FINDING NEMO: ESTIMATING IMPORT DEMAND FOR LIVE REEF FOOD FISH

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ABSTRACT

Reef fish traded alive for table food are high value-to-volume products, with demand centred in Hong Kong and southern mainland China. Import demand functions for live reef food fish are estimated for Hong Kong, in aggregate and for individual fish species. Cross-price, income and population elasticities, and the impact of SARS and Chinese New Year on demand, are estimated. Results show that price has a smaller influence on import demand than expected. The most influential factor is Chinese New Year. The price of low and medium-value species exhibited a negative impact, whereas the price of very high-value species exhibited a positive impact, on demand. This suggests that high-value live reef species may be Veblen goods, where consumption increases as a direct function of its price, in this case due to associated prestige and status.

Keywords: demand analysis, trade, live reef food fish

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1. Introduction

Live fish have long been traded throughout Southeast Asia as a luxury food item. Species captured on coral reefs entered this trade in the 1970s and, because of their superior qualities (such as taste, colour and texture), have become some of the most sought after species. Sadovy and Vincent (2002) estimate that 60 percent of the international trade goes to Hong Kong, with as much as 50 percent of this being re-exported to southern mainland China where direct import tariffs are currently significantly higher than in Hong Kong (this is likely to change with China's accession into the World Trade Organization). Hong Kong imports approximately 15-20,000 tonnes annually, valued at approximately US$350 million (Muldoon and McGilvray 2004). Given this, the global trade in live reef fish may exceed 30,000 tonnes annually. In the immediate wake of the Asian economic crisis, declared imports of live fish into Hong Kong declined by almost one-third and have since failed to recover from these levels (Muldoon and McGilvray 2004).

While fish consumption has been a staple dietary component of these countries for centuries, live reef fish are consumed in especially high quantities during special occasions and festivals (for example, in celebration of Chinese New Year, Mothers Day and to mark the close of business agreements). These festive periods often correspond with higher prices paid to fishers in source countries. Approximately twenty Asia-Pacific countries supply these markets, with Thailand, the Philippines, Australia, Malaysia and Indonesia being the dominant suppliers (ACFD 2003).[1]

A number of economic, environmental and social issues have arisen as a result of the trade. Preliminary data analysis indicates that the live reef fish trade has been susceptible to economic shocks such as the Asian Economic Crisis and Severe Acute Respiratory Syndrome (SARS**,** a severe form of pneumonia) (Muldoon and McGilvray 2004). The impacts of these shocks are felt throughout the supply chain, from the fisher to the retailer, to differing degrees. There are concerns about the sustainability of supply due to economic and biological over-exploitation of coral reefs and the environmentally damaging aspects of some harvesting techniques; including cyanide fishing and targeting of spawning aggregations (Cesar *et al.* 2000). Moreover, the trade is beset by social disruption, which arises mainly due to disputes over resource access and use, distribution of benefits, and the use of destructive fishing practices (see Smith, 2004). In many cases, while the trade has provided additional income generating opportunities, these benefits have come at a cost to future ecological, economic and social sustainability.

Quantities of live fish traded regionally are difficult to determine. Actual records of annual imports of live fish into Hong Kong are derived from data collected by the Census and Statistics Department, and the Agriculture, Fisheries and Conservation Department (AFCD). The reliability of these estimates is hindered by the re-export of live fish into southern mainland China and the likely under-recording of imports. This latter issue is largely a result of there being no requirement for Hong Kong registered live transport vessels to declare their imports. The AFCD estimates of live marine fish

[1] In this paper, we refer only to live reef fish traded for table food and not aquarium display. Estimates of the value of retail aquarium trade in the late 1990s range between US$90 and US$400 million (Sadovy and Vincent 2002).

entering Hong Kong by sea are thought to capture only about 50 percent of all shipments although the data do not distinguish country of origin.

The market for live reef fish includes a wide variety of low-value (e.g. Mangrove snapper, Green grouper and Flowery grouper), medium-value (e.g. Tiger grouper, Giant grouper, Spotted coral trout and Leopard coral trout[2]) and high-value fish species (e.g. Humphead wrasse and Humpback grouper) (Table 1). The preferred family of fish species are the grouper (Serranidae). The Humphead (Napoleon) wrasse remains one of the highest priced, most sought after and most endangered species in the trade.[3] The Leopard coral trout is especially favoured due to its bright red colour. The preferred size of fish for consumption is 600 –1000 grams.

