The Australian Journal of
Agricultural and Resource Economics
Journal of the Australian Agricultural and Resource Economics Society

The Australian Journal of Agricultural and Resource Economics, 52, pp. 321–338

Demand for fish in Asia: a cross-country analysis*

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Fish demand patterns in nine Asian countries were investigated using a multistage budgeting framework allowing a disaggregated approach to analysing fish consumption. This paper highlights the heterogeneity of fisheries products in terms of species, sources and cultural responses of consumers, factors that are important in fish demand under the Asian setting. Specifically, fish demand by income groups were compared to determine how the low- and high-income households respond to price and income changes. Results showed that the estimated price and income elasticities of all fish types included in the study were relatively more elastic among the poorer households.

Key words: Asia, fish demand, inverse Mills ratio, multistage budgeting framework, price and income elasticity, quadratic AIDS model.

1. Introduction

Fish is an important economic commodity in Asia. About 61 per cent of the world supply of fish comes from this region where a large proportion of it is

* The authors wish to acknowledge the financial support from Asian Development Bank and the WorldFish Center for the conduct of this study. Special thanks are accorded to Mr Ferdinand J. Paraguas, Ms Sheryl M. Navarez and Ms Oai Li Chen for their excellent research support and Dr Rhoelano Briones for his insightful comments about the model specification.

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doi: 10.1111/j.1467-8489.2008.00418.x

consumed domestically. Per capita consumption in Asia averaged to about 27 kg annually, which is higher than the world's average of 18 kg. Across the region, per capita consumption varies significantly ranging from 63 kg/year in the case of Japan (Delgado *et al*. 2003) to only 4.5 kg/year in India where only one-third of the population are fish-eaters (Dey *et al*. 2005). The growth in fish consumption in Asia over the last decade had been increasing at notable rates. A large part of this increase was attributed mainly to population growth, urbanisation and expansion in per capita income that are currently being experienced in the region.

Responses of fish demand to changes in prices and incomes are important in analysing the effects of any technological change, infrastructure development or economic policy on future production, consumption and trade of various fisheries products. While many past researches on fish demand have treated fish as a single commodity in the consumer food basket, recent studies have evolved into more disaggregated analyses (Wessells and Wilen 1993; Dey 2000; Garcia *et al*. 2005). The intention is to capture short-term responses of species-specific markets to price and non-price factors, a feature that does not lend easily from using aggregated data.

Since the market for fishery products is rapidly gaining competitiveness both at the domestic and international scene, more detailed and disaggregated market analyses are often needed due to the following reasons: (i) fish generally come from different production environments, that is, aquaculture vs. capture and freshwater vs. marine fisheries; (ii) fish preferences vary according to type of consumers, that is, rural vs. urban consumers, and poor vs. non-poor households; and (iii) fish trade is often differentiated according to market destinations, that is, domestic vs. international channels. The effect of these factors are often useful to stakeholders in the fishery sector, for example, fishermen, fish farmers, traders and consumers, in assessing market sensitivity to new developments in the sector. For example, as the role of Asian aquaculture becomes more important in the global supply of fish, the market responses of various aquaculture species grown in the region have important implications in technology development, species selection, welfare effects (in terms of consumption and livelihood); and foreign exchange earnings.

The present study aims to address the need to recognise fish as a heterogeneous product especially in analysing market structure and policy effectiveness in the fishery sector. This is particularly important in Asia, since unlike in many western and developed countries where processed and value-added fish products are popular, consumers in the region generally prefer whole and live fish including choice-cuts like head, belly, roe, etc. Often, consumer preference is based on fish characteristics such as size, freshness, colour, flesh quality and taste. However, existing demand studies in Asia have mostly treated fish as a single commodity. Sadly such an approach obscures the tremendous heterogeneity of fishery products in terms of fish types/species, production source and consumer preferences, thus blunting the usefulness of most demand analyses pertaining to the sector.

This study is focused on the estimation of demand price and income elasticities for major fish groups that are commonly found in Asia. In this paper, the term 'fish' refers to finfish (both fresh and processed) and non-finfish, for example, shrimps, crabs, bi-valves, squids and other aquatic products. Section 2 of the paper is devoted to the model used in the analysis. Section 3 discusses the cross-country comparison of consumption and the estimated own-price and income elasticities for various fish types derived from the empirical demand model. Furthermore, this section is focused on how the elasticity estimates behaved at different levels of household income. The final section presents some policy implications of the results of the study.

2. Model and estimation procedure

A multistage budgeting framework was used in this paper to model the fish consumption behaviour of Asian households. The study built on the framework used by Deaton and Muellbauer (1980), Blundell *et al.* (1993) and Heien and Wessells (1990) which extended the idea of exhaustive expenditure system to different levels or stages. Specifically, the present model was similar to the approach employed by Dey (2000) and Garcia *et al.* (2005) in their earlier fish demand studies for Bangladesh and Philippines, respectively. These two papers were largely instrumental in the development of the current study.

