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Investment Opportunities for the Shrimp Processing Industry in the Philippines: Results from a Hedonic Analysis

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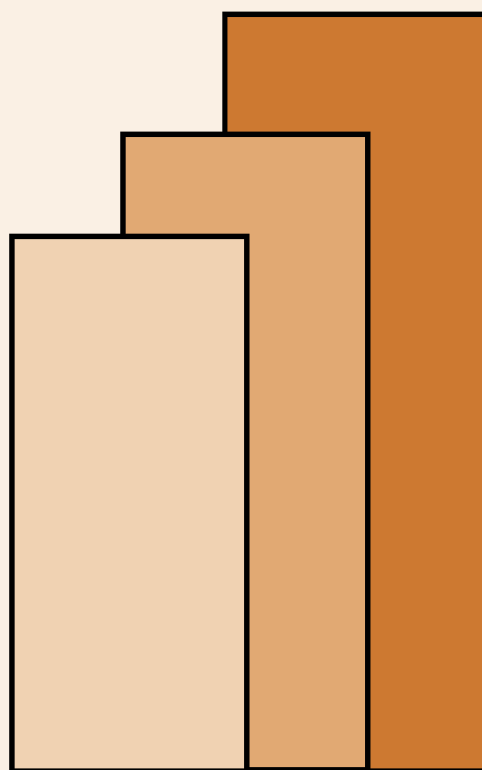
Nerissa D. Salayo

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Investment Opportunities for the Shrimp Processing Industry in the Philippines : Results from a Hedonic Analysis *

Nerissa D. Salayo

Abstract

The Philippine shrimp industry is beset with production problems arising from disease infestation. With declining production and low per capita consumption, this paper sees the opportunities from value-adding, either by enhancing the shrimp product attributes desired by domestic consumers or from reducing or eliminating the unwanted attributes. This paper used a comparative-statics analysis to estimate economic returns that form the basis for suggesting investment opportunities for the shrimp processing industry. The estimation of economic surplus applied hedonic prices of product characteristics obtained from a previous study. The range of producer and consumer gains suggests that there are broadly three groups of value-adding processes.

1. The Philippine Shrimp Industry

Shrimp is produced by the capture and aquaculture fishery sectors in the Philippines. During the peak production years from 1989 to 1994, aquaculture accounts for about 80% of total production. The remaining 20% comes from sea-capture fishery. However, the signs of a crisis in the Philippine shrimp culture industry began in 1996.

The luminous bacteria disease in shrimp started the outset of a range of diseases that become a major concern among production experts. As the disease problem gets worst, and competition with other producer-exporters such as Thailand, Indonesia, India and Vietnam grows, controlling and treating the disease did not help solve the problem of declining productivity in the aquaculture sector. Yap (1998) documented that the disease problem was, in fact, the result of a combination of factors such as poor fry quality, unsuitable practices,

* The empirical basis of this paper comes from the paper co-authored with Associate Professor T.J. Voon on *Estimating Economic Benefits for Value-Added Product Characteristics*, presented at the 42nd Annual Conference of the Australian Agricultural and Resource Economics Society (AARES), University of New England, Armidale, NSW, 19-21 January 1998 and at the 9th Biennial Conference of the International Institute of Fisheries and Economics and Trade (IIFET), Tromsø, Norway, 9-11 July 1998. Discussions on the hedonic theory and methodology are sourced from the PhD thesis of the author titled *Hedonic Prices of Product Characteristics: Evidences from the Shrimp Industry in the Asia Pacific*, submitted to Griffith University, 1999. The views expressed in this paper are those of the author and do not necessarily reflect those of the PIDS.

clogged waterways, poor water quality due to pollution, poor engineering and poor site management.

Recent data on the total shrimp production by the capture and aquaculture sectors in the Philippines shows an alarming and declining trend (Table 1). A continuously increasing trend in production only occurred from 1983 to 1990. In fact, there was a slight decline in 1987. Erratic changes began in 1991, primarily due to the variable yield from aquaculture arising from the management and disease problems mentioned earlier. The largest decline in production occurred in 1997, which is 39% lower than previous years' production.

Table 1 also shows the variable share used for export and domestic consumption. There seems to be no association between production and domestic use, or with export volume. However, on the instance where the domestic market managed with only 38% share of the total production in 1993 and with an average share of 74% during the 15-year period, it appears that in many cases, the domestic market is being offered extra quantities and qualities of what the export market cannot accept. Whether the domestic market will accept them is a question that relates to the attributes that are preferred by the domestic consumers. Thus, there are opportunities for understanding domestic preferences even when production is problematic.

Table 1. Total production of shrimp from capture and aquaculture sectors in the Philippines, and the relevant proportion of total production for export and domestic consumption¹, 1983-1997.

	Total Production (‘000 mt)	Export		Domestic consumption	
		Volume (‘000 mt)	% of Total production	Volume (‘000 mt)	% of Total production
1983	41.2	5.0	12.1	36.2	87.9
1984	53.2	6.4	12.0	46.8	88.0
1985	63.0	8.1	12.9	54.9	87.1
1986	72.3	11.2	15.5	61.1	84.5
1987	68.1	15.0	22.0	53.1	78.0
1988	79.6	23.7	29.8	55.9	70.2
1989	82.5	26.2	31.8	56.3	68.2
1990	87.0	24.1	27.7	62.9	72.3
1991	84.9	30.5	35.9	54.4	64.1
1992	118.8	23.6	19.9	95.2	80.1
1993	113.8	70.1	61.6	43.7	38.4
1994	128.3	74.8	58.3	53.5	41.7
1995	131.6	18.2	13.8	113.4	86.2
1996	127.0	19.0	14.9	108.0	85.1
1997	77.8	10.5	13.5	67.3	86.5
Average	88.6	24.4	25.4	64.2	74.3

¹ There is no explicit data on volume of domestic consumption of shrimp in the Philippines. In this analysis, domestic consumption is estimated as the difference between total production and export. Domestic use or consumption includes shrimp for direct human consumption, inputs for other production purposes, and other uses in the country. Imports of shrimp is negligible to influence volume either for domestic use or re-exports.

