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Implicit Prices of Prawn and Shrimp Attributes in the Philippine Domestic Market

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Abstract *Improving quality is a major goal in the global seafood market due to increasing consciousness among buyers, who are becoming "quality consumers" rather than "quantity consumers." This paper uses the hedonic approach to determine the marketable characteristics of prawn and shrimp in a domestic market that prioritizes export of quality products to a more lucrative market. Using price and attribute data for prawn and shrimp purchased from the Philippine domestic market, we estimate a log-linear hedonic price model with combined continuous and dummy explanatory variables. The estimation results show significant implicit prices of attributes, such as: tail length, freshness, product form, species, color, size, ease of preparation, discoloration, protein, and carbohydrate content. Longer tails and banana species are highly valued. Peeling and breading to ease preparation obtain a high premium. Freezing, although commonly practiced, receives the highest discount among forms of preservation. As the characteristics of local consumers and the market in the Philippines are similar to other competing Asian exporters such as Indonesia, India, Malaysia, Thailand, and Vietnam, the results presented in this paper will be applicable to these exporting countries.*

Key words Attributes, characteristics, hedonic prices, Philippines, prawn and shrimp, quality, seafood.

Introduction

In the seafood industry, the evolving concept that 21st century consumers are "consumers of quality" rather than "consumers of quantity" highlights the role played by quality factors in determining market prices (*INFOFISH* 1994). Notwithstanding that price and quantity are important factors necessary in every market study, current

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trends in consumption and trade recognize that quality is a major issue in the global seafood market, and that the price of seafood is affected by its quality. Therefore, improving seafood quality aside from increasing quantity is a major thrust of policy issues in the global seafood markets. Quality in prawn and shrimp generally relates to having optimum "quantities" of attributes, such as: freshness, size, color, texture, taste, and other aesthetic characteristics. In spite of the generally accepted relationship between price and quality in the seafood industry, to our knowledge no attempt has been made to estimate the functional linkages between price and such quality attributes for any country.

Hedonic price analysis, developed by Court (1939) and revived by Griliches (1961), is generally used to analyze the relationship between price and quality of various consumer goods. Consumers obtain utility 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 sellers are, therefore, expected to identify attributes desired by consumers and offer optimum quantities of attributes that receive price premia and minimize those attributes that are discounted. The framework of hedonic price analysis identifies the market clearing price at which the consumers and sellers of "marketable attributes" are satisfied (Rosen 1974). On the premise that quality improvement and value-adding processes either increase the quantity of desired attributes of a product, or minimize, if not eliminate, the undesirable attributes of a product, hedonic price models are useful in estimating the implicit price associated with each process.

The objective of this paper is to identify the marketable characteristics of prawn and shrimp in the Philippine domestic market. The prawn and shrimp industry in the Philippines is among the most lucrative, both at the domestic and international levels. The Philippines ranked sixth among the major prawn and shrimp producers in the world from 1989 to 1995. On average, while the Philippines export about 30% of its product to a competitive world market, a major portion (about 70%) is intended for domestic consumption.

The hedonic approach is used in this study because it enables estimation of the influences of changes in the quantity of attributes on product price. Changes in the quantity of attributes reflect quality changes. We estimate a model that describes a functional relationship between price, quantitative attributes, and qualitative attributes, using primary data based on observed and measured product characteristics of prawn and shrimp samples collected in local consumer markets in the Philippines. The estimation results of this study will help measure economic benefits from investing in the production of seafood with a number of preferred attributes or value-added features associated with a price premium. By estimating the implicit prices of marketable characteristics of a major export seafood product, this study aims to help understand the often-neglected domestic consumption behavior in developing countries. The study also aims to contribute to the sparsely studied seafood market in general.

The Philippine Prawn and Shrimp Market

The Philippine prawn and shrimp industry is characterized by two main sectors, aquaculture and sea-capture. As in many developing countries, the aquaculture sector, where prawn farming is done in a controlled environment to produce desired attributes, is motivated by the export market.[1] The sea-capture sector mainly caters to the

[1] During its peak year in 1994, the Philippine aquaculture sector accounted for about 72% of total production, while the remaining 28% came from the sea-capture fishery. The aquaculture of prawn and shrimp has also developed in other Asian exporting countries, such as: Indonesia, Thailand, Malaysia, Vietnam, India, and Taiwan (Rosenberry 1994).

domestic market. Figure 1 presents the prawn and shrimp production trend of these two sectors from 1983 to 1996. Sea-caught production has generally remained stable over the period, whereas aquaculture production increased steadily until 1994. The growth in prawn aquaculture has contributed to a significant increase in the total volume of prawn and shrimp production and improved product characteristics.