Table 1: Average landed price, quantity and value of live reef fish species imported annually into Hong Kong (2001-2003), excluding Hong Kong-flagged shipping vessels [a]

Variable	*Average price (HKD/kg)*	*Average annual quantity imported (tonnes)*	*Value (million HKD)*
Low-value species			
"Other marine fish"	23.5	4,360	102
Mangrove snapper	40.6	255	10.4
Green grouper	57.8	1,470	84.9
Flowery grouper	75.6	132	10.0
Medium-value species			
"Other groupers"	94.6	1,620	153
Tiger grouper	96.8	145	14.0
Giant grouper	100	10.0	1.00
Spotted coral trout	141	96.9	14.2
Leopard coral trout	147	2,140	314
High-value species			
Humphead wrasse	232	18.6	4.32
Humpback grouper	285	8.7	2.08
Total		10,300	710

Source: Hong Kong Trade Statistics from Census and Statistics Department

[a] Hong Kong-flagged vessels are estimated to capture approximately 50 percent of imports by sea to Hong Kong, averaging at approximately 1,800 tonnes per year.

This paper is the first analysis of a larger project aimed at analysing economic and market impacts of the live reef food fish trade in Asia-Pacific.[4] It aims to provide single equation estimates of import demand for live reef food fish in Hong Kong, analysing the effects of population growth, seasonal factors (i.e. Chinese New Year), income growth and economic shocks (i.e. SARS). The analysis provides initial exploration of data before demand systems are estimated. The paper proceeds as

[2] Leopard coral trout is on the upper end of the medium-priced continuum and during peak demand periods exhibits high-value status. It is considered a high value species in most exporting countries.

[3] The World Wildlife Fund (WWF) Hong Kong and Ocean Park conducted a campaign in June 2004 to raise public awareness of the endangered species, Humphead wrasse. This led to an online petition urging the Hong Kong government to save the species, with more than 3,000 signed for the petition. These signatures were submitted to the representative of Agriculture, Fisheries and Conservation Department (AFCD) Hong Kong ahead of voting at the CITES in October for the listing of the fish on CITES Appendix II.

[4] Funded by the Australian Centre for International Agricultural Research.

follows. Section 2 is a discussion of the theory of demand for fish with preliminary analysis for live reef fish to develop hypotheses regarding own-price (Section 2.1), cross-price (Section 2.2) and income elasticities (Section 2.3). Section 3 provides the results and discussion of demand analysis, conducted in three stages: aggregated demand analysis (Section 3.1), demand analysis disaggregated by low, medium and high-valued species (Section 3.2), and demand analysis for individual species (Section 3.3). Some conclusions are drawn in Section 4.

2. Demand theory and its application to live reef fish

Theory suggests that demand for a good depends on price, the average income of consumers, the size of the market (often measured by population), the price of substitutes, tastes/preferences, and special influences (such as festival occasions) (Sloman and Norris 2002). To the authors' knowledge, no study has attempted to estimate demand for live reef fish. Wing and On (2002) is the only empirical study on the fishery known to the authors. They provide a time-series analysis of historical prices of three species of cultured groupers in Hong Kong using an Autoregressive Integrated Moving Average (ARIMA), but do not address structural changes in the industry.[5] Their model was not extended to estimate the demand functions for these fish species.

There are four different representations of the consumer's preferences that are dual in the sense that they provide identical information about the consumer's preferences: the utility function, the indirect utility function, the cost (or expenditure) function and the distance function. When using a *utility function* it is assumed that the consumer's preferences may be represented with a utility function *U(q)*, where *q* denotes a vector containing the quantity consumed of each good. Given a budget *X*, the consumer's problem is to maximise *U(q)* given *X*. Deriving and solving the first order conditions to this problem yields a system of demand functions (known as the uncompensated or Marshallian demand functions), where the demanded quantity for each good is a function of prices and expenditure.

The first empirical demand studies specified single equation demand functions linear in the parameters, of which the double log was the most common functional specification (e.g. DeVoretz (1982), Kabir and Ridler (1984), Bird (1986), Hermann and Lin (1988), DeVoretz and Salvanes (1993), Hermann *et al.* (1993)). This specification is still common today, however, single equation models are generally not theoretically consistent as changes in the price of goods omitted from the specification may cause changes in demand for the commodity in question through changes in expenditure.

To estimate functions that are consistent with consumer theory, a system of demand functions are estimated using the concept of weak separability to separate a group of goods from the rest of the consumer's bundle. Weak separability assumes that the consumer partitions total consumption into groups of goods, so that preferences within groups can be described independently of the other groups. The demand functions for the goods inside the group are then specified in a system of demand

[5] They were able to successfully predict future prices of two of the three species analysed.

functions. There are a number of demand systems specified in the literature, of which the most commonly used is the Almost Ideal Demand System (AIDS) of Deaton and Muellbauer (1980).