Source: ABD-INFOFISH 1991; BAS compilation; BFAR 1997.

The need for changes in farm management practices are often viewed as solutions to counter the problem in the aquaculture sector. Platon (1998) believes that there is still hope for the industry, but only with a total systems approach involving technology, capital, policy, and enforcement backed up by a firm resolve and political will. Yap (1998) also sees that such a complex problem in the shrimp industry requires a total approach involving the cooperation and coordination between growers, fry producers and various government agencies. However, these long-term solutions are still being organized and whose benefits are yet unforeseen.

2. Value-Adding in Shrimp Products

How could investment opportunities for the shrimp processing industry arise in such situation of declining production? The per capita consumption of shrimp in the Philippines (all types) is almost negligible at 0.5 grams (BFAR 1997). There are also rapid changes in lifestyle that increases the demand for convenience products. The desire to consume seafood is also increasing as awareness on the benefits of consuming seafood improves. These factors becomes an opportunity for the shrimp industry to promote consumption of value-added shrimp in the domestic market than pushing for competition in the lucrative export market during periods of low production and tight competition in the international market. This paper sees the opportunities from value-adding, either by enhancing the shrimp product attributes desired by domestic consumers or from reducing or eliminating the unwanted attributes. In a way, this approach deals with a management system, as proposed by Sylvia (1994) that generates increasing social benefits in spite of the declining resource supplies. Value-adding in shrimp is viewed as among the alternatives to continuously obtain benefits from declining quantities produced.

Value-adding involves processing of shrimp to increase the quantities of attributes with positive implicit prices. This generates additional value or ‘willingness to pay’ among consumers. Processing to reduce or eliminate negatively-valued attributes is also deemed as value-adding because it reduces the ‘reluctance to pay’ and therefore raises the willingness to pay. An example of value-adding is the processing of headless shrimp to breaded form which improves eating quality and the ease of preparation, and raises the willingness to pay per unit.¹

Because value-adding increases the quantities of desirable product attributes and generates additional willingness to pay among consumers, an upward shift in the ordinary demand curve results from value-adding. Previous studies on returns to quality improvement have also postulated that investments in quality-improving research in agricultural commodities may be depicted as an upward parallel shift in the demand curve for the commodity (as in Voon and

¹ It should be noted that only those shrimp of good quality are processed into breaded form, otherwise contamination, spoilage and losses are inevitable. Therefore, value-added products uses raw materials with desirable attributes and further value-adding creates another set of desirable product attributes that further increases willingness to pay among consumers.

Edwards 1992; and Unnevehr 1986). There are other value adding processes such as improved packaging and other customer-oriented services. However, this will not be dealt in this analysis. Initially, only those attributes that were identified affecting price in a hedonic model for shrimp by Salayo, *et al.* (1999) are assumed to be engineered by processors in this study.

3. Estimation of Economic Benefits Using Implicit Prices of Product Attributes

Most market-related studies of fishery products in the Philippines do not account for the benefits from such quality improvement in their analysis of productivity and profitability. Navera (1975), dela Cruz and Lizarondo (1983), Librero (1985), and Torres, *et al.* (1987) are some examples of studies where the methods of analysis have not weaned away from quantifying productivity as an increase either in quantity of harvest, income or profit among producers and traders. This paper departs from this usual point of view as the proposed measures of productivity and profitability incorporates the economic benefits from improvement of product characteristics desired by consumers.

These characteristics desired by consumers are determined using the hedonic approach to price analysis. Hedonic analysis involves the identification of a set of quality characteristics which are associated with each product, and the estimation of the implicit marginal prices which represent the amounts consumers are willing to pay for each of such characteristics.² This approach will be demonstrated in estimating gains from value-added shrimp products.

Using a hedonic price model founded on Rosen's (1974) seminal paper, Salayo, *et al.* (1999) identified the characteristics of shrimps that domestic consumers either value or abhor and the corresponding premiums and discounts that consumers are willing to pay for such characteristics. The study showed that while there is a growing demand for seafood in the burgeoning export market, estimates of the implicit prices of marketable shrimp characteristics imply that domestic consumers are also quality conscious. Thus, there is a strong demand both domestically and overseas for value-added products that meet the changing lifestyle. This, in turn, implies that investments in seafood processing and quality improvement enjoy excellent prospects of positive returns (BAS 1995 and DTI 1995).

Estimating economic benefits that incorporates the implicit prices of value-added product attributes runs complementary with current global issues that enhances competition and production efficiency. With the Philippines' accession to the World Trade Organization (WTO), there should be preparedness towards such measures of productivity. The WTO emphasises globalisation and enhances competition among producers and among traders in terms of production efficiency and product quality.

Nevertheless, the current production crisis in the shrimp industry seem to point out that before the industry aim for the highly competitive seafood international market, as it used to during the boom times, the industry could gain from expanding the barely explored domestic market for processed shrimp.

² An account of the development of hedonic analysis and how other disciplines, such as econometrics, have contributed to the growth of the hedonic literature was provided by Griliches (1990).

In view of the above argument, the purpose of this paper is to measure and compare the benefits accruable from improvements in quality characteristics of shrimp for the Philippine domestic market. In this paper, the hedonic estimates (i.e. price premiums and discounts) obtained for attributes present in value-added shrimps are used to calculate and compare the economic benefits that could be expected from changes in quality due to value-adding. In so doing, this paper assesses both the producer and consumer benefits from several important value-adding processes that either incorporate the desirable attributes or eliminate the undesirable traits (explicit or implied).