The Philippine prawn and shrimp aquaculture industry suffered a serious disease outbreak in 1996, but still managed to be among the world's top fifteen producers. Table 1 shows that although total prawn and shrimp production in the Philippines has increased from 83,000 metric tons (mt) in 1989 to 127,000 mt in 1996, the proportion of exports to total production has declined by half, from 31% to 15%. This sudden decline may be due to the disease outbreak that lowered product quality, and thus, much product was unable to meet export standards.

Prawn and shrimp possess many characteristics that may either be equally desirable, or in contrast, uniquely appreciated by a domestic consumer in an exporting country but not in the export market, or *vice versa*. Characteristics such as freshness and color may be similarly valued by domestic and foreign consumers. However, Japanese consumers prefer head-on, shell-on forms, and Americans prefer peeled. This indicates that segmented demand for some characteristics exists, and efficiency in allocating characteristics or qualities in segments where they are marketable may take place.

Given the existing diversity of prawn and shrimp attributes in the domestic market, which attributes are preferred in the Philippines? A wide range of attributes can be noted on the variety of species, marketable sizes, product forms and preparations, degree of freshness, methods of preservation, color, packaging, and other physically observable characteristics. However, diversity of product attributes prevails and is encouraged in the Philippine domestic market to meet the demand of various consumer groups. Identification and estimation of relative implicit values of various attributes desired by consumers, rather than standardization, seem to be a more relevant objective in the domestic setting.

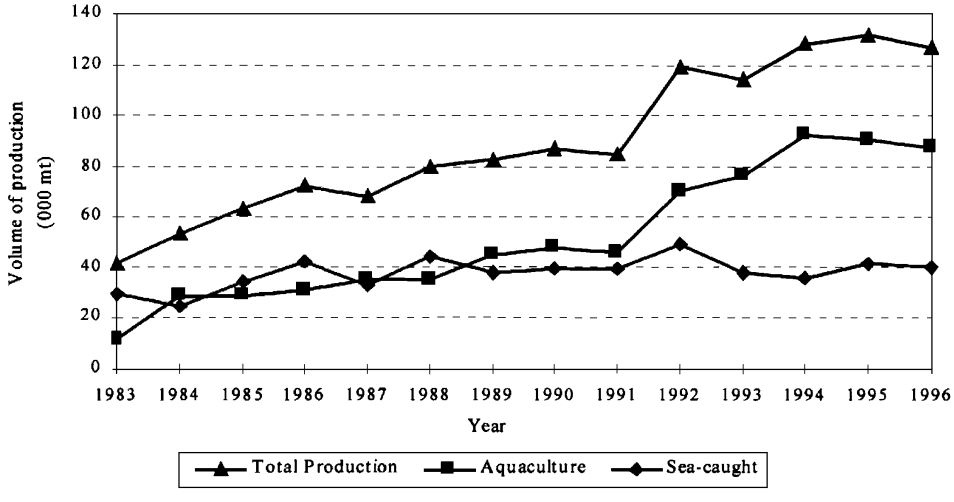

Figure 1. Production of Prawn and Shrimp from Aquaculture and Sea-capture Sectors in the Philippines, 1983–96

Table 1
Total Production and Exports of Prawn and Shrimp

Country	1989[1]		1996[2]	
	Total Production (000 mt)	Percentage of Export	Total Production (000 mt)	Percentage of Export
China	502	24	622	9
Thailand	227	30	404	58
India	223	26	301	34
Indonesia	200	34	336	24
United States	161	0	139	14
Philippines	83	31	127	15
Taiwan	na[3]	na[3]	49	7

[1] Source: ADB/INFOFISH 1991.
[2] Source: FAO 1996.
[3] Not applicable since data for 1989 is included with China.