The purpose of this paper is to conduct initial exploration of data by estimating a single import demand function for live reef fish. It is a precursor to stystem modeling of the fishery. A standard Marshallian demand function is used, expressing the quantity of a species demanded as a function of prices, income, seasonal factors and economic shocks:

$$q_i = f(p_i, p_s, p_c, y, s, e) \quad (1)$$

where q_i is the quantity of species (or species group) *i* demanded in the period; p_i is the real price of species (or species group) *i*, p_s is a vector of the real prices of substitute products; p_c is a vector of the prices of complementary products[6]; *y* is the income of consumers (real gross domestic product (GDP) per capita), *s* is a seasonal dummy variable (indicating the occurrence of Chinese New Year); and *e* is a dummy variable indicating an economic shock (the incidence of SARS). Monthly data is used over the time period from July 2000 to May 2004, provided by the Hong Kong Agriculture, Forestry and Conservation Department. The following subsections review the literature and propose hypotheses regarding own-price, cross-price and income elasticities of demand for live reef fish that can be derived from empirical analysis.

2.1 Price elasticity of demand

A number of general trends may be elicited from existing demand models for fish, although comparisons must be made with caution as model specifications used differ across studies. First, demand in most markets for seafood seems to be price elastic (Asche and Bjorndal 1999). There are a few exceptions; for example, demand for some canned seafood in aggregate such as canned tuna (e.g. Wallstrom and Wessells (1995)). Second, there is a tendency for more valuable seafood to be exhibit more elastic demand. Third, existing demand analysis of fisheries show a tendency for demand closer to the consumer (e.g. retail demand) to be more elastic than demand closer to the producer (e.g. ex-vessel demand). This may be reflecting the short-run inelastic nature of the supply elasticities, where the supply of fish cannot change significantly with price due to stock catchability (in the case of wild capture) or farming (in the case of mariculture) constraints. A fourth, and related, finding from existing demand analysis is that price elasticities decrease with increases in supply, as one would expect with a movement down the demand curve. As some live reef fish are high value-to-volume species, demand for these fish is also expected to be price elastic. Furthermore, the relatively high-priced live reef fish species are expected to have greater elasticities than the relatively low-priced species. For live reef species where production is increasing rapidly (e.g., Leopard coral trout), the price elasticity of demand is hypothesised to be decreasing.

[6] Note that not all species or species groups have complements or substitutes.

We identify two special demand features of the live reef fish trade. First, increases in demand during celebration periods (e.g., Chinese New Year and Mother's day) leads to price spikes, suggesting consumers are willing to pay a considerable premium to ensure purchases during such periods. The price elasticity of demand may be highly inelastic during such periods. The second is consumers' willingness to pay higher prices for scarce fish species (e.g., Humphead wrasse). It is also likely that the demand elasticities of these goods are positively related to income. The effect of these 'prestige' prices is likely to encourage greater levels of effort, leading to over-fishing of the resource in the absence of regulation.

2.3 Cross-price elasticities of demand

Demand studies of other fisheries provide some evidence that similar species and product forms tend to be the closest substitutes. Salvanes and DeVoretz (1997) found that the degree of substitution between seafood and meat is substantially less than between seafood products. Asche *et al.* (2001) and Jaffry *et al.* (2000) found little substitution between farmed and wild-caught products when comparing different species, but Asche *et al.* found some substitution when comparing similar species. It is expected that individual live reef fish species will be substitutes, especially species of similar value, and this substitutability is likely to be affected by seasonality.

2.2 Income elasticities of demand

Theory suggests that income elasticities of demand depend on the time period over which they are measured (the shorter the time period the lower the income elasticity of demand) and the degree of necessity of the good (the more necessary the good, the lower the income elasticity of demand) (Sloman and Norris 2002). Certain live reef fish species are considered luxury goods, consumed in especially high quantities during traditional Chinese festivals and to celebrate special occasions. It follows that income elasticities of demand may be quite high, more so for the relatively higher-valued species.

The Hong Kong economy has grown very slowly over the last few years due to a slow-down in the global economy, the Asian economic crisis and the economic effects of SARS (EIU 2003). This slow economic growth has led to poor levels of growth in income, and hence disposable income that may be spent on reef fish consumption. The prospect for growth in the Hong Kong economy is promising for the medium term. Moreover, mainland China's economy has been growing strongly over the last few years and this looks to continue in the medium term. This income growth in Hong Kong, and especially mainland China, is likely to lead to increased demand for all species of live reef fish.