This analysis follows the traded goods model developed by Voon and Edwards (1992) for measuring economic benefits from value-adding or quality improving investments. This model provides the theoretical basis for the computation of benefits accruing to the domestic producers and consumers in an exporting country, allowing for the fact that price in the domestic market are influenced by the world market. This traded goods model is adopted because shrimps are important export products from the Philippines aside from its importance in the domestic market.³

The next section of this paper presents the benefits that may be expected from each quality-improving process. The concluding section discusses the implications of the results of this study. Detailed discussions of the theoretical basis and technical computations are presented in the technical appendices at the end of this paper. That is, Appendix A describes the supply and demand curves of the shrimp industry in the Philippines, and its suitability for being described by the traded goods model. Appendix B presents the matrix of willingness to pay for value-added attributes and the additional costs of value-adding. It also elaborates on the data and some assumptions used to demonstrate the application of the abovementioned matrix and the traded goods model in estimating economic benefits.

4. Estimates of Consumer and Producer Benefits from Value-Adding

This section shows the estimates of consumer and producer benefits from value-adding using the implicit marginal prices of marketable attributes reported in Salayo, *et al.* (1999) and applied on the Voon and Edwards' (1992) traded goods model. This procedure departs from the conventional approach which typically uses *ex-ante* nominal prices (rather than the implicit prices) in estimating gains from innovative processes. The details of the estimation are discussed in Appendix B.

Table 2 below shows the estimates of consumer and producer benefits that may be expected from each value-adding process. Overall, positive gains for both the producers and consumers are possible from nearly all the processes, except for the three processes that involve headless shell-on end-product forms. An overview of the fifteen value-adding processes in Table 2 indicates that value-adding processes can be categorised into three groups based on the trends in producer, consumer and total surplus.

³ The country ranked sixth, following the USA, among the major world exporters in 1989 until 1995 (ADB/INFOFISH 1991; also see Salayo. 1999. Chapter 3, Table 3.1).

a. Labour and technology intensive value-adding processes

The first group is comprised of labour- and technology-intensive value-adding processes coded as A, D and H through O in Table 2. The shrimp raw material comprise of head-on shell-on forms that are either processed to peeled or breaded forms and freshness is maintained either by chilling, freezing or drying/cooking. These processes tends to yield substantial positive economic gains for both the producers and the consumers. These processes produce total net gains valued in the range of 151 mpesos as in process D to 4,516 mpesos as in process N. Smaller total gains are obtained from processes that do not substantially change the product form as in process D that produces head on shell on dried shrimp, process M that produce headless frozen shrimp, and process A which maintains the head on live product form. In contract, larger total surplus are obtained from processes that produced substantial changes in product form. These includes process N that produces headless peeled frozen form, process O that produces breaded frozen form, and process J that produces headless peeled deveined form. The producers take 91% to 100% of the total benefits while the consumers obtain 0.1% to 10%.

Table 2. Prices and estimates of total surplus (TS) and corresponding proportions of consumer (CS) and producer gains (PS) arising from value-adding in shrimp in the Philippine domestic market, 1995 (surplus values in million Philippine pesos, see Appendix B for details).

Processes ¹	Price after value- adding <i>P'</i>	Value added ²	Total surplus (TS) ³	Consumer surplus (CS) as % of TS ³	Producer surplus (PS) as % of TS ³
A. Labor- and technology-intensive					
head on live (A)	398	94.51	674	35	639
head on shell on ~ head on shell on dried (D)	278	23.57	151	9	143
head on shell on ~ headless peeled cooked (H)	488	234.39	2,350	126	2,224
head on shell on ~ headless peeled frozen (I)	452	198.44	2,273	172	2,101
head on shell on ~ headless peeled dried (J)	459	205.45	3,227	321	2,906
head on shell on ~ breaded cooked (K)	483	228.72	1,531	1	1,530
head on shell on ~ breaded frozen (L)	443	188.90	1,604	72	1,533
head on shell on frozen ~ headless frozen (M)	284	60.49	514	43	471
head on shell on frozen ~ headless peeled frozen (N)	478	254.49	4,516	414	4,102
head on shell on frozen ~ breaded frozen (O)	468	244.95	3,593	288	3305
B. Moderately technology-intensive and less labor-intensive					
head on shell on ~ head on shell on cooked (B)	305	51.15	277	(11)	288
head on shell on ~ head on shell on frozen (C)	277	22.76	2	(28)	30
C. Least labor- and technology-intensive					
head on shell on ~ headless cooked (E)	290	36.20	(351)	(134)	(217)
head on shell on ~ headless frozen (F)	258	4.12	(435)	(124)	(311)
head on shell on ~ headless dried (G)	217	37.33	(580)	(130)	(450)

¹ Letters in parentheses () refers to the process codes as in Table B-1 in Appendix B. Process codes A to O are used to simplify its frequent mention in the discussions. The product form and level of freshness of the raw material for processing comes before the ~ mark, while the form and level of freshness of the value-added or end-product comes after the ~ mark.

² Value added refers to the price of the final product less the price before the value-adding process. Table B-1 in Appendix B shows that the price before value adding of head on shell on live shrimp is 303.58 pesos/kg, head on shell chilled shrimp is 254 pesos/kg and head on shell on frozen is 224 pesos/kg.

³ Values in parentheses indicate economic losses.

b. Moderately technology-intensive and less labour-intensive processes

Processes B and C comprise the second group where the product form remains as head on shell-on and value-adding is only through maintaining freshness in various stages such as chilling, freezing and drying/cooking. In this intermediate group of value-adding processes which uses moderate level of technology and less labour, the producers take all of the total benefits from value-adding while while the consumers incur losses. That is, the producers are taking positive gains ranging from 30 to 288 mpesos while consumers obtain negative returns estimated at 11 to 28 mpesos.

c. Least labour- and technology-intensive processes

The third group consist of head-on shell-on forms that are beheaded to produce headless chilled, frozen and dried/cooked forms. These processes are least labour-intensive value-adding processes coded as E, F and G in Table 2. The total benefits are negative and both the producers and consumers are losing. The total losses range from 351 mpesos, obtained from process E that produces headless cooked shrimp, to 580 mpesos from process G that produces headless dried form. The producer losses are larger at 62 to 78% while consumers account for 32 to 42% of the loss from such processes.