The multistage budgeting technique addresses a common problem in empirical estimation of system demand models requiring a sizeable number of equations, given the wide variety of consumption goods jointly purchased by households (Thomas 1987; Blundell *et al.* 1993; Mustapha *et al.* 1994; Fan *et al.* 1995; Tiffin and Tiffin 1999). Specifically, a full demand system containing all consumer goods warrants a huge number of own- and cross-price parameters that are impractical to estimate under the constraint of limited data. Hence, the solution is to estimate the model in stages, whereby expenditures on goods belonging to broad food categories are incorporated in the model by estimating them sequentially.

In this study, a three-stage budgeting framework was adopted to enable the specification of a fish demand system in the final stage that is species-specific, while keeping the number of equations in the demand system manageable. Per capita expenditure functions (for food and subsequently for fish) were specified at the initial two stages of the model. While the quadratic extension of the Deaton and Muellbauer's linear approximate AIDS model (1980), suggested by Banks *et al.* (1997), hereinafter referred to as the QUAIDS model was formulated at the final stage.

Stage 1 of the model assumes that households allocate consumption expenditures to broad groupings such as food and non-food commodities which in turn are affected by income and some demographic characteristics of the household. The food expenditure (FD) function is specified as follows:

$$\mathrm{FD} = \mathrm{f}(\mathrm{PF}, \mathrm{PNF}, Y, Y^2, Z) \quad (1)$$

The price index for food (PF) was computed as the geometric mean of food prices ($\Sigma\ W_j \ln P_j$), where W_j is the share in total food expenditure of the jth commodity and P_j is the price. Due to data constraints, the per capita expenditure for non-food commodities was used as a proxy variable for the price index for non-food commodities (PNF). This proxy variable takes into account the 'income effect' of the changes in PNF. Equation (1) further assumes that the 'substitution effect' between food and non-food commodities is negligible.

The income variable (Y) was included in the model in both linear and squared forms. The quadratic income term (Y^2) aims to capture the possible non-linearity in food consumption behaviour of households with respect to income. The variable Z represents the vector of household characteristics to account for demographic factors that may affect consumption such as family size, number of children and urbanity of residence.

The fish expenditure (FS) equation in stage 2 was specified as a function of the prices of various types of food commodities, such as cereal, fish, meat, poultry products, pulses, vegetables and beverages and is defined as follows:

$$\text{FS} = \text{f}(P, \text{FD}^*, \text{FD}^{*2}, Z) \tag{2}$$

Variable P is a vector of prices of the various food commodities listed above while Z is a vector of demographic variables similar to those defined in Equation (1). To incorporate the effect of the food expenditure variable from stage 1, the predicted value of FD was included in Equation (2) as an instrumental variable. The squared term FD^{*2} was also added to capture the non-linearity in fish consumption which is similarly assumed to exhibit a certain threshold level.

The QUAIDS model for specific fish types is specified in stage 3 as a system of equations where the budget share of each fish type (W_i) is expressed as a function of fish prices (PF), predicted fish expenditures (FS*) from stage 2 and some demographic characteristics of households (Z). The QUAIDS model is expressed as follows:

$$W_i = \text{f}(\text{PF}, \text{FS}^*/P^*, \text{FS}^{*2}/P^*, Z, \text{IMR}_i) \tag{3}$$

The linear approximate form of the model is achieved by deflating the predicted fish expenditure variables (FS* and FS^{*2}) by P^* which is the household-specific Stone's price index for fish (where $\log P^* = \Sigma_k W_k \log P_k$ for k number of goods). Stone index allows the empirical approximation of the non-linear AIDS model (with translog price index) to be linearly estimated. However, a number of papers (e.g. Moschini 1995; Asche and Wessels 1997) have indicated that Stone index is not invariant to changes in units of measurements and its application introduces measurement errors. Asche and Wessels (1997) have suggested normalisation of prices to 1.0 as a solution to this problem, but this approach holds only at a particular point. Given that our aim is to use QUAIDS to estimate elasticities for different economic groups, we have used Stone's price index which may not be problematic for our dataset.[1]

Aside from capturing the non-linearity condition in consumption (as suggested, for example, by Blundell *et al.* 1993; Dickens *et al.* 1993), the quadratic expenditure term (FS^{*2}) also relaxes the equality restriction imposed by linear demand functions regarding the allocation of marginal expenditures for various fish types among rich and poor households. Such an assumption limits the classification of certain fish types into either necessity or luxury commodities and denies the possibility that some fish types may be considered luxuries at low level of incomes but can become necessities at higher level of incomes (Banks *et al.* 1997; Beach and Holt 2001).

The QUAIDS model also assumes that fish is weakly separable from all the other food categories included in the model, such as cereals, meat, poultry products, fruits, vegetables, and beverages. The separability assumption is necessary to satisfy the condition for estimating the demand model in a multistage budgeting framework (Eales and Unnevehr 1988; Jorgenson *et al.* 1988; Yen and Roe 1989; Michalek and Keyzer 1992). Specifically, demand separability requires the ordering of the marginal utilities derived from the consumption of fish commodities to be independent from those derived from consuming other food commodities especially those from alternative sources of animal protein like dairy and meat products.