3. Results and discussion

Import demand analysis for live reef fish in Hong Kong is performed in three stages. First, demand for live reef fish species is estimated in aggregate (Section 3.1). Second, live reef species are divided into three categories - low, medium and high-valued species. Separate demand functions are estimated for each of these categories (Section 3.2). Third, individual demand functions will be estimated for each species (Section 3.3). The data for each of the variables used in the analyses are presented below. These variables include quantity of live reef fish imported (aggregated), import price, income, population, and dummy variables indicating the occurrence of Chinese New Year and SARS.

Monthly imports of live reef fish into Hong Kong are derived from data collected by the Hong Kong Census and Statistics Department and the Agriculture, Fisheries and Conservation Department. There is compulsory reporting of all live reef fish imports, except those arriving by sea in Hong Kong-flagged vessels. These vessels voluntarily report imports. The AFCD estimates that these voluntary reports capture approximately 50 percent of all shipments.

Quantities of live reef fish imported into Hong Kong from July 2000 to May 2004 are shown in Figure 1. The thin line represents total imports into Hong Kong not including the voluntary reporting of Hong Kong-flagged ships. The middle line represents total imports including the voluntary reporting of Hong Kong-flagged ships. The top (most heavily bolded) line represents total imports with Hong Kong-flagged vessels multiplied by two to represent the AFCD's estimates that these vessels capture approximately 50 percent of all shipments. Note that the data including Hong Kong-flagged vessels closely mirrors the peaks and troughs of data excluding these vessels. Voluntary reports from Hong Kong-flagged vessels report annual imports of approximately 400 tonnes to early 2001, and declined after this to approximately 200 tonnes per year from early 2001 to May 2004. The reason for this break in the data is unclear and may be due to a data weakness. For this reason, and given the data in each curve mirror the same peaks and troughs, imports excluding Hong Kong-flagged shipments by sea are used in the demand analysis. However, the results should be considered in light of this.

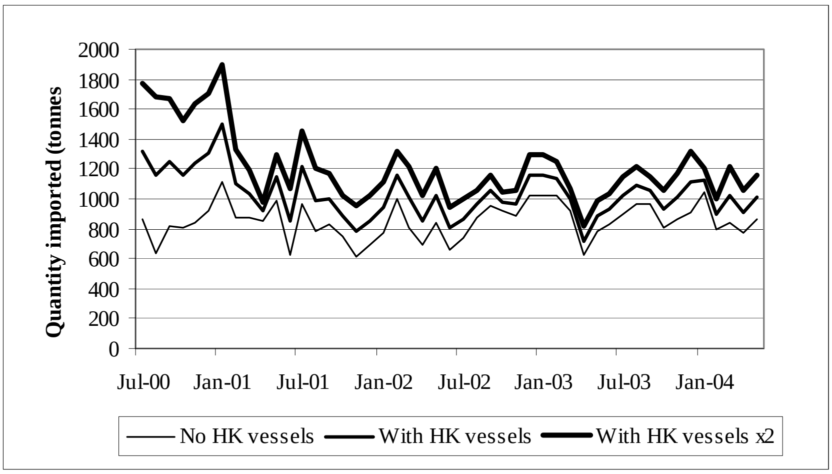

Figure 1: Quantity of live reef fish imported into Hong Kong, July 2000 to May 2004

The data excluding Hong Kong-flagged shipments by sea (the lowest line in Figure 1) do not appear to be trending upwards or downwards. However, they do provide evidence of peaks during Chinese New Year (January 2001, February 2002, February

2003 (to a lesser extent), and January 2004). Quantity demanded spiked downwards in February to June 2003 during the SARS epidemic.

Figure 2 shows the weighted average price of live reef fish, imported into Hong Kong from July 2000 to May 2004. Price appears to be trending upwards until January 2002, after which it ha been trending downwards. Price dropped dramatically during the SARS epidemic, but recovered strongly in August 2003. There does not appear to be obvious spikes in price during Chinese New Year (although spikes may be evident with individual species during this festival).