The Model

Many prawn and shrimp attributes, such as color, odor, and tenderness are qualitative and are generally believed to be determinants of seafood purchase behavior in most countries. Meanwhile, flavor, 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, Hermann, and Dunn 1995). However, food scientists emphasize the importance of chemical and microbiological aspects of traded seafood (Huss 1988; Whitfield *et al.* 1988; Buchanan 1991). Some references useful for understanding and measuring qualitative seafood characteristics are Pearson 1970; Pearson and Dutson 1994; Shahidi and Botta 1994; and Hanson, Hermann, and Dunn 1995. Most hedonic models use categorical dummy variables to measure the influence of qualitative attributes on price. Studies using these include Ethridge and Davis 1982; Brorsen, Grant, and Rister 1984; Porter and Todd 1985; Unnevehr 1986; Bartik 1987; Williams 1989; Coelli *et al*. 1991; Goodwin and Espinosa 1991; Mullen and Wohlgenant 1991; Stanley 1991; Oczkowski 1994; Wilson 1994; and Mullen 1995.

Let P_i be the purchase price per kilogram of prawn sample i, where $i = 1, 2, \ldots, n$, and n is the number of samples.[2] Price constitutes the dependent variable, while the explanatory attributes are categorized as continuous and dummy variables. Each sample is evaluated according to characteristics such as weight, length, species, freshness, form, and color.

The hedonic price model for prawn and shrimp is characterized by a continuous dependent price variable and multiple independent variables representing the characteristics. Therefore, the price attribute relationship could be expressed as:[3]

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[2] The use of purchase price eliminates the limitations associated with the usual practice of imputing "missing" prices in hedonic regressions, especially for new products, as discussed by Feenstra (1995). Furthermore, this study uses absolute price because the prawn and shrimp samples were purchased within a one-month period, and variations in supply, demand, and prices within a short period are generally nil to merit an analysis using relative prices, as comprehensively discussed in Mullen (1995).
[3] Continuous variables are used in logarithmic form to reduce variation in the data. They also facilitate ease of interpretation of estimation results.

$$\ln P_i = \alpha + \sum_{j=1}^{m_1} \beta_j \ln C_{ij} + \sum_{k=1}^{m_2} \sum_{q=1}^{m_{3k}} \gamma_{kq} D_{ikq} + \varepsilon_i, \quad i = 1, 2, \ldots, n \tag{1}$$

where $\ln P_i$ is the logarithm of price P_i; $\ln C_{ij}$'s are logarithms of the continuous variables, $j = 1, \ldots, m_1$, with m_1 being the number of continuous variables; and D_{ikq}'s are the dummy variables representing each category q of the kth qualitative variable, $q = 1, \ldots, m_{3k}$, $k = 1, \ldots, m_2$, with m_2 being the number of qualitative variables and m_{3k} being the number of categories in the kth qualitative variable. The coefficient α is the intercept; β_j's are the coefficients of the continuous variables, $j = 1, \ldots, m_1$; γ_{kq}'s are the coefficients of the dummy variables, $q = 1, \ldots, m_{3k}$, $k = 1, \ldots, m_2$; and ε_i is an error term satisfying the classical regression assumptions. 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 plots of alternative transformations of a data series provide a basis for using the quantitative variables in log form. The diagnostic tests for specification error are also instrumental in defining the structural part of reduced form models. A review of such procedures, as applied to linear and log-linear models, was documented by Godfrey, McAleer, and McKenzie (1988). In this paper, we use Ramsey's regression specification error test (RESET) to formulate the preferred model for estimation.

Data

Collection and Characteristics

Forty-seven prawn and shrimp samples were purchased from selected markets in metropolitan Manila and outlying areas during the month of July 1995. A sample comprises a lot/bunch of prawn and shrimp pieces offered for sale with a single tag price. Each sample is evaluated according to some quantitative and qualitative characteristics, such as: weight, length, species, freshness, form, and color, that may either be observable or unobservable at the time of purchase. These attributes, especially the observable ones, may influence a consumer's on-the-spot purchase decision.

Homogeneity of attributes is assumed within a sample, *i,* since sorting of prawn and shrimp according to some characteristics is generally practiced in all markets included in the study.[4] In some cases where assorted species are 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.