The inverse Mills ratios (IMRs) are also incorporated in the model to correct for the possible bias created by the presence of zero consumption for certain fish types (Heckman 1979; Cheng and Capps 1988; Heien and Wessells 1990; Byrne *et al.* 1996). Zero consumption results when households report no consumption due to either abstention or corner solution in the household's utility maximisation problem (Shonkwiler and Yen 1999; Perali and Chavas 2000). Corner solution results when consumers cannot afford to pay the price of certain high-value fish types given budget constraints while abstention may be due to non-preference or infrequent purchases. Both cases render the share in expenditure W_i to zero. In this paper, the correction of the sample selection bias resulting from the presence of numerous zero consumption of certain fish types was done either through the use of the Heckman (1979) two-step procedure in estimating the IMRs for specific fish types or through the Tobit specification of the fish expenditure function in stage 2.

Using the parameter estimates of the QUAIDS model, the uncompensated price elasticities for the different fish types are estimated as follows:

$$\xi_{ij} = (b_{ij}/W_i) - \{c_{1i} + 2c_{2i}\ \ln(\mathrm{FS})\}(W_j/W_i) - k_{ij} \quad (4)$$

[1] Fish prices were measured as USD/kg, which is more or less a 'universal' unit for this kind of study.

where k_{ij} is the Knonecker delta which is equal to 1 for own-price elasticity and zero for cross-price elasticity; W_i is the consumption share of the ith fish type; while b_i and c_i are parameter estimates of the QUAIDS model. On the other hand, the fish expenditure elasticity η_i of the individual fish type is given by the following formula:

$$\eta_i = (c_{1i} + 2c_{2i} \ln(\text{FS})/W_i) + 1 \quad (5)$$

The income elasticity, η_i^Y for a specific fish species is then computed as the joint product of food expenditure elasticity η^{FD} from stage 1, fish expenditure elasticity η^{FS} with respect to food from stage 2, and fish expenditure elasticity for the individual fish type, i.e.

$$\eta_i^Y = (\eta^{\text{FD}})(\eta^{\text{FS}})(\eta_i) \quad (6)$$

The price and income elasticities of fish demand for the poor and non-poor households is computed by substituting the specific income level of the particular household group in the elasticity formula. This technique implies that only one set of demand parameters needs to be estimated from the global sample to arrive at elasticity estimates of different income groups. Such segmented approach to elasticity measurement is more useful in analysing consumer demand as compared to using 'average' estimates for the whole population especially when significant variation in demand responses are expected from various income groups (Park *et al*. 1996).

3. Sources of data

The data used in this paper were from a study conducted by the WorldFish Center entitled 'Strategies and Options for Increasing and Sustaining Fisheries and Aquaculture Production to Benefit Poor Households in Asia' led by the principal author of the paper with funding from the Asian Development Bank. This project was implemented in nine Asian countries, namely: Bangladesh, China, India, Indonesia, Malaysia, Philippines, Sri Lanka, Thailand and Vietnam from 2001–2004. Fish consumption data were obtained mainly from the municipal or national household consumption surveys conducted either by the project or statistical bureaus of partner countries, respectively (Appendix Table A1). Primary surveys were conducted whenever fish consumption by species is not available in the national survey.

Since there was wide variation in fish classifications found in the respective country data (each containing 6–11 fish types), some degree of aggregation was employed to facilitate cross-country comparison of species-specific elasticities. Seven broad categories were adopted in the study, which included four types of finfish, two types of non-finfish and one category for processed fish (Appendix Table A2).

4. Results and discussion

Table 1 presents the allocation of consumption expenditures to various food items commonly purchased by Asian households. Cereals generally contribute the largest share ranging from 24 to 38 per cent across the nine countries. This is immediately followed by the shares of meat (ranging from 3 to 26 per cent) and fish (5–21 per cent). These results highlight the important role of fish in the animal-protein intake of most Asian households.

Moreover, the proportion of the budget spent on fish is larger for consumers belonging to the higher income group (ranging from 8 to 21 per cent) compared to the lower income group (ranging only from 5 to 16 per cent). Similarly, the share of fish expenditure was found to be higher in the urban areas (6–32 per cent) compared to the rural areas (3–15 per cent). Expectedly, these results suggest that increasing affluence and urbanisation can potentially increase the consumption of fish and fishery products.

Table 1 also presents the share of each fish group in total fish expenditure across countries. The share of freshwater species was found to be consistently higher than that of the marine species except in the case of Malaysia and Philippines. This emphasises the relative preference of most Asian households for freshwater species, especially for those living in deltaic countries with abundant inland waters like Bangladesh, India, China, Vietnam and Thailand. On the other hand, for countries with long coastlines like the Philippines and Malaysia, marine species appeared to dominate household fish consumption. These results imply that geographical factors seemed to mold the preference of fish consumers.

Processed fish appeared to be an important component of fish expenditure (averaging 10 per cent), especially among Indonesian and Philippine households where expenditure shares reaching 22 per cent in both countries. This could be explained by the abundant supply of marine fish in these countries due to their archipelagic geology thus encouraging a culture for fish processing.