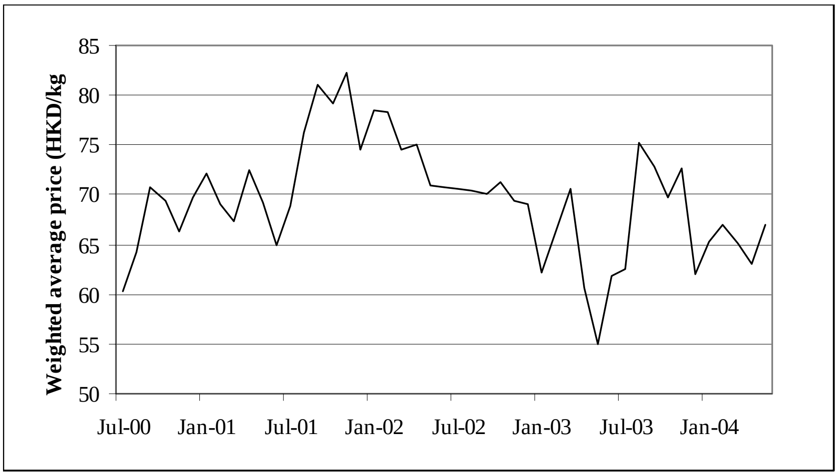

Figure 2: Weighted average price of live reef fish in aggregate, July 2000 to May 2004

Income is measured through real GDP per capita. Figure 3 displays real GDP per capita data in Hong Kong from July 2000 to December 2003. As noted in the previous section, GDP per capita growth was very slow during these years due to a slow-down in the global economy, the Asian economic crisis and the economic effects of SARS (this latter effect is evidenced in the decrease in total GDP per capita from January to July 2003). Given this slow growth, it is unlikely that any significant income-related trends can be drawn from the live reef fish trade data. It is expected that income will grow more strongly in the next few years. This may allow income-related trends in import demand to be estimated in more detail in the future.

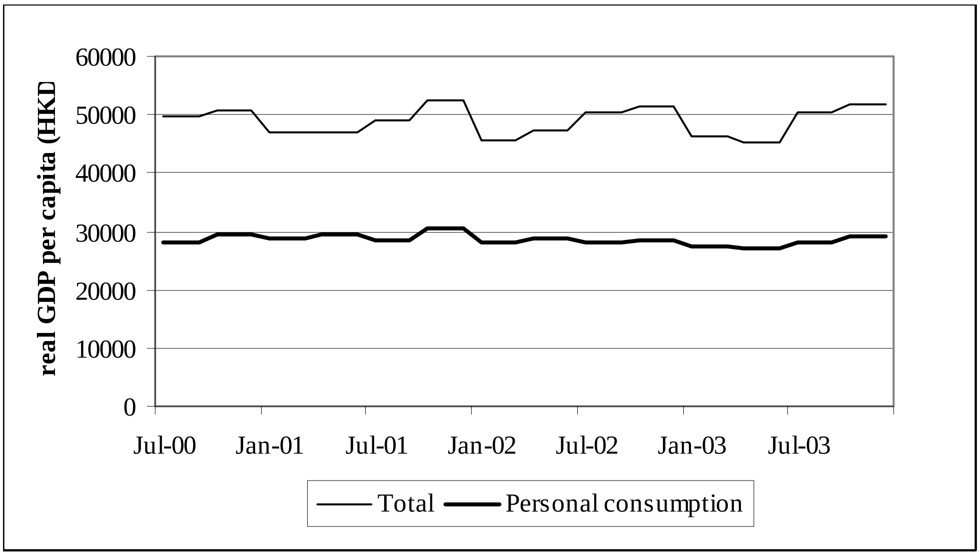

Figure 3: Real GDP per capita over time, total and personal consumption only

Hong Kong's population grew steadily by just over 1 percent per year from July 2000 to December 2003, totaling just over 6.8 million at the end of this period (Figure 4). The main lunar festival that is likely to affect live reef fish demand is Chinese New Year. This festival is included in the model as a dummy variable. Table 2 shows the dates when Chinese New Year occurred from 2000 to 2004. Preliminary analysis showed that other festivals, such as Mothers Day, did not significantly affect import demand for any live reef fish species and was omitted from the analysis.