5. Conclusion and Implications

This paper shows a comparative-static estimation of the economic benefits arising from the processes suggested by a previous hedonic price estimation. Fifteen such processes were considered, and estimates were obtained for producer, consumer and total gains from each process. The results suggest that there are broadly three groups of value-adding processes.

These three group includes (a) the labour- and technology-intensive value-adding processes; (b) the moderately technology-intensive and less labour-using processes; and (c) the least labour- and technology-intensive processes.

The differences in increases in cost, and in the final prices received for the value-added products, explain the above outcomes. For example, while chilling typically involves the highest increases in cost, there is usually sufficient willingness to pay commensurately higher prices for chilled forms. By contrast, the marginal increases in cost involved to produce dried/cooked forms are quite small, but correspondingly the prices offered for dried/cooked forms are also not very high. Freezing increases costs only moderately, but in many cases, frozen forms yield the lowest prices compared with both the chilled and dried/cooked forms, due to a relatively low willingness to pay for attributes of frozen products. A lower-cost chilling technology would be very much welcome, in view of the higher willingness to pay, as reflected in the higher final prices offered, for chilled products.

Overall, these results suggest that labour- and technology-intensive value-adding processes should be encouraged, as they tend to produce large positive total gains. By contrast, both consumers and producers are expected to lose from the least labour-intensive value-adding processes such as the freezing and chilling of headless forms, initially from whole forms, without further value adding. Labour-using value-added processes are therefore recommended considering the relatively low cost of labour in the fish processing industry in the Philippines and other Asian exporters. Manually processed peeled and breaded products are also to be preferred for more consistent quality compared with those produced using machines.

Technical Appendices

Appendix A: The Traded Goods Model

This Appendix discusses the Voon and Edwards traded goods model used in the estimation of economic benefits from value-adding in shrimp products for the Philippine domestic market. The model assumes that an increase in quality occurs in all production within a market segment and the product before and after the quality change is homogeneous.⁴ In the estimation procedure, the analysis maintains the above assumption of the traded goods model for each value-adding process applied on a homogeneous product sample i instead of applying the model to analyse the country's shrimp industry where the market is dubbed as heterogeneous. That is, quality improvement occurs with each value-adding process in all samples of its product group. The producer and consumer gains from each quality-improving process are modeled in Figure A-1 below.

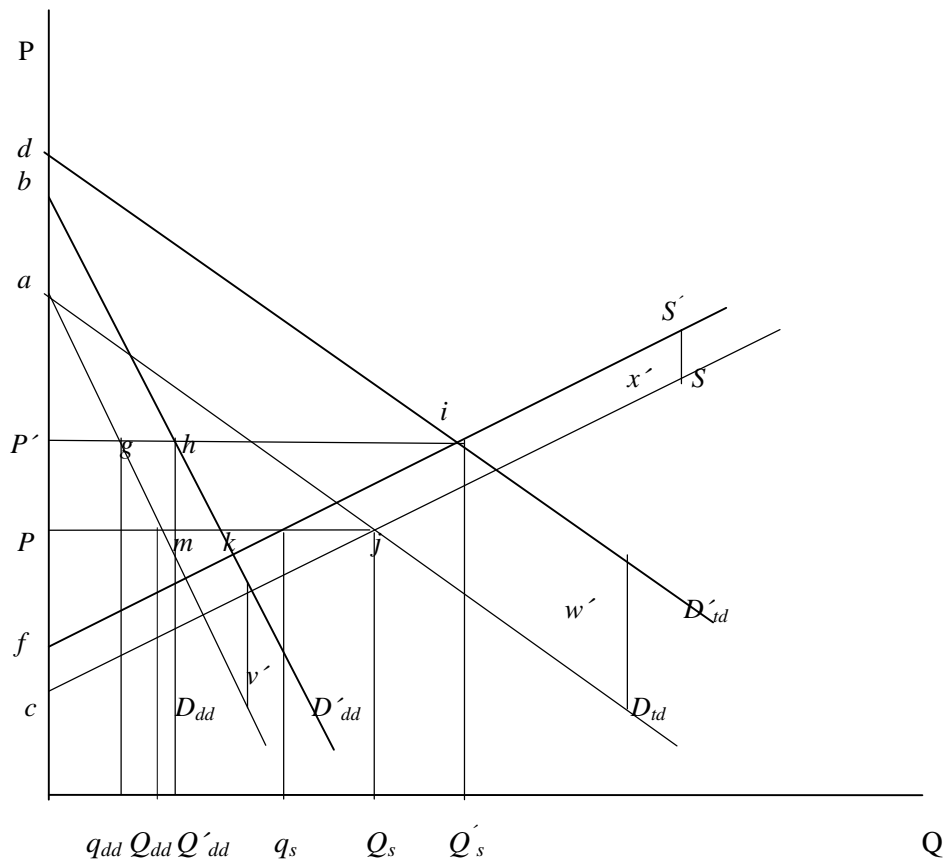


Figure A-11. Changes in producer and consumer surplus in an exporting country arising from investments in a process that produces value-added products.

⁴ Note that there is homogeneity of product attributes within a sample, and this should not be confused with the overall product heterogeneity in the domestic market for shrimp.

To demonstrate the application of the traded goods model which may use marginal implicit price estimates for computing the economic benefits, we begin by defining the variables and their relationships. In the empirical estimation of the hedonic price model for shrimp by Salayo, *et al.* (1999), the purchase price P_i of shrimp is a function of its characteristic z_i , that is,

$$(1) \quad P_i = f(z_i) \quad i = 1, \dots, n \text{ shrimp samples}$$

where z_i s comprise a set of continuously measurable and qualitative characteristics such as tail length, number of pieces per kilogram or size, color, discoloration, species, degree of freshness, ease of preparation, product form or extent of processing, carbohydrate content and protein content, mode of sale and store or seller type. These attributes, especially the observable ones, influence the domestic consumers' on-the-spot purchase decision. The unobservable attributes such as carbohydrate content and protein content influence price and purchase decision as consumers recognize the nutritional benefits from consuming shrimps. These kinds of attributes whose influences may or may not be determined after its consumption are called the 'credence' qualities of goods (Wills and Harris 1994).⁵

The estimated hedonic price model for shrimp in the Philippine domestic market show that different combinations of attributes that are generally linked with the concept of quality have significant positive implicit prices or premium. For example, it is estimated that a 1% increase in tail length would fetch a 1.1% premium. Similarly, shrimp size is found to affect price. Relative to a medium-sized shrimp (16-35 pieces/kg), the large size (≤ 15 pieces/kg) attracts a 49% premium. Other characteristics that fetch premium are banana species (142%), being easy to clean or prepare (48%), ready to cook forms such as headless peeled (219%) and breaded form (197%). The details of the percentage impact of the presence of an attribute on price relative to a chosen benchmark are discussed in Salayo, *et al.* (1999). These percentage impacts are either the corresponding premiums or discounts associated with any one of the desirable or the unwanted product characteristics.