Table 2 presents the summary statistics for price, the measurable length- and weight-related attributes derived from the sample data, and their correlation coefficient with price. The qualitative attributes represented as dummy variables listed in column 1 of table 3 include organoleptic factors, such as: color and odor; market-related product characterization, such as grades according to the size or species; attributes of convenience such as product form; and attributes related to marketing and transportation cost, which are captured in variables such as mode of sale and type of store. Inevitable large variation in quantitative continuously measurable attributes, such as number of pieces per kilogram $C_{i,5}$ (see column 3 of the last row in table 2) is stabilized by forming dummy categories that represent grades according to size that prevails in the domestic market (see $D_{i,1,k}$, $k = 1, \ldots, 5$, in column 1 of

[4] 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 within the seafood industry.

Table 2
Summary Statistics of the Continuous Variables and Their Correlation with Price Prawn and Shrimp Samples from the Philippines, July 1995

Variable[1] (1)	Mean (2)	Variance (3)	Correlation with Price (4)
Price (peso/kg) P_i	253.30	20,515.40	1.00
Tail length (cm) $C_{i,1}$	8.51	11.63	0.74
Head-on, shell-on length (cm) $C_{i,2}$	11.88	26.09	0.62
Meat weight (g) $C_{i,3}$	13.85	228.86	0.74
Head-on, shell-on weight (g) $C_{i,4}$	23.97	961.28	0.64
Number of pieces/kg $C_{i,5}$	689.30	8,461,388.00	–0.30

[1] All notations follow model (1).

table 3 for the size categories).[5] Grades according to size are more relevant to price than number of pieces per kilogram, *per se*. Many of the attributes observed are similar to those identified by Hanson, Hermann and Dunn (1995) as determinants of seafood purchase behavior. Column 2 of table 3 gives the percentage frequency of each category of attributes found in the sample.

Recognizing the nutritional importance of gourmet prawn and shrimp, proximate component variables, such as moisture, protein, fat, carbohydrate, fiber, and ash content, are included among the explanatory variables.[6] Consumers are generally aware of the presence of these nutritional characteristics in seafood. Consumers purchase seafood products partly because the nutrients they contain are needed for a healthy diet. However, nutritional attributes are not explicitly disclosed and quantified in seafood products. These kinds of attributes comprise the "credence" qualities of goods (Wills and Harris 1994).[7] The case of seafood is different than other processed and labeled food products (*e.g.*, milk, breakfast cereals) where labels provide nutritional information (Lenz, Mittelhammer, and Shi 1994; Stanley 1991).

Price-attribute Relationships

To analyze the direction and strength of the relationship between the variables and price of prawn and shrimp, a correlation matrix between all variables was calculated.[8]

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[5] For this type of data, measurement errors are reduced when continuous quantitative variables are transformed into groups of dummy variables. The size categories under the number of pieces/kg $D_{i,1,q}$, $q = 1, \ldots, 5$ are a modification of the standard ranges in international prawn and shrimp trade where there are about ten to fifteen categories (see *INFOFISH TradeNews* fortnightly 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, such as: "very small," "small," "average," "medium," and "large."

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

[7] However, these "credence" attributes may be linked with some "search" and "experience" characteristics whose effects could be determined after consumption. For example, our data showed that protein (a credence attribute) is inversely related with carbohydrate (another credence attribute). Carbohydrate content showed positive correlation with meat weight per piece and tail length (both are search attributes), which may be a function of meat texture (an experience attribute). Consumers tend to value prawn based on observable "search" and "experience" attributes. In the process, they also indirectly value the unobservable, but more objectively measurable, nutritional attributes. However, there seems to be some difficulty in establishing such strong relationships between "search," "experience," and "credence" attributes in the literature.

[8] The correlation table is available from the author by request.

