired quantities.

References

Anderson, J.L. 1995. Purchase Behavior, Food Safety and Quality Control in Seafood and Aquaculture Marketing: Discussion. *Amer J. of Agr. Econ.* 77(5):1319-1321.

Auburn University. 1993. *Philippine Prawn Industry Policy Study: Final Report. U.S. Agency for International Development.* Philippine Assistance Program Support Project No. 492-0452. Manila, Philippines.

Bartik, T.J. 1987. The Estimation of Demand Parameters in Hedonic Price Models. *Journal of Political Economy.* 95(1):81-87.

BAS. 1995. Shrimp and Prawn Situation Report (1989-93). *Fishery Statistics Bulletin.* Bureau of Agricultural Statistics, Department of Agriculture, Philippines.

Brorsen, B.W., W.R. Grant and M.E. Rister. 1984. A Hedonic M del for Rough Rice Bid/Acceptance Markets. *Amer. J. Ag. Econ.* 66(2):156-163.

Buchanan, R.L. 1991. Microbiological Criteria for Cooked, Ready-to-Eat Shrimp and Crabmeat. *Food Technology.* 45(4):157-160.

Coelli, T., J. Lloyd-Smith, D. Morrison and J. Thomas. 1991. Hedonic Pricing for a Cost Benefit Analysis of a Public Water Supply Scheme. *The Aust. Jour. of Agr. Econ.* 35(1):1-20.

Ethridge, D.E. and B. Davis. 1982. Hedonic Price Estimation for Commodities: An Application to Cotton. *West. J. Agr. Econ.* 57:501-518.

Feenstra, R.C. 1995. Exact Hedonic Price Indexes. *The Rev. of Econ. and Stats.* ( ): 634-653.

Floyd, J.M. 1985. The Role of Fish in Southeast Asian Diets: Focus on Indonesia, Malaysia, the Philippines and Thailand. *INFOFISH Marketing Digest* No. 4. Kuala Lumpur, Malaysia.

Godfrey, L.G., M. McAleer and C.R. McKenzie. 1988. Variable Addition and Lagrange Multiplier Tests for Linear and Logarithmic Regression Models. *The Rev. of Econ. and Stats.* 70:492-503.

Goodwin, B. and J. Espinosa. 1991. Hedonic Price Estimation for Kansas Wheat Characteristics. *Western Jour. of Agr. Econ.* 16(1):72-85.

Gujarati, D. 1988. *Essentials of Econometrics.* McGraw Hill, Inc. USA.

Hanson, G.D., R.O. Herrmann and J.W. Dunn. 1995. Determinants of Seafood Purchase Behavior: Consumers, Restaurants and Grocery Stores. *Amer. J. Of Agr. Econ.* 77(5):1301-1305.

Huss, H.H. 1988. *Fresh Fish Quality and Quality Changes*. FAO-DANIDA. Rome. FAO Fisheries Series No.29.

INFOFISH. 1994. Who is the 21st Century Consumer? *INFOFISH International*. 1/1994.

Judge, G., W. Griffiths, C. Hill and T.C. Lee. 1985. *The Theory and Practice of Econometrics*. Wiley, New York.

Kennedy, P. 1989. Interpreting Dummy Variables. *The Rev. of Econ. and Stats.* 68(1):174-75.

Kraus, B. 1975. *Calories and Carbohydrates*. 5th ed. Grosset and Dunlap, Inc. New York.

Ladd, G.W. and V. Suvannunt. 1976. A Model of Consumer Goods Characteristics. *Amer. J. Ag. Econ.* 58:504-510.

Ladd, G.W. and M. Martin. 1976. Prices and Demand for Input Characteristics. *Amer. J. Ag. Econ.* 58(1):21-30.

Lucas, R.E.B. 1975. Hedonic Price Functions. *Econ. Inquiry*. 13:157-178.

Marte, C.L. 1993. Research Activities and Accomplishments of the SEAFDEC Aquaculture Department, 1988-1991. In: *Proceedings of the Aquaculture Workshop for SEAFDEC/AQD Training Alumni*, 8-11 September 1992, Philippines. SEAFDEC AQD, Iloilo, Philippines.