Considering product Z , such as shrimp, with attributes z_i s, the simplified hedonic price function for sample i of product Z is

$$(2) \quad P_{zi} = \alpha \pm \sum g_i$$

where α is the constant which represents the aggregated price of all benchmark attributes in a hedonic price model, while g is the marginal implicit price of each attribute equal to $\frac{dP_{z_i}}{dz_i}$.

The domestic demand for product Z without the value-added attribute is

$$(3) \quad Q_{Z_i}^{dd} = a_0 - c_0 P_{Z_i}$$

⁵ The case of seafood is different with other processed and labelled food products (e.g. milk, breakfast cereals) where consumers have been made aware of the nutrient component analysis which are possibly influencing price (Lenz, *et al.* 1994, Stanley 1991, and Stanley and Tschirhart 1991). It has long been reported in consumer surveys (e.g. Heimbach 1979) that nutritional information will be used if they were available. Thus, the emergence of labels in food products (such as nutrient content label in milk; certification of leanness and fat content in beef and pork).

where a_0 is the constant of the domestic demand curve and c_0 is the slope. The total demand curve for product Z without the value-added attributes is

$$(4) \quad \underline{Q_{Z_i}^{td} = a_0 - d_0 P_{Z_i} .}$$

Total demand comprises the domestic and export demand. Similarly, a_0 and d_0 are the constant and slope of the total demand equation. As in the traded goods model, this study also assumes a common intercept a_0 for the domestic and total demand functions of the product Z without value-added attributes. The supply function in the absence of the quality improvement is

$$(5) \quad \underline{Q_{Z_i}^S = c_0 + b_0 P_{Z_i}}$$

where c_0 is the constant of the supply curve and b_0 is the slope.

Figure A-1 above shows the model for evaluating the economic benefits from investing in value-adding of attributes that generate positive marginal implicit price or those that reduce or eliminate the negatively-valued product characteristics. A parallel shift in domestic demand from D_{dd} to D'_{dd} is assumed when there is no corresponding change in the willingness to pay at different quantity levels.

The extent of the parallel shift in domestic demand, such as v' in Figure A-1, varies with the amount of 'value' added to the product. Therefore, v' is the difference between the sum of the implicit prices between the initial product (v_1) and the end-product form (v_2). Intuitively, the consumer response to such improvement added to the end-product form manifests in their 'additional willingness to pay' for the same amount Q of commodity Z. Each Z contains more units of positively-valued attribute z_i and less of negatively valued z_i due to value-adding. However, a change in the price elasticity of domestic demand, and consequently, of total demand for the product cannot be assumed away since value-adding, as suggested by the marginal implicit prices estimated from a hedonic model, implies changes in the marginal willingness to pay curve for the desirable attribute. This topic comprises another study and will not be dealt with in this paper.⁶

Similarly, a parallel shift in the total demand curve is expected due to value-adding as consumers in both the domestic and export markets will express willingness to pay a higher price for the additional desirable attribute or a reduction of the undesirable traits. After value-adding, the total demand curve for shrimp becomes D'_{td} or $\underline{Q_{Z_i}^{td'} = d - d_1 P_{Z_i}}$, representing a shift of w' per unit output, where $w' = (d - a)$ as shown in Figure A-1.

On the supply side, value-adding in shrimp is labour, technology and capital intensive (in different intensities according to process) and is likely to increase unit cost. Figure A-1 also shows that a cost-increasing process shifts the supply curve parallel to the left, from S to S' .

⁶ Studies such as Duncan and Tisdell (1971) and Lindner and Jarret (1978) demonstrate the cases of various extents of gains from innovations depending on the nature of the supply shift. Voon and Edwards (1991) extended this analysis to include linear and nonlinear demand and supply shifts. Note, however, that Pearce (1983) and Willig (1976) discussed the overestimations in consumer surplus with such parallel shift compared with the Hicksian compensated demand curve.

The supply curve of the value-added commodity is $Q_{Z_i}^{S'} = f + b_1 P_{Z_i}$, where f is the new constant ($f = c + x'$, where x' is the increase in marginal processing cost). The slope remains as b_0 .

The supply curves before and after value-adding is relatively elastic because inputs for value-adding, which are mainly labour, machinery, packaging and storage equipment, can readily be allocated to other processes, and *vice-versa*, as the market requires. On the production aspect, supply is relatively inelastic as there is considerable time lag in aquaculture production and inputs such as growing ponds and feeds are more species specific. Also, there are resource renewability factors to consider in capture shrimp fishery. Since this analysis deals with value-adding processes, there is sufficient time to change allocation of inputs and other resources for processing of qualities and quantities desired by the market. Therefore, the supply curve for processed seafood products such as shrimp is relatively elastic.

Although the demand curve for fishery food commodities in general is relatively elastic, shrimp has less elastic demand especially in the domestic market, being gourmet food and not an inferior good (Jolly and Clonts 1993). There is also an increasing global preference for seafood over other meat products due to recent health issues. In comparison, excess demand, as shown in Figure A-1, is more elastic because there is multitude of substitute for the traded shrimp in the export market from various sources and in various product forms.