Table 3
Dummy Variables Included in the Regression

Variable[1] (1)	Frequency (%) (2)
Number of prawn pieces per kilogram	
16–35 pieces $D_{i,1,2}$ *	8
≤ 15 pieces $D_{i,1,1}$	13
36–110 pieces $D_{i,1,3}$	45
111–999 pieces $D_{i,1,4}$	28
≥ 1,000 pieces $D_{i,1,5}$	6
Protein content[2]	
< 15% $D_{i,2,2}$ *	13
≥ 15% $D_{i,2,1}$	87
Carbohydrate content[2]	
< 1.5% $D_{i,3,2}$ *	62
≥ 1.5% $D_{i,3,1}$	38
Discoloration	
Nil [scale 0, 1, 2] $D_{i,4,2}$ *	72
Present [scale 3, 4, 5] $D_{i,4,1}$	28
Mode of sale	
Wholesale $D_{i,5,2}$ *	23
Retail $D_{i,5,1}$	77
Ease of preparation	
Difficult $D_{i,6,2}$ *	17
Easy $D_{i,6,1}$	83
Store/seller type	
Farm or wet market $D_{i,7,1}$ *	49
Supermarket $D_{i,7,2}$	32
Processing plant $D_{i,7,3}$	19
Species or type[3]	
Black tiger $D_{i,8,1}$ *	30
King, green, flower tiger $D_{i,8,2}$	13
White, banana $D_{i,8,3}$	23
Freshwater $D_{i,8,4}$	4
Endeavour $D_{i,8,5}$	21
Assorted species $D_{i,8,6}$	8
Degree of freshness	
Live $D_{i,9,1}$ *	4
Chilled, raw $D_{i,9,2}$	81
Frozen $D_{i,9,3}$	8
Dried/cooked $D_{i,9,4}$	6
Product form/extent of processing	
Head-on $D_{i,10,1}$ *	68
Headless $D_{i,10,2}$	17
Headless, peeled $D_{i,10,3}$	8
Headless, breaded $D_{i,10,4}$	6
Color at purchase	
Black $D_{i,11,2}$ *	15
Orange $D_{i,11,1}$	32
White $D_{i,11,3}$	19
Grey $D_{i,11,4}$	34

Note: * Denotes benchmark category of each dummy variable.
[1] All notations follow model (1).
[2] Assumptions and approximations on desirable ranges of percentage composition of the edible portion of prawn and shrimp are based on Pearson (1970) who states that cooked prawns contain 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% to 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 carbohydrates 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%.
[3] The scientific names for the species are: black tiger, *Penaeus monodon*; king, green, flower, *P. latisulcatus*, *P. semisulcatus*, *P. esculentus*; white, banana, *P. indicus*, *P. merguiensis*; freshwater, *Macrobrachium rosenbergii*; and endeavour, *P. endeavouri*.

These correlation coefficients provide insight to the relationship between price and each product attribute, as well as relationships between all pairs of attributes.

Column 4 of table 2 presents the sample correlation between price and the continuous attributes listed in column 1. As can be seen, all the length- and weight-related variables are positively correlated with price, as expected.

Model Selection

The estimates derived from regressing price (in log form) against each quantitative variable (in log form) and qualitative variables using the prawn and shrimp data provided a basis for identifying potential explanatory variables. An attribute that is believed preferred by consumers, such as tail length ($C_{i,1}$), had a significant positive coefficient estimate, while an undesirable attribute, such as discoloration ($D_{i,4,2}$) had a significant negative coefficient estimate.

Among the continuous explanatory variables listed in table 2, only tail length is chosen because length-related attributes are more directly observable during purchase than weight-related attributes. Also, fourteen of the forty-seven prawn samples were headless. Tail length also represents all other length- and weight-related attributes, as it is highly correlated with other attributes.

Estimation of model (1) for various combinations of selected explanatory variables was performed, and the preferred model was selected based on the high proportion of significant attributes as well as minimum prediction error. Attributes that consistently produced insignificant categories were dropped. However, unique attributes, such as those representing marketing and transportation cost, remained in the model even if insignificant. Therefore, the logarithmic price was regressed against the logarithm of the continuous variable, tail length, together with all the qualitative attributes represented as dummies. The model with eleven groups of dummy variable categories showed the best results. Therefore, the log-linear hedonic price model presented in equation (1) becomes

$$\ln P_i = \alpha + \beta_1 \ln C_{i1} + \sum_{k=1}^{11} \sum_{q=1}^{m_{3k}} \gamma_{kq} D_{ikq} + \varepsilon_i, \; i = 1, 2, \ldots, 47. \tag{2}$$

As discussed earlier, to confirm the appropriateness of a log-linear model instead of a linear model, RESET was performed, and only the log-linear form was found to be satisfactory (see table 4 for the results).