Expenditure shares of non-finfish such as shrimp, other crustaceans and molluscs were found to be low, generally less than 10 per cent except in China, Bangladesh and Thailand. High expenditure shares for these species could be related to the fast growth of cultured species (especially shrimp) in these countries making them easily accessible and affordable.

The estimated parameters of the country QUAIDS model were not presented in this paper for brevity but will be available from the authors upon request. To capture the effect of income on fish demand, country data were partitioned into quintile groups before price and income elasticities were estimated. The own-price elasticities of fish demand by major fish types and income groups are presented in Table 2. The elasticity estimates are expressed as weighted averages of various fish species under specific fish types (i.e. high-value vs. low-value) by using the shares of specific fish species/group in the total fish expenditure as weights. Although elasticity estimates for all

Table 1 Share of food/fish expenditure to total budget by country, income group and geographic location, 2004

Food item	Bangladesh	China	India	Indonesia	Malaysia	Philippines	Sri Lanka	Thailand	Vietnam	Average
Food share in total expenditures										
Cereals	38	24	32	24	24	33	23	31	34	29
Meat	12	26	6	3	15	13	14	22	20	14.5
Fish	20	5	6	9	21	14	11	16	19	13.5
Others	30	45	56	64	40	40	52	31	27	43
Total share	100	100	100	100	100	100	100	100	100	100
Fish share by income group										
Lowest	–	–	5	–	–	16	–	15	15	13
Highest	–	–	8	–	–	12	–	18	21	15
Fish share by location										
Rural	10	3	7	–	15	–	–	–	–	9
Urban	21	7	6	–	32	–	–	–	–	16
Fish share by species										
Freshwater fish	71	40	62	42	7	28	69	43	68	48
High-value	25	4	49	–	2	15	69	22	27	26
Low-value	46	36	13	42	5	13	–	21	41	27
Marine fish	13	35	29	30	81	41	29	16	27	33
High-value	1	17	8	13	10	23	21	8	4	12
Low-value	12	18	21	17	71	18	8	8	23	22
Non-finfish										
Shrimp	14	13	5	6	5	4	–	9	2	7
Crustaceans/molluscs	–	12	4	–	7	5	–	23	–	10
Processed fish										
Dried fish	2	–	–	22	–	22	2	9	3	10
Total	100	100	100	100	100	100	100	100	100	100

– Not available.
Data were based on ADB-RETA 5945 Country Reports.

Table 2 Own-price elasticities of major fish groups across countries, 2004

Fish Types	Bangladesh	China	India	Indonesia	Malaysia	Philippines	Sri Lanka	Thailand	Vietnam	All
Freshwater fish										
High-value	–1.22	–0.29	–0.99	–	–0.98	–2.14	–1.08	–0.13	–0.90	–0.97
Low-value	–0.96	–0.39	–0.99	–0.94	–1.08	–1.58	–	–0.76	–1.23	–0.99
Marine fish										
High-value	–1.92	–0.44	–0.98	–1.40	–0.91	–1.61	–0.98	–0.60	–1.04	–1.10
Low-value	–0.88	–0.95	–1.03	–0.27	–1.12	–1.34	–0.85	–1.28	–	–0.96
Non-finfish										
Shrimp	–1.00	–0.46	–0.99	–1.04	–0.89	–0.95	–	–0.64	–4.25	–1.28
Others	–	–	–1.00	–	–0.99	–0.79	–	–	–	–0.93
Processed fish	–	–	–	–0.72	–	–1.33	–0.85	–0.66	–	–0.89
Average	–1.01	–0.46	–0.92	–0.84	–1.07	–1.51	–1.04	–0.46	–1.12	–0.94
Lowest income group										
Freshwater fish										
High-value	–2.02	–	–0.99	–	–1.46	–3.61	–1.06	–0.16	–0.88	–1.45
Low-value	–1.08	–	–0.99	–0.89	–1.08	–1.87	–	–0.75	–1.74	–1.20
Marine fish										
High-value	–2.78	–	–0.62	–1.45	–0.58	–1.48	–0.96	–0.61	–0.94	–1.26
Low-value	–1.04	–	–0.96	–0.37	–1.12	–1.30	–0.84	–1.20	–	–0.98
Non-finfish										
Shrimp	–0.98	–	–0.96	–1.06	–1.24	–0.92	–	–0.66	–2.21	1.18
Others	–	–	–1.01	–	–1.08	–0.87	–	–	–	–0.98
Processed fish	–0.40	–	–	–0.84	–	–1.19	–0.86	–0.62	–	–0.78
Average	–1.29	–	–0.95	–0.87	–1.07	–1.70	–1.02	–0.46	–1.03	–1.06
Highest income group										
Freshwater fish										
High-value	–1.08	–	–0.99	–	–0.97	–1.46	–1.15	–0.36	–0.90	–0.99
Low-value	–0.83	–	–0.99	–0.94	–1.08	–1.40	–	–0.70	–0.92	–0.98
Marine fish										
High-value	–1.49	–	–0.97	–1.35	–0.91	–1.73	–0.98	–0.64	–1.09	–1.17
Low-value	–0.80	–	–0.94	–0.10	–1.12	–1.48	–0.79	–1.32	–	–0.94
Non-finfish										
Shrimp	–1.04	–	–1.00	–1.02	–0.89	–1.00	–	–0.74	–3.06	–1.25
Others	–	–	–0.99	–	–0.99	–0.70	–	–	–	–0.89
Processed fish	–0.40	–	–	–0.56	–	–1.51	–0.83	–0.71	–	–0.80
Average	–0.92	–	–0.98	–0.77	–1.07	–1.47	–1.08	–0.52	–0.72	–0.94