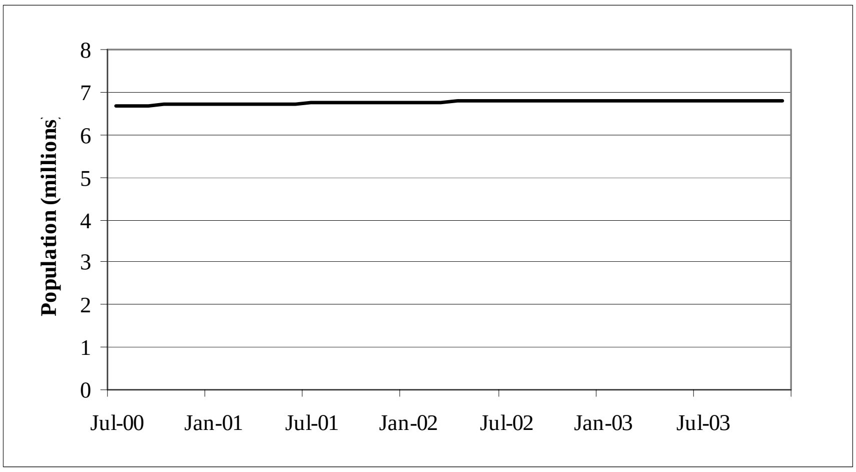

Figure 4: Hong Kong population, July 2000 to December 2003

Table 2: Date of Chinese New Year - 2000 to 2004

Year	*Date*
2000	05 February
2001	24 January
2002	12 February
2003	1 February
2004	22 January

The effects of the Asian Economic Crisis, which began with the forced devaluation of Thailand's baht in the second half of 1997, could not be estimated as the data is not available prior to 2000. However, the data does span the years in which SARS swept through Asia and other areas of the world. SARS created a short-term impact on demand, with local consumption and the export of services related to tourism and air travel severely affected. The outbreak started in the Chinese province of Guangdong in November 2002 and was first reported in Hong Kong in February 2003. Hong Kong was removed from the World Health Organization's SARS infected areas list by the end of June 2003.

3.1 Demand for live reef fish in aggregate

Results of the linear regression analysis for live reef fish in aggregate are shown in Table 3. The overall model is significant (although the F-statistic is low) with a relatively strong adjusted-R^2 for time-series data. However, all coefficient estimates but the Chinese New Year (CNY) dummy variable, are insignificant. This indicates that consumption is relatively unaffected by changes in price, income and population, and due to the occurrences of SARS. It is estimates that quantity demanded increases during Chinese New Year by approximately 260 tonnes. While the income elasticity is very low, and the population elasticity is very high, the coefficients relating to these variable are insignificant, and hence these elasticity measures may be misleading. Note that there is no evidence of autocorrelation (the p-value of the Durban-Watson statistic is 0.94), and estimation of per capita demand and an inverse demand function provided similar results as those presented in Table 3.

Table 3: Estimated demand coefficients and calculated elasticities for aggregated live reef fish

Variable	*Estimated coefficient*	t-*statistic*	*Calculated elasticity*
Price	-5,384.40	1.61	-0.44
CNY dummy	259,517.50	*3.70* ***	
GDP per capita	1.38	0.16	0.08
Population	0.64	0.34	5.09
SARS dummy	-114,341.00	1.58	
Model *F* statistic:	3.13		
Model *p*-value:	0.02		
Adj-R^2:	0.21		
Number of observations:	42		

Note: *** indicates significance at the 1% level, two-tailed test.

3.2 Demand for live reef fish - disaggregated into low, medium and high-valued species

The quantity and price data were disaggregated into low, medium and high-value species as shown in Table 1. The quantity imported and weighted average prices of these categories through time are shown in Figures 5 and 6. Import quantities of the high-value species are extremely small compared with the low and medium-value species. Import quantities seem to be relatively constant over time, with low-value species increasing slowly and medium-value species decreasing slowly. The prices of low and medium-value species are relatively constant through time compared with the high-value species, whose price trended upward until early 2001 and down since then. There is some evidence of a slow increase in prices of medium-value species.

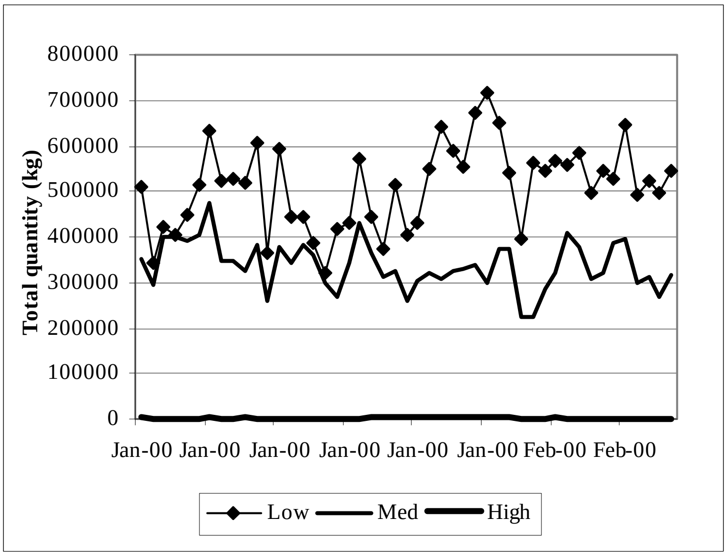

Figure 5: Quantity of live reef fish imported into Hong Kong divided into low, medium and high-value categories