Following Belsley, Kuh, and Welsh (1980, Section 3.2), we use the condition index (CI) to test for collinearity among the attributes. A general rule for weak dependency is when $5 \leq \text{CI} \leq 10$. Moderate to strong dependency is when $30 \leq \text{CI} \leq 100$. Column 2 of table 5 presents the CI for the attributes selected for the model, which range from 1 to 22.32 for 26 variables. Only one dummy variable, the grey category of the color attribute, is significant, with CI = 41.6, showing moderate dependency. Therefore, it can be concluded that, overall, the data do not indicate linear dependencies between explanatory variables, and multicollinearity is not a problem.

The Breusch-Pagan-Godfrey (BPG) heteroskedasticity test applied to equation (2) gives the observed value of the test statistic $\chi^2 = 32.3$ with 26 degrees of freedom, compared to the critical value of 38.9 at the 5% level of significance. Therefore, the null hypothesis of equal variances cannot be rejected.

Column 3 of table 5 presents the estimation results. The results show that an attribute preferred by consumers, in general, such as easy-to-prepare, has a significant positive coefficient estimate (0.39), while an undesirable attribute, such as discol-

Table 4
Results of Ramsey's Regression Specification Error Test (RESET)

Statistics	Critical Value	Functional Form	
		Linear	Log-linear
RESET(2)	$F_{0.05,1,19} = 4.38$	16.213*	0.336
RESET(3)	$F_{0.05,2,18} = 3.55$	12.575*	1.676
RESET(4)	$F_{0.05,3,17} = 3.20$	8.082*	1.898

* Significant at the 5% level.

oration has a significant negative coefficient estimate (–0.36). The F-test statistic for testing the overall utility of the model is 24.06, which is greater than the critical value of 2.85, confirming the overall significance of the estimated hedonic price model. The model, however, may be criticized for reduced degrees of freedom.[9]

Results

As can be seen from column 2 of table 5, the coefficient estimate for tail length (in log) is 1.072 and is highly significant. That is, a 1% increase in tail length would have the effect of increasing the price by 1.07%. This positive implicit price suggests that longer edible tails obtain proportionately higher prices.

Column 3 of table 5 gives the percentage impact on price due to the presence of an attribute. The number of prawn pieces per kilogram representing size significantly affects price. Large (≤15 pieces/kg) and average (36–100 pieces/kg) prawn receive significant positive implicit prices at 49% and 48%, respectively, relative to the benchmark medium-sized prawn (16–35 pieces/kg). Small shrimp, such as (111–999 pieces/kg) and (≥1,000 pieces/kg), are linked with positive, but insignificant, implicit prices. When a preferred size is unavailable, substitution may be expected across the next smaller or larger size category. Thus, the positive implicit prices suggest that all sizes are marketable in the domestic market. The model nullified the expected negative coefficient estimates for smaller sizes.

Among the nutritionally important attributes, high levels of protein (≥15% per gram) and carbohydrates (≥1.5% per gram) receive price discounts. As discussed earlier, our data showed that some unobservable "credence" attributes are related to some observable "search" and "experience" attributes (see footnote 7). However, these associations between attributes need further study.

Among organoleptic attributes, discoloration which occurs after harvest if proper temperature is not maintained, receives a significant 30% discount. This tends to suggest that producers and middlemen should prevent their products from reaching such undesirable discoloration to avoid discounts. However, there is lack of a standard defining the extent of discoloration that consumers dislike. Odor and brokenness were also evaluated, but they do not significantly affect price. Natural

[9] This is a limitation learned from this attempt. One major difficulty is the unavoidable option to use ten groups of dummy variables to represent qualitative attributes that generally characterize food products (*e.g.,* color, form). These variables further required dummy categories to capture the variation within a characteristic. In particular, implicit price of continuously measurable attributes, such as carbohydrate and protein, may not have been captured in the model had they not been scaled into dummy categories. More samples (df < 40% of N as in Belsley, Kuh, and Welsch 1980) are recommended for future studies.