The item ‘others’ under non-finfish category refers to crustaceans and molluscs.
Data were based on ADB-RETA 5945 Country Reports.

quintile groupings were generated for each country model, comparisons were made only between the two extreme groups, that is, first vs. fifth quintiles which were used to represent the lowest and highest income groups, respectively. Elimination of the three middle quintiles allowed the study for a more dramatic comparison of elasticity differences between the poor and the non-poor households. Individual elasticity estimates by species, countries and income groups are presented in Appendix Table A3. Note that the cross-price elasticities of the various fish species/groups were also estimated in the country models but were similarly not presented. Estimates, however, can also be requested from the authors.

On average, the own-price elasticities were found to vary widely across fish types ranging from –0.13 to –4.25, demonstrating the heterogeneity of fish demand in the region. Except for the high-value marine fish (e.g. large pelagic and demersal species), and shrimp, all the other fish types were found to have average elasticities less than 1, implying that the demand for fish is generally inelastic. These results are consistent with those observed by Asche *et al.* (2007) where high-value fish species tend to have more elastic demand than low-value species. Specifically, the observed inelastic demand, especially for the low-value fish groups suggests that most Asian households are generally less responsive to changes in prices for these fish types. This can be explained by the relative importance of fish in the Asian diet contributing about 37 per cent to the total animal protein intake in most households (Dey *et al.* 2005).

Furthermore, the own-price elasticity of fish demand was observed to be lower among households with higher incomes. Specifically, the average elasticities of the various fish categories were generally found to be lower for the highest income group as compared to the lowest income group. These suggest that the poorer households consider fish as an elastic commodity while their more affluent counterparts regard it as an inelastic good. Furthermore, these imply that the poorer households tend to exhibit more demand responsiveness given changes in fish prices than the richer households. More importantly, price elasticity seems to move from elastic to inelastic as households go up the income bracket. This result is important since it emphasises the flexibility in fish demand of the Asian poor in absorbing potential supply expansions in the market. Note that this observation is consistent with most demand studies for various food commodities available in the literature, for example, rice (Senauer 1990), rice and cassava (Timmer and Alderman 1979) and fish (Park *et al.* 1996).

While the highest income group exhibited inelastic demand for most of the fish types, the elasticities for high-value species were surprisingly elastic. One possible explanation for this is that the high-value species like grouper, tuna and shrimp can have numerous substitutes at their price range in terms of meat and other poultry products. Hence, even if the rich households can afford to pay the price of the high-value fish, they tend to respond quickly to any price change, thus rendering this subgroup to be price elastic.

It is interesting to note that among the low-income households, while average elasticities were found to be mostly greater than 1, the cheaper fish types such as the low-value marine fish (e.g. anchovy, roundscad, small pelagic and demersal species), crustaceans/molluscs and dried fish were found to be price inelastic. This can be explained in two ways. First, the low-value fish is the cheapest form of animal protein that is affordable for the poor. Second, since the price is generally low, there is limited number of substitutes for fish as protein source at that price range, thus making the low-value fish inelastic.

The estimated income elasticities for fish demand by income groups are presented in Table 3. Based on these tables, income elasticities for all the fish types yielded positive values suggesting that fish in general (whether fresh or processed) is considered as a normal good by all households in the region, whether rich or poor.

All country income elasticities, on average, were found to be elastic with values ≥1. This implies that fish is generally considered as a luxury good by Asian consumers. On average, freshwater fish (both low- and high-value) were found to have lower income elasticities than their marine counterpart suggesting less variability in demand as income rises. This reiterates the preference of most Asian households for freshwater fish species.

With respect to income groups, average income elasticities for all fish types were found to be elastic for the low-income households with values ranging from 1.25 to 2.19. Conversely, the high-income households yielded inelastic values for all the fish types ranging from 0.61 to 0.90. Note that similar to the case of price elasticities, the trend in income elasticities took the same trend of shifting from elastic to inelastic as households go up the income ladder. This suggests that fish consumption among the poorer households responds more to income changes than the richer households. Hence, as countries in Asia become more successful in their drive towards poverty alleviation, more demand for fish can be expected to come from the low-income households which comprised the bulk of the Asian population.