The benefits accruable from the value-adding processes could be estimated following the supply and demand changes illustrated in Figure A-1. At the initial equilibrium, that is before value-adding, price is P and quantity demanded in the domestic market is Q_{dd} , where D_{dd} , D_{td} and S prevail. Total quantity supplied is Q_s , where $Q_s - Q_{dd} = Q_{ed}$ is taken by the export market. The domestic consumer surplus (CS) is represented by area amP while producer surplus (PS) is Pjc . With investment in value-adding, processing cost increases by x' . The relevant supply curve with value-adding is S' , domestic demand is D'_{dd} and total demand is D'_{td} . The equilibrium quantity demanded in the domestic market increased to Q'_{dd} and the quantity demanded by the export market is $Q'_s - Q'_{dd} = Q'_{ed}$ offered at a higher price P' . The domestic consumers' surplus (CS') due to value-adding becomes bhP' while producer surplus (PS') is $P'if$. The change in domestic consumers' surplus (ΔCS) is equal to area $bhga$ less $P'gmP$ while the change in producer surplus (ΔPS) is equal to area $P'ikP$ less $fkjc$. The overall benefit from processing (ΔTS) is ΔCS and ΔPS combined.

Appendix B: Data, Assumptions and the Estimation of Benefits from Value-Adding

This technical appendix introduces a matrix of value-adding costs (x) and of the domestic marginal willingness to pay or the sum of the implicit prices (v) of all attributes in a particular product involved in a value-adding process (Figure B-1). The matrix also shows the hedonic ranking of selected combinations of shrimp attributes desired by consumers. The hedonic rank (HR) is based on the price of a set of attributes valued by consumers, where rank 1 is assigned to the highest v and rank 12 means lowest v .

For a highly perishable food product such as shrimp, there is a multitude of possible combinations of shrimp attributes, which could be altered to add value to this product. Figure B-1 focuses on comparing the aggregate effects of changes in degree of freshness and product form on price, while holding tail length, species and other attributes constant. The degree of freshness plotted in the vertical axis of Figure B-1, and product form in the horizontal axis are the likely attributes to be engineered by food processors to add value to the product.

In Figure B-1, the sum of implicit prices (v) range from 147.64, with rank 12 for headless dried shrimp, to 454.92 with rank 1 for chilled raw peeled shrimp. This wide range of v values indicates substantial differences in consumers' marginal willingness to pay for alternative sets of product attributes that manifest either value-adding or quality-improvement, or both. Hence, a change in the overall demand for shrimp with specific set of attributes occurs. For example, a one percent increase in the sum of implicit prices (v) corresponds to a one unit or peso increase in the price of the value-added product.

Cost	F r e s h n e s s	Live	$v = 303.58$ HR = (6) $x = 0.4$	Not applicable	not applicable	not applicable
		Chilled raw	253.93 (7) 0.3	220.53 (10) 0.6	454.92 (1) 0.9	433.19 (3) 1.2
		Frozen	223.38 (9) 0.2	189.98 (11) 0.4	424.37 (4) 0.6	402.64 (5) 0.8
		Dried/cooked	229.02 (8) 0.1	147.64 (12) 0.2	447.79 (2) 0.3	not applicable
			Head-on Shell-on	Headless	Peeled	Breaded
		Product Form				
0	Cost					

Figure B-1. Sum of implicit prices (v), hedonic ranking (HR) and increase in marginal cost (x) of value-added shrimp products with various combinations of levels of freshness and product forms, other attributes are held constant.

The absence of published data on cost associated with various value-adding processes, becomes one of the limitations of this study. For the purpose of analysis, we assume a 10 percent increase in cost for every rightward or upward movement in the hedonic matrix⁷ in Figure B-1. For example, processing headless shell-on dried cooked shrimp from head-on shell-on raw shrimp will involve 20 percent additional cost. Similarly, processing chilled raw breaded form from chilled headless form will require 60 percent additional cost (that is, 1.2 less 0.6). For consistency, we also assume that a percent increase in cost corresponds to a unit or peso increase in processing cost. Hence, a 60% increase in cost is 60 cents increase per peso of the actual processing cost.

Given such estimates of processing costs x and the sum of implicit prices of all attributes denoted as v for domestic consumers, and w for world consumers, and the interplay between the demand and supply functions due to value-adding, the equilibrium price P' and quantities Q'_{dd} , Q'_{id} and the producer and consumer benefits from value-added products could be derived following the Voon and Edwards formulae.

Rational processors will only be motivated to engage in higher cost investments (i.e. a parallel leftward shift in the supply curve), if a sufficiently compensating shift in the demand curve may be expected. A sufficient shift in demand is one which compensates the increase in cost. That is, in cases where v' and w' are larger than x' . Voon and Edwards (1992) performed a simulation showing that both producer surplus and total surplus can increase as the ratio between the increase in production cost (or shift in supply) and relevant increase in total demand decreases. However, this condition is not common given that both supply and demand are only relatively elastic for fishery products and that the increase in cost due to value-adding shifts the supply curve upward.⁸ Thus, many cases in the literature demonstrated that the supply and demand equilibrium with value-adding is characterised by a small increase in Q' and substantial increase in P' especially that the equilibrium is likely to occur at the upper inelastic segment of the demand curve. The analysis in this paper is relevant to investors in cost-increasing but highly desired value-adding processes.

Some assumptions are necessary in order to demonstrate the application of the traded goods model using the sum of implicit price (v) estimates obtained from hedonic price models. First, the initial quantity (denoted Q_s in Figure A-1 in Appendix A) allocated for value-adding is set at 10 thousand metric tons for each process, which is about 8% of the average annual shrimp production in the Philippines. This is based on an assumption that 92% of the total produce, or part of it, is processed into other forms or are directly marketed without processing - the prevailing general condition in many domestic rural markets. Processing 8% of the total produce is within the capacity of existing established factories.

⁷ Actual processing cost including labour, materials and wastage increases as product form changes from head-on shell-on form, designated at the left bottom corner of the matrix, to breaded form, at the right hand end of the matrix. Similarly, processing cost also increases as freshness varies from dried/cooked form, at the left bottom of the matrix, to live form at the top left of the matrix.