Table 5
Estimation Results for the Hedonic Price Model (2)

Variables (1)	Condition Index (2)	Coefficient Estimate[1] (3)	Percentage Impact on Price[2] (4)
Constant α	1.00	4.160 (7.994)*	
Log tail length $\ln C_{i,1}$	1.51	1.072 (5.976)*	
Number of prawn pieces per kilogram			
≤ 15 pieces $D_{i,1,1}$	2.14	0.398 (2.678)**	48.88
36–110 pieces $D_{i,1,3}$	1.94	0.395 (3.081)*	48.44
111–999 pieces $D_{i,1,4}$	1.81	0.087 (0.459)	9.10
≥ 1,000 pieces $D_{i,1,5}$	1.62	0.369 (0.814)	44.66
Protein content			
≥ 15% $D_{i,2,1}$	2.28	–0.464 (–2.444)**	(37.13)
Carbohydrate content			
≥ 1.5% $D_{i,3,1}$	2.57	–0.274 (–2.753)**	(23.99)
Discoloration			
Present [scale 3, 4, 5] $D_{i,4,1}$	2.65	–0.361 (–3.704)*	(30.29)
Mode of sale			
Retail $D_{i,5,1}$	2.71	–0.348 (–2.019)	(29.40)
Ease of preparation			
Easy $D_{i,6,1}$	2.93	0.392 (3.623)*	47.98
Store/seller type			
Supermarket $D_{i,7,2}$	3.13	0.191 (1.595)	21.05
Processing plant $D_{i,7,3}$	3.82	–0.281 (–1.215)	(24.48)
Species or type[3]			
Ocean, sea, king, green, flower tiger $D_{i,8,2}$	3.95	0.602 (2.981)*	82.64
White, banana $D_{i,8,3}$	4.36	0.882 (4.039)*	141.59
Freshwater $D_{I,8,4}$	4.43	0.684 (2.556)**	98.09
Endeavour $D_{i,8,5}$	4.83	0.712 (3.943)*	103.74
Assorted species $D_{i,8,6}$	5.32	0.264 (1.565)	30.27
Degree of freshness			
Chilled, raw $D_{i,9,2}$	5.97	–0.686 (–3.443)*	(49.65)
Frozen $D_{i,9,3}$	6.66	–1.619 (–5.317)*	(80.20)
Dried/cooked $D_{i,9,4}$	7.14	–0.866 (–1.772)	(57.93)
Product form/extent of processing			
Headless $D_{i,10,2}$	9.39	–0.406 (–3.173)*	(33.40)
Headless, peeled $D_{i,10,3}$	13.36	1.159 (6.115)*	218.77
Headless, breaded $D_{i,10,4}$	14.93	1.089 (2.732)**	197.04
Color at purchase			
Orange $D_{i,11,1}$	15.95	–1.039 (–5.083)*	(64.61)
White $D_{i,11,3}$	22.32	–1.072 (–5.108)*	(65.76)
Grey $D_{i,11,4}$	41.46	–0.556 (–3.116)*	(42.68)

Sum of squared errors (SSE) = 0.696 Final prediction error (FPE) = 0.055
R^2 = 0.969 Adj R^2 = 0.929 Generalized cross validation (GCV) = 0.082
F_{mean} = 24.063 Degrees of freedom = 20 Rice (1984) criterion = –0.099

[1] In column (3), t-values are in parentheses; *Significant at 1% level; **Significant at 5% level.
[2] In column (4), figures in parentheses are negative impact or price discounts, otherwise, the figures are price premia.
[3] The scientific names for the species are: black tiger, *Penaeus monodon*; king, green, flower, *P. latisulcatus*, *P. semisulcatus*, *P. esculentus*; white, banana, *P. indicus*, *P. merguiensis*; freshwater, *Macrobrachium rosenbergii*; and endeavour, *P. endeavouri*.

seafood smell and some forms of brokenness may be acceptable among less stringent local buyers.

Easy-to-prepare prawn with fine textured shells or those that have been cleaned and prepared receive a price premium that is 48% higher than the unprepared benchmark. Shrimp with moderately textured shells are easier to behead and peel, preparation is faster, and costs are reduced for processors. Thus, harvesting during the molting stage when shells are moderately soft and difficult to detach should be avoided.