Among the high-income households, except for Malaysia, the high-value species tend to exhibit higher income elasticities than the low-value species especially for the marine subgroup. A similar trend is observable among the low-income households. This means demand for high-value fish becomes more unstable in the face of rising incomes. This could similarly be related to the wide variety of choices available to consumers at the upper price range, thus making demand more volatile when income increases. On the contrary, the elasticity of high-value fish in Malaysia was found to be lower than the low-value species. This is expected since Malaysia is one of countries in Asia with very high per capita fish consumption.

5. Conclusion and policy implication

Two important results emerged from this analysis. First, fish is clearly a heterogenous product, as shown by the wide variability in the estimated

Table 3 Income elasticities of major fish groups across countries, 2004

Fish Types	Bangladesh	China	India	Indonesia	Malaysia	Philippines	Sri Lanka	Thailand	Vietnam	All
Freshwater fish										
High-value	1.43	0.99	1.62	1.46	0.87	0.57	0.86	0.12	0.99	1.00
Low-value	0.91	0.99	1.62	1.46	1.94	0.56	–	0.06	0.66	1.02
Marine fish										
High-value	1.56	1.05	1.62	1.46	0.52	1.89	0.98	0.64	1.06	1.20
Low-value	1.05	0.95	1.62	1.46	1.13	0.64	1.00	0.62	–	1.06
Non-finfish										
Shrimp	0.68	1.36	1.61	–	–	1.78	–	0.66	0.94	1.17
Others	–	–	1.66	1.46	0.73	1.38	–	–	–	1.31
Processed fish	1.06	–	–	1.46	–	1.01	1.01	0.62	–	1.03
Average	1.03	0.92	1.62	1.46	1.12	1.07	0.90	0.26	0.59	1.00
Lowest income group										
Freshwater fish										
High-value	2.63	0.58	1.63	3.05	1.12	0.14	0.72	0.41	0.99	1.25
Low-value	1.15	1.07	1.64	3.05	2.34	0.49	–	0.32	0.66	1.38
Marine fish										
High-value	3.07	0.90	1.14	3.05	0.69	2.14	1.19	0.91	1.14	1.58
Low-value	1.25	0.52	1.65	3.05	1.04	0.87	0.86	0.77	–	1.25
Non-finfish										
Shrimp	0.80	0.93	1.14	3.05	–	2.66	–	1.00	0.98	1.51
Others	–		3.75	–	0.92	1.91	–	–	–	2.19
Processed fish	1.38	–	–	3.04	–	1.08	1.03	0.88	–	1.48
Average	0.70	0.66	1.35	0.53	0.68	0.73	1.04	0.13	0.73	0.73
Highest income group										
Freshwater fish										
High-value	0.94	0.44	1.36	0.53	0.54	0.59	1.05	0.03	0.99	0.72
Low-value	0.59	0.77	1.36	0.53	1.18	0.48	–	0.008	0.98	0.74
Marine fish										
High-value	1.00	0.87	1.37	0.53	0.40	1.54	1.00	0.37	1.04	0.90
Low-value	0.85	0.47	1.35	0.53	0.76	0.33	1.01	0.35	–	0.71
Non-finfish										
Shrimp	0.47	0.99	1.39	0.53	–	0.89	–	0.35	0.96	0.80
Others	–	–	1.12	–	0.45	0.89	–	–	–	0.82
Processed fish	0.78	–	–	0.53	–	0.39	1	0.33	–	0.61
Average	0.70	0.66	1.35	0.53	0.68	0.73	1.04	0.13	0.73	0.73

The item ‘others’ under non-finfish category refers to crustaceans and molluscs.
Data were based on ADB-RETA 5945 Country Reports.

income and price elasticities of different fish types. This result is important for future modelling and analysis of the fisheries sector. Also, it goes without saying that past assumptions regarding fish as a single or homogenous commodity is faulty and unrealistic, especially in the case of Asian demand models.

Second, the estimated price and income elasticities for all fish types tend to be higher among the poorer sector of the economy compared to the more affluent members of the society. This implies that the poorer households often consider seafood and fishery products as luxury commodities especially the high-value species while the rich simply consider them as basic food items. Hence, partitioning the population by income groups allows a better understanding of fish demand responses that are characteristic of the poor and rich consumers.

Both of these results have important policy implications. The analysis showed that as per capita income and population grow in most Asian countries, there will be tremendous increases in fish demand that are expected to come mostly from the poorer sector of the economy. Absence of commensurate increases in fish supply will create pressure for fish prices to go up, which will hurt the consumers. This has worrisome consequences on the protein intake of households, particularly among the poor. A way to circumvent this welfare loss is to expand fish production, which to date can be easily addressed through aquaculture. However, increasing fish supply, in turn will exert a downward pressure on the price of fish, which is detrimental on the part of the fish farmers. Nevertheless, when fish demand is price elastic, a decline in the price can bring about rising revenues. There is therefore a need to focus aquaculture expansion to fish species where consumer demand exhibits elastic responses. This information is important in considering future policies and developments in fishery technology and investment, especially in aquaculture. As highlighted in this study, the consumption of low-value fish species among the poorer households tends to exhibit the kind of demand response that can trigger beneficial effects to both consumers and producers in the face of rising production. In such a case, tilapia, carp, catfish and other low value aquaculture species can continue to play an important role in Asian aquaculture.