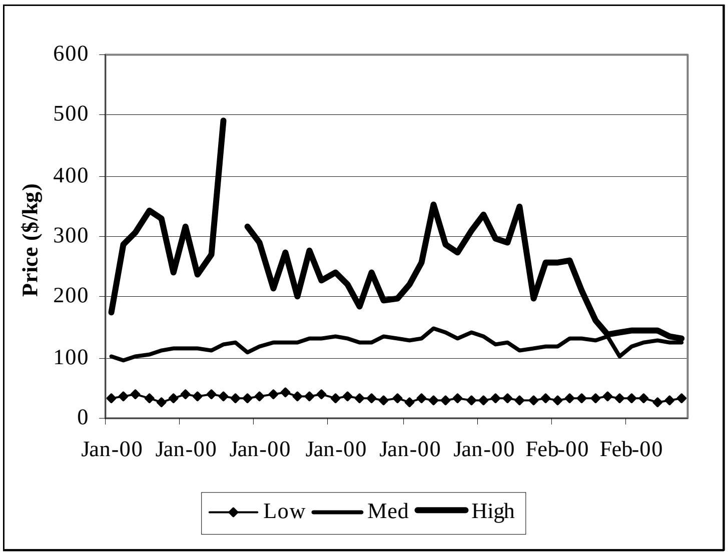

Figure 6: Weighted average price of live reef fish imported into Hong Kong divided into low, medium and high-value categories

Results of linear regression analyses for each price category are shown in Table 4, and the calculated elasticities are shown in Table 5. Each of the overall models for each category are significant, however, all estimates but the Chinese New Year (CNY) dummy variable (in the case of the low-value and medium-value categories) and the cross-price variables (in the case of the high-value category), are insignificant. The results indicate that during Chinese New Year, quantity demanded increases by approximately 135,000kg and 112,000kg, for the low and medium-value categories, respectively. The different signs of the cross-price elasticities (in the case of the medium and high-value categories) is difficult to explain and may be due to too few observations. The positive sign of the own-price elasticity for the high-value species is unexpected and may indicate that they are Veblen goods - goods whose consumption increases as a direct function of its price (Leibenstein 1950). Consumers may be willing to purchase higher quantities as price increases, as a gesture of prestige and favour. This relationship will be investigated further in the next section.

Table 4: Estimated demand coefficients for low, medium and high-value live reef fish

Variable	*Low-value*		*Medium-value*		*High-value*	
	Estimated coefficient	t-*statistic*	*Estimated coefficient*	t-*statistic*	*Estimated coefficient*	t-*statistic*
Price - Low value	-4423.42§	0.96	1080.21	0.44	-156.66	2.47**
Price - Med value	1947.14	1.11	-428.96§	0.46	46.67	1.94*
Price - High value	248.04	1.06	-9.04	0.07	2.73§	0.85
CNY dummy	135330.90	2.44**	112172.80	3.85***	977.02	1.29
GDP per capita	0.89	0.13	3.61	1.01	-0.10	1.04
Population	0.45	0.68	-0.17	0.49	-0.00	0.43
SARS dummy	63.27	0.00	-42841.00	1.36	-474.63	0.58
Model F statistic:	2.42		3.56		2.68	
Model p-value:	0.04		0.01		0.03	
Adj-R^2:	0.20		0.31		0.23	
No of observations:	41		41		41	

Note: ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.
§ indicates own-price coefficients.

Table 5: Calculated elasticities for low, medium and high-value live reef fish

Variable	*Low-value*	*Medium-value*	*High-value*
Price - Low value	-0.30§	0.11	-2.54
Price - Med value	0.47	-0.16§	2.79
Price - High value	0.12	-0.01	0.33§
GDP per capita	0.09	0.52	-2.29
Population	5.96	-3.46	-12.89

Note: § indicates own-price elasticities.