⁸ This is the reverse of the cases considered in many studies where the supply shifts to the right due to the impact of research and technology that decreases per unit cost, or increases product value (eg. Voon 1991). A rightward shift of the supply curve, together with the increase in D'_{id} , often guarantee an increase of domestic consumers' and producers' surplus.

Domestic demand before value adding Q_{dd} is 7.3 thousand metric tons which is set at 73% of the initial quantity Q_s . The domestic market consumes approximately 73% of the country's total shrimp production and the remaining 27% goes to the export market (Salayo 1999). Therefore, excess demand before value adding Q_{ed} is 2.7 thousand metric tons which is 27% of 10 thousand mt, the initial quantity Q_s allocated for each value-adding process.

The shrimp price before value-adding are denoted by P . For example, process L, which involves processing breaded frozen forms, uses inputs such as chilled head-on shell-on forms valued at 253.93 pesos/kg. However, for processes using frozen head-on shell-on form such as processes M, N and O, P_0 is equal to 223.38 pesos/kg. In particular, see column 4 of Table B-1 in Appendix B, for the chilled head-on shell-on form with hedonic rank 7 and column 5 for frozen head-on shell-on form with hedonic rank 9. The computations of these implicit prices are detailed in Salayo, *et al.* (1999).

The price elasticity of domestic demand (η_{id}) for unprocessed shrimp in Southern Luzon region which include Metro Manila, the study area, is 1.5 (ACIAR 1996). For frozen form, it is assumed slightly more elastic at 1.7 due to longer storage period. The price elasticity of total demand (e) was estimated at 3.0 considering the multitude of substitutes in terms of product form and sources in the world market. The elasticity of supply of value-added products was estimated at 1.9 recognising that inputs for value-adding are easily allocated to other processes as discussed in the previous section. This assumption was also based on a comparison with the elasticity of supply of unprocessed forms at 0.9 in Southern Luzon region which include Metro Manila (ACIAR 1996).

The vertical shift in domestic demand (v') is obtained from the difference between the sum of the implicit prices of the characteristics that comprise the initial product (v_1) and sum of the implicit prices of the characteristics of the final product (v_2). The marginal implicit price was also adjusted for a set of benchmark attributes relevant either to unalive head-on shell-on form or head-on shell-on frozen form, the raw material for each process. Meanwhile, the vertical shift in excess demand (w') is estimated as 30% more than v' since consumers in major shrimp importing countries, such as Japan and the USA, generally have greater preference for value-added forms and have higher disposable income than the domestic consumers in the Philippines. The vertical shift in supply (x') varies with each value-adding process as shown in Table B-1 below. The values of x' are derived from the matrix of increases in marginal cost illustrated earlier in Figure B-1, also in this Appendix.

Considering the traded goods model and the above assumptions that will allow the use of the matrix of value-adding costs (x) and of the domestic marginal willingness to pay or the sum of the implicit prices (v) of all attributes in a particular product involved in a value-adding process, we evaluate each process to better understand its potential economic benefit.

The preparation of live shrimp for sale in the domestic market, called process A in Table 2 in the main text of this paper and in Table B-1 in this Appendix, is estimated to obtain 674 million Philippine pesos (henceforth called mpesos) worth of benefits to producers and consumers. Figure B-1 in this Appendix shows that the increase in cost involved in the preparation for live marketing of seafood $x'=40$ is reasonably higher than frozen $x'=20$ and chilled forms $x'=30$. Nevertheless, relative to an unalive head-on shell-on form as benchmark, the market is willing to pay more for live product form. The additional willingness to pay for attributes is designated as the vertical shift in domestic demand at $v'=99.3$. The price of live

Appendix Table B-1 Estimates of consumer (CS), producer (PS) and total surplus (TS) arising from value-adding in shrimp in the Philippine domestic market, 1995 (surplus values in million Philippine pesos)

Process Code ¹	Price before value- adding P	Price elasticity of domestic demand h_{dd}	Price elasticity of total demand h_{td}	Elasticity of supply of the value- added products e	Vertical shift in domestic demand v'	Vertical shift in excess demand w'	Vertical shift in supply x'	Price after value- adding P'	Total quantity supplied Q'_s	Domestic demand Q'_{dd}	Consumer surplus CS	Producer surplus PS	Total surplus TS
A - hoso-live	303.58	1.5	3	1.9	99.3	129	40	398.09	13,414	7,535	35.3	638.6	673.8
B - hoso ~ hoso/c	253.93	1.5	3	1.9	49.65	65	30	305.08	11,582	7,211	-10.9	288.2	277.4
C - hoso ~ hoso/f	253.93	1.5	3	1.9	19.10	25	20	276.89	10,221	7,072	-27.7	29.9	2.2
D - hoso ~ hoso/d	253.93	1.5	3	1.9	24.74	32	10	277.50	11,015	7,369	8.6	142.6	151.2
E - hoso ~ hl/c	253.93	1.5	3	1.9	16.25	21	60	290.13	8,219	6,122	-133.9	-216.8	-350.7
F - hoso ~ hl/f	253.93	1.5	3	1.9	-14.30	-19	40	258.06	7,316	6,211	-124.5	-310.6	-435.1
G - hoso ~ hl/d	253.93	1.5	3	1.9	-56.64	-74	20	216.60	5,711	6,159	-130.0	-450.3	-580.3
H - hoso ~ hlp/c	253.93	1.5	3	1.9	250.64	326	90	488.32	20,803	8,260	126.4	2,223.8	2,350.3
I - hoso ~ hlp/f	253.93	1.5	3	1.9	220.09	286	60	452.37	20,358	8,579	171.9	2,101.4	2,273.3
J - hoso ~ hlp/d	253.93	1.5	3	1.9	243.51	317	30	459.38	23,128	9,548	320.6	2,906.1	3,226.7
K - hoso ~ b/c	253.93	1.5	3	1.9	228.91	298	120	482.65	18,135	7,311	1.4	1,529.5	1,530.8
L - hoso ~ b/f	253.93	1.5	3	1.9	198.36	258	80	442.83	18,148	7,859	71.7	1,532.6	1,604.4
M - hoso/f ~ hl/f	223.38	1.7	3	1.9	65.90	86	20	283.87	13,420	7,733	42.8	470.8	513.6
N - hoso/f ~ hlp/f	223.38	1.7	3	1.9	300.29	390	40	477.87	28,248	10,784	413.9	4,102.5	4,516.4
O - hoso/f ~ b/f	223.38	1.7	3	1.9	278.56	362	60	468.33	25,736	9,856	288.1	3,305.1	3,593.2