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Appendix

Table A1 Summary of information regarding fish consumption survey and geographical coverage by countries

Country	Type of data	Year	Coverage	Sample size (households)	Data source
Bangladesh	Primary	1999	9 out of 64 districts	810	Project survey
China	Panel/ Secondary	1997 and 2001	Nationwide (20% of total national sample)	49 508	National Statistics Bureau (Household Expenditure Survey)
India	Primary	2002	6 out of 18 fish eating states	591	Project survey
Indonesia	Secondary	1999	Nationwide (All 26 provinces)	61 482	Central Bureau of Statistics (Socio-Economic National Survey)
Malaysia	Secondary	2000	Nationwide (All 13 states)	9 198	National Statistics Bureau (Household Expenditure Survey)
Philippines	Secondary	2000	Nationwide (All 16 regions)	39 615	National Statistics Office (Family income and expenditure survey)
Thailand	Panel/ Primary	1999 and 2002	10 inland provinces 5 coastal provinces	456	Project survey
Sri Lanka	Secondary	1996	Nationwide (All 8 provinces)	19 752	Department of Census and Statistics (Household Income and Expenditure Survey)
Vietnam	Primary	2002	13 out of 62 provinces	780	Project survey

Data were based on ADB-RETA 5945 Country Reports.

Table A2 Fish species included in the major fish groupings by source and country, 2004

Fish Types	Bangladesh	China	India	Indonesia	Malaysia	Philippines	Sri Lanka	Thailand	Vietnam
Freshwater fish									
High-value fish	Indian major carp, live fish, hilsa	Grass carp, Crucian carp	Indian major carp	–	Freshwater fish	Milkfish	Freshwater fish	Snakehead, silver barb	Snakehead, silver barb, high value freshwater fish
Low-value fish	Tilapia, pangas, other carp, freshwater fish	Common carp, silver carp	Common carp, other freshwater fish	Other freshwater fish	Other fish	Tilapia	–	Tilapia, catfish	Tilapia, carp, catfish, low value freshwater fish
Marine fish									
High-value fish	High value marine fish	Yellow croaker, hairtail, marine fish	Pelagic high value fish, demersal high value fish	High value fish	High value fish	Other fresh fish	Large pelagic fish, demersal fish	Indo-Pacific mackerel Other high value fish	High value marine fish
Low-value fish	Low value marine fish	Other fin fish	Pelagic low value fish, Demersal low value fish	Low value fish	Anchovy, other fish	Anchovy, roundscad	Small pelagic fish, other marine fish	Other low value fish	Low value marine fish
Non-finfish*	Shrimp	Shrimp	Shrimp, molluscs	Crustaceans	Crustaceans, molluscs	Shrimp, squid, crabs and shells	–	Shrimp	Shrimp
Processed fish	Dried fish	–	–	Dried fish, preserve fish	–	Preserved fish	Processed fish	Dried fish	–
Number of fish types	11	9	9	6	7	10	6	9	10

* Two subcategories of non-finfish were specified in the demand model but there were country data where only one type of non-finfish was present.
Source: Data were based on ADB-RETA 5945 Country Reports.

Table A3 Price and income elasticities of various fish species belonging to major fish grouping by country and income group, 2004

	All income groups		Low income group		High income group	
Fish species	Price ξ	Income η	Price ξ	Income η	Price ξ	Income η
High value freshwater fish						
Bangladesh						
Indian major carp	–1.22	1.49	–2.52	3.10	–1.02	0.98
Live fish	–1.84	1.25	–2.01	1.50	–1.63	0.88
Hilsa	–0.58	1.38	–0.30	2.09	–0.72	0.84
China						
Crucian carp	–0.29	0.95	–	0.59	–	0.41
Grass carp	–	1.04	–	0.56	–	0.48
Indian (Major carp)	–0.99	1.62	–0.99	1.63	–0.99	1.36
Indonesia	–	1.46	–	3.05	–	0.53
Malaysia	–0.98	0.87	–1.46	1.12	–0.97	0.54
Philippines (Milkfish)	–2.14	0.57	–3.61	0.14	–1.46	0.59
Sri Lanka	–1.08	0.86	–1.06	0.72	–1.15	1.05
Thailand						
Snakehead	–0.24	0.24	–0.18	0.74	–0.29	0.07
Silver barb	–0.13	0.09	–0.25	0.39	–0.70	0.01
Vietnam						
Snakehead	–0.87	1.00	–0.81	1.00	–0.89	1.00
Silverbarb	–1.78	0.96	–1.92	0.96	–1.68	0.96
Other high value fish	–0.52	0.97	–0.54	0.98	–0.53	0.97
Low value freshwater fish						
Bangladesh						
Tilapia	–1.24	0.99	–1.45	1.29	–1.21	0.62
Pangas	–0.78	0.62	–	–	–	–
Other carp	–1.08	1.36	–1.70	2.00	–0.97	0.96
Assorted small fish	–0.80	0.72	–0.82	0.89	–0.75	0.52
China						
Silver carp	–0.39	0.94	–	0.51	–	0.03
Common carp	–	0.85	–	0.52	–	0.05
Freshwater fish	–	1.00	–	1.10	–	0.82
India						
Common carp	–0.99	–	–	–	–	
Other freshwater fish	–0.99	1.62	–0.99	1.64	–0.99	1.36
Indonesia	–0.94	1.46	–0.89	3.05	–0.94	0.53
Malaysia	–1.08	1.94	–1.08	2.34	–1.08	1.18
Philippines (Tilapia)	–1.58	0.56	–1.87	0.49	1.40	0.48
Thailand						
Tilapia	–0.74	0.05	–0.74	0.30	–0.66	0.001
Catfish	–0.96	0.12	–0.95	0.43	–0.95	0.03
Vietnam						
Carp	–1.28	0.98	–1.21	0.99	–1.20	0.98
Catfish	–1.04	1.01	–1.05	1.01	–1.03	1.01
Tilapia	–6.08	0.94	–12.84	0.07	–2.82	0.98
High value marine fish						
Bangladesh	–1.92	1.56	–2.78	3.07	–1.49	1.00
China				0.55		
Hairtail	–0.44	0.90	–	0.61	–	0.27
Yellow croker	–	1.26	–	1.04	–	0.64
Marine fish	–	1.08	–	–	–	1.09
India			–0.62	1.14	–0.97	1.37
Pelagic high value fish	–0.99	1.62	–	–	–	–