While all species are associated with positive implicit price relative to the abundant aquacultured black tiger, sea-caught banana prawn are most highly valued at a 142% price premium, followed by endeavour prawn at 104%, and freshwater prawn at 98%. Assorted species are not discounted. Banana prawn are generally harvested from off-shore deep waters and may be preferred by some buyers because of the concept of purity. The small endeavour species is common in local markets either fresh or prepared as dried, cooked, or salted paste. Freshwater prawn are not commercially preferred due to their disproportionately large head and less edible meat. They are often used in soup, and there are few other preparation options.

With live prawn as the control dummy, other levels of freshness are discounted. Freezing without value adding gets an 80% discount, while chilling and cooking/drying receive 58% and 50% discounts, respectively. For prawn and shrimp that cannot be marketed live to obtain a premium price, the alternatives are either to market them as chilled, add value by cooking, or process and prolong shelf-life by drying. Freezing is the last option. However, freezing is most practiced, as this prolongs storage at lower cost than other preservation methods.

The peeled tail shell-on or completely peeled product form, which represents substantial processing, has the highest implicit price, at 219% over the benchmark attribute, head-on shell-on. Value-added headless, breaded follows with a 197% price premium. Although the headless, shell-on form represents some processing, it is nevertheless, associated with a 33% price discount, as beheading does not substantially add desirable attribute to the product. Headless, shell-on forms are often products of downgraded head-on, shell-on forms with discoloration on the carapace, broken appendages, or drooping head.

Color significantly affects price. With natural black color as the benchmark variable, all other colors have a negative impact on price. Grey receives the lowest price discount at 43%, while white and orange obtain 66% and 65% discounts, respectively. The value placed on black-colored prawn is linked with the acceptability of black tiger species, which comprise 75% of total prawn and shrimp production in the country (BAS 1995).

Conclusion and Implications

Recognizing that attributes defining quality are among the primary determinants of prawn and shrimp prices, this paper used a hedonic price model to estimate the percent impact of various attributes on price. The model was estimated using primary price data collected from local markets in the Philippines and various measurements of length- and weight-related attributes, as well as information about product characteristics through direct observation and laboratory testing. Using various diagnostic tests, continuously measurable attributes and qualitative characteristics that significantly influence the domestic price of prawns and shrimps in the Philippines were selected as explanatory variables.

The estimation results showed that different combinations of attributes that are generally linked with the perception of quality (*i.e.*, either live, longer tails, banana species, or easy-to-clean or easy-to-prepare, ready-to-cook forms such as headless,

peeled, or breaded) have significant positive implicit prices. Attributes that reduce quality are discounted. For fresh forms, discoloration, headless, with no value added, and colors other than black are less desirable attributes in the domestic market. The discount on higher levels of protein (≥15% per gram) and carbohydrate content (≥1.5% per gram) in prawn and shrimp may be attributed to undesirability of characteristics that are associated with higher levels of protein and carbohydrate (*e.g.*, our data showed positive correlation between protein content in the dried cooked form, while carbohydrate was negatively related with moisture content. However, live or fresh, chilled prawn receives a premium compared to dried, low-moisture content forms). Nevertheless, these linkages between unobservable nutritional "credence" attributes and observable "search" attributes need further study.

The implicit prices of attributes in a domestic market of an exporting country, such as the Philippines, suggest the alternative value-adding options for producers, processors, and researchers who are interested in developing the domestic market. These implicit prices, expressed as percent impact on price created by each attribute relative to a chosen benchmark characteristic, indicated that the domestic market also values the attributes that define today's consumers' product preferences and quality standards. In the domestic market, willingness to pay for desirable attributes seems to be similar to attributes preferred in the export market. This indicates competition for the availability of desirable characteristics between the two markets. The export market may generally offer higher prices, but a comparison of the relative benefits of domestic and export trade is worth investigation. Thus, identifying consumers' demand for product attributes facilitates efficiency in resource use.

While there is a market for all sizes in the domestic setting, local consumers have a strong preference for fresh, chilled, and live forms, and discount frozen or preserved forms. Innovations to improve chilling facilities are encouraged, since chilled forms obtain higher prices than frozen. Investment in value-added forms in the Philippine domestic market offers opportunities. Technical improvements either through genetic engineering, pond management, or feed formulation may result in longer tails, bigger sizes, attractive color, and easy to remove shells, attributes for which consumers are willing to pay a premium.

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