¹ Each process is coded with a letter from A to O to simplify its frequent mention in the discussions. The second 'term' (eg. hoso/f) refers to the form of the raw material for processing. The third term that follows the ~ mark (eg. ~ hoso/c) refers to the form and level of freshness of the value-added or end-product.

Definition of process codes: hoso: head-on shell-on, hl: headless shell-on, hlp: headless peeled, c: chilled, f: frozen, d: dried/cooked, and b: breaded.

produce is higher at $P'=398$ which compensates for the increase in marginal production cost, hence, there is positive total gains.

About 277 mpesos worth of total benefits can be obtained from process B which involve processing head-on shell-on to chilled raw form. The total benefit is lower in process B than in process A because the willingness to pay for chilled form at $v'=49.65$ is less than live form at $v'=99.3$. Also, the relative difference in the shift in domestic demand v' does not compensate for the lower cost of chilling at $x'=30$ against live marketing at $x'=40$.

Smaller total gains of 2.18 mpesos was recorded for process C since consumers do not highly value frozen head-on shell-on form, with $v'=19.10$, perceived as not as fresh as live and chilled forms. In contrast, process D showed 151 mpesos total gains since consumers value dried/cooked forms more because the product is ready for consumption. There is substantial value added on cooked form and there is some willingness to pay for additional charges for the product quantified at $v'=24.74$. The increase in cost involved with cooking, $x'=10$, in a labour-abundant market as the Philippines is not as much as the increase in cost of preparation for marketing of live, frozen or chilled forms. Hence, the benefits to producers and consumers are high for dried/cooked products. Therefore, for less intensive value-adding processes such as B, C and D, highest total gains can be obtained from chilling (277 mpesos), followed by drying/cooking (151 mpesos) and least from freezing of head-on shell-on forms (2.2 mpesos). Note, however, that consumers obtain positive gains from drying/cooking of head-on shell-on forms but they get negative returns from chilling and freezing. Meanwhile, producers take large proportions of the returns.

As mentioned earlier, processes E, F and G are less intensive value-adding procedures where head-on shell-on forms are beheaded to produce either headless chilled raw, frozen or dried cooked. These three processes recorded negative total gains attributing to the negative values of v' and w' that represent the vertical shifts in domestic and excess demand, except in process E. Negative shift in demand suggests that the final product form is less preferred than the initial form and there is negative willingness to pay for the added attribute. Furthermore, the increase in cost x' is higher than processes B, C and D due to additional cost of beheading the product. Although the price P' of the final product is higher than the initial form, except the headless dried form, P' is relatively lower than those from processes B, C and D.

Also among processes E, F and G, the least loss is recorded for headless chilled form (351 mpesos), followed by headless frozen (435 mpesos) and dried/cooked form (580 mpesos). Notice that the price P' of any value-added chilled form (290 pesos/kg), holding other attributes constant, is highest, followed by the frozen form (258 pesos/kg) and lastly, by the dried/cooked form (217 pesos/kg). There is also a positive willingness to pay for chilled form indicated by positive v' and w' coefficients for process E but not for processes F and G. The headless end-products of these three processes were called a downgrade of processes B, C and D. Nevertheless, these headless forms were often resorted to because greater losses due to spoilage may occur if beheading is not done. The head is the first to show signs of deterioration either by drooping or having discolourations once harvested, and not handled properly and kept in appropriate temperature.

The benefits from the preparation of head-on shell-on form into various highly value-added peeled forms through processes H, I and J showed a different trend. Among these three, the total benefit from process J which produces peeled dried/cooked form is highest at 3,227 mpesos, followed by process H (producing peeled chilled raw) which obtained 2,350 mpesos total gains, and process I (peeled frozen) showed 2,273 mpesos. The differences in increase in cost and the relative final prices received for the value-added product explain this pattern.

However, for breaded forms produced from processes K and L, the former which produces chilled breaded form generated lower total benefit at 1,531 mpesos compared with the breaded frozen form at 1,604 mpesos. This is different from all other cases where chilling always obtain higher gains than freezing, especially that the final price P' of chilled forms is always higher than frozen forms. In this case, the increase in cost $x'=120$ is highest for process K among all processes and could offset the higher willingness to pay for breaded chilled forms ($v'=229$) than process L where is $x'=80$ and $v'=198$. The need to reduce the cost of process K is, therefore, important as it may further improve the benefits associated with higher willingness to pay for value-added attributes in breaded chilled form.

Processes such as M, N and O use frozen head-on shell-on inputs, whose initial implicit price $P=223$ is lower than fresh head-on shell-on forms at $P=254$. To produce various frozen value-added forms either as headless, peeled and breaded forms, the highest benefit can be expected from process N with peeled frozen forms at 4,516 mpesos, followed by the breaded frozen form at 3,593 mpesos, and least with headless frozen form at 513 mpesos. Between processes N and O, there is lower cost associated with producing peeled frozen form at $x'=40$ than breaded frozen with $x'=60$, yet there is slightly more willingness to pay for peeled form at $v'=300$ than for breaded frozen form with $v'=279$. Consequently, the final price P' for peeled form is 478 pesos/kg, which is higher than for breaded form at 468 pesos/kg. We also note that process N is both less labour and technology intensive than process O. There remains an abundance of household labour in the Philippines such that breaded forms are not really desired by many, if they have to pay a higher price.

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