McLen, J.D. 1995. The Influence of Fat and Weight on the Price of Lamb in the Homebush Livestock and Wholesale Markets. *Rev. Mktg. and Ag. Econ.* 63(1):64-76.

Mullen, J.D. and M.K. Wohlgenant. 1991. The Willingness of Consumers to Pay for Attributes of Lamb. *The Australian Journal of Agricultural Economics*. 35(3):247-262.

Oczkowski, E. 1994. A Hedonic Price Function For Australian Premium Table Wine. *Aust. Jour. Agr. Econ.* 38(1):93-110.

PCCARD. 1985. *State of the Art Abstract and Bibliography of Shrimp and Prawn Researches*. Fisheries State of the Art Abstract and Bibliography Series No.5/1985. Philippine Council for Agriculture and Resources Research and Development. Los Baños, Laguna, Philippines.

Pearson, D. 1970. *The Chemical Analysis of Foods*. 6th ed. Chemical Publishing Company, Inc. New York.

Pearson, A.M. and T.R. Dutson (eds.) 1994. *Quality Attributes and Their Measurement in Meat, Poultry and Fish Products*. Advances in Meat Research Series Volume 9. Blackie Academic and Professional, imprint of Chapman and Hall. London.

Porter, D. and M. Todd. 1985. The Effect of Carcass Quality on Beef Carcass and Auction Prices. *Aust. Journ. of Agric. Econ.* 29(3):225-234.

Primavera, J.H. 1993. A Critical Review of Shrimp Pond Culture in the Philippines. *Reviews in Fisheries Science*. 1(2):151-201.

Primavera, J.H. 1992. Prawn/Shrimp Culture Industry in the Philippines. In: *Marine Shrimp Culture: Principles and Practices*. Fast, A.W. and L.J. Lester (eds). 1992. Elsevier Science Publishers. B.V.P.

Ramanathan, R. 1992. *Introductory Econometrics with Applications*. 2nd Ed. Harcourt Brace Jovanovich Inc. U.S.A.

Rosen, S. 1974. Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition. *Jour. Polit. Econ.* 82(1):34-55.

Shahidi, F. And J.R. Botta (eds.) 1994. Seafoods: Chemistry, Processing Technology and Quality. Blackie Academic and Professional, imprint of Chapman and Hall. London.

Suits, D.B. 1984. Dummy Variables: Mechanics and Interpretation. *The Rev. of Econ. and Stats.* 66(1):177-80.

Unnevehr, L.J. 1986. Consumer Demand for Rice Grain Quality and Returns to Research for Quality Improvement in Southeast Asia. *Amer. Jour. Agr. Econ.* ( ):634-641.

White, H. 1980. A Heteroscedasticity Consistent Covariance Matrix and a Direct Test for Heteroscedasticity. *Econometrica* 48:817-838.

Whitfield, F.B., J.H. Last, K.J. Shaw and C.R. Tindale. 1988. 2-6Dibromophenol: The Cause of an Iodoform-like Off-flavour in Some Australian Crustacea. *Journal of Food Science and Agriculture* 46:29-42.

Williams, C. 1989. *The Choice of the Functional Form For Hedonic Price Functions: An Application of the Box-Cox Transformation to Cattle Prices in Queensland.* Discussion Paper 15. ISSN 1033-4661. Department of Economics, University of Queensland.

Wills, I. and J. Harris. 1994. Government Versus Private Quality Assurance for Australian Food Exports. *Aust. Journ. of Agr. Econ.* 38(1):77-92.

Wilson, C.W. 1994. Differentiation and Implicit Prices in Export Wheat Markets. *Western Jour. of Agr. Econ.* 14(1):67-77.

York, R.K. and L.M. Sereda. 1994. Sensory Assessment of Quality in Fish and Seafoods. In. *Seafoods: Chemistry, Processing Technology and Quality.* Shahidi, F. And J.R. Botta (eds.). Blackie Academic and Professional, imprint of Chapman and Hall. London.