Table A3 *Continued*

Fish species	All income groups		Low income group		High income group	
	Price ξ	Income η	Price ξ	Income η	Price ξ	Income η
Demersal high value fish	–0.95	1.62	–	–	–	–
Indonesia	–1.40	1.46	–1.45	3.05	–1.35	0.53
Malaysia	–0.91	0.52	–0.58	0.69	–0.91	0.40
Philippines	–1.61	1.89	–1.48	2.14	–1.73	1.54
Sri Lanka						
Large Pelagic fish	–0.95	0.99	–0.89	0.96	–0.96	1.00
Demersal fish	–1.02	0.98	–1.04	1.42	–1.01	0.99
Thailand						
Indo-Pacific mackerel	–0.41	0.66	–0.48	0.90	–0.52	0.35
Other high value fish	–0.78	0.62	–0.74	0.93	–0.76	0.38
Vietnam	–1.04	1.06	–0.94	1.14	–1.09	1.04
Low value marine fish						
Bangladesh	–0.88	1.05	–1.04	1.25	–0.80	0.85
China	–0.95	0.95	–	0.52	–	0.47
India	–	–	–0.96	1.65	–0.94	1.35
Pelagic low value fish	–1.05	1.62	–	–	–	–
Demersal low value fish	–0.88	1.62	–	–	–	–
Indonesia	–0.27	1.46	–0.37	3.05	–0.10	0.53
Malaysia						
Anchovy	–0.88	0.82	–	1.03	–0.88	0.48
Other low value fish	–1.12	1.13	–1.12	0.01	–1.12	0.76
Philippines						
Anchovy	–1.52	0.70	–1.34	1.04	–1.78	0.34
Roundscad	–1.31	0.63	–1.29	0.84	–1.42	0.33
Sri Lanka						
Small pelagic fish	–0.69	0.93	–0.63	–	–0.57	–
Other marine fish	–1.01	1.07	–1.04	0.86	–1.01	1.01
Thailand	–1.28	0.62	–1.20	0.77	–1.32	0.35
Non-finfish – Shrimp						
Bangladesh	–1.00	0.68	–0.98	0.80	–1.04	0.47
China	–0.46	1.36	–	0.93	–	0.99
India	–0.99	1.61	–0.96	1.14	–1.00	1.39
Indonesia	–1.04	–	–1.06	3.05	–1.02	0.53
Malaysia	–0.89	–	–1.24	–	–0.89	–
Philippines	–0.95	1.78	–0.92	2.66	–1.00	0.89
Thailand	–0.64	0.66	–0.66	1.00	–0.74	0.35
Vietnam	–4.25	0.94	–2.21	0.98	–3.06	0.96
Crustaceans/mollusc						
India	–1.00	1.66	–1.01	3.75	–0.99	1.12
Indonesia	–	1.46	–	–	–	–
Malaysia	–0.99	0.73	–1.08	0.92	–0.99	0.45
Philippines						
Squids	–1.30	1.61	–1.47	2.41	–1.17	0.92
Shells and crabs	–0.45	1.23	–0.47	1.58	–0.39	0.87
Dried fish						
Bangladesh	–	1.06	–0.40	1.38	–0.40	0.78
Indonesia	–0.72	1.46	–0.84	3.04	–0.56	0.53
Philippines	–1.33	1.01	–1.19	1.08	–1.51	0.39
Sri Lanka	–0.85	1.01	–0.86	1.03	–0.83	1.00
Thailand	–0.66	0.62	–0.62	0.88	–0.71	0.33

Data were based on ADB-RETA 5945 Country Reports.