3.3 Demand for live reef fish - individual species

The estimated demand coefficients and calculated elasticities for the low-value species are provided in Tables 6 and 7, respectively. Each of the models are significant except for Flowery grouper. All species show a negative impact of price on quantity demanded. All species show inelastic demand, except for Green grouper, which is a low-value species imported in relatively high quantities. "Other marine fish" results show only one significant variable, the cross-price coefficient for high-value species. Results for Mangrove snapper suggest that Chinese New Year, GDP per capita, population and SARS all influence quantity demanded. For GDP per capita, this implies that as income grows consumption decreases, perhaps as consumers substitute high-value for lower and medium value species. Green grouper results show two significant variables, own-price and CNY. No variables were significant in the analysis for Flowery grouper.

Results for a preferred model (defined as the most significant model where all independent variables are significant and explicable) are presented in Table 8. Green grouper is the only low-value species where own-price affects demand. Chinese New Year has a significant influence on demand for Mangrove snapper and Green grouper. Results indicate that SARS has a negative impact on Mangrove snapper demand, but no significant effect on the other species. Medium-value species appear to be substitutes for "Other marine fish". Data limitations prevent the analysis of a preferred model for Flowery grouper.

Tables 9 and 10 display results for estimated demand coefficients and calculated elasticities for medium-value species, respectively. The models for Giant grouper and Spotted coral trout are not significant. Each of the species in this category show negative own-price elasticities except for Leopard coral trout, which seems to defy the law of diminishing demand. This may be due to data limitations, but also may be representative of Veblen good type qualities, where the higher the price, the more people are willing to consume as a show of favour and prestige. Leopard coral trout is popular due to its red colour - a colour symbolising good fortune in Chinese culture.

The results for a preferred model for each of the medium-value species are shown in Tables 11 and 12. Own-price effects are important for "Other groupers", Tiger grouper and Leopard coral trout. Cross price effects are important for "Other groupers" and Spotted coral trout. The population elasticity is inexplicably high for Tiger grouper. GDP per capita has a significant positive impact on Leopard coral trout. If this species is a Veblen good, then it is intuitive that demand increases as GDP per capita increases.

Regression results for high-value species are provided in Tables 13 and 14. Both of these species appear to defy the law of diminishing demand. The own-price elasticity is not significant for Humphead wrasse, but is positive and strongly significant for Humpback grouper. Cross-price elasticities are important for both species.

Table 6: Estimated demand coefficients for the low-value live reef fish species

Variable	*Other marine fish*		*Mangrove snapper*		*Green grouper*		*Flowery grouper*	
	Estimated coefficient	t-*statistic*	*Estimated coefficient*	t-*statistic*	*Estimated coefficient*	t-*statistic*	*Estimated coefficient*	t-*statistic*
Own-price	-6.05	1.11	-27.60	0.15	-5554.67	3.03***	-26.75	0.36
Price - Med value	2325.46	1.49	47.10	0.22	-404.76	0.64	-13.19	0.09
Price - High value	358.85	1.85*	-4.00	0.15	-86.20	1.02	-0.54	0.03
CNY dummy	62985.00	1.40	13884.60	2.29**	61307.21	3.14***	-1546.29	0.32
GDP per capita	2.33	0.41	-2.48	3.11***	1.56	0.64	-0.01	0.02
Population	0.64	1.23	-0.28	3.52***	-0.36	1.22	-0.01	0.11
SARS dummy	18164.86	0.63	-16388.80	2.3**	11150.61	0.51	-1428.30	0.29
Model F statistic:	2.96		11.35		3.03		0.14	
Model p-value:	0.02		0.00		0.01		0.99	
Adj-R^2:	0.26		0.66		0.26		-0.18	
Number of obs:	41		35		41		41	

Note: ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Table 7: Calculated elasticities for the low-value live reef fish species

Variable	*Other marine fish*	*Mangrove snapper*	*Green grouper*	*Flowery grouper*
Own-price	-0.00	-0.05	-2.70	-0.18
Price - Med value	0.80	0.28	-0.42	-0.14
Price - High value	0.25	-0.05	-0.180	-0.01
GDP per capita	0.32	-5.64	0.64	-0.05
Population	12.02	-87.80	-20.67	-3.22

Table 8: Estimated demand coefficients and calculated elasticities for the low-value live reef fish species - preferred model

Variable	*Other marine fish*			*Mangrove snapper*			*Green grouper*		
	Estimated coefficient	t-*statistic*	*Calculated elasticity*	*Estimated coefficient*	t-*statistic*	*Calculated elasticity*	*Estimated coefficient*	t-*statistic*	*Calculated elasticity*
Own-price	-	-	-	-	-	-	-2416.08	2.85***	-1.18
Price - Med value	3024.99	3.23***	1.04	-	-	-	-	-	-
Price - High value	-	-	-	-	-	-	-	-	-
CNY dummy	-	-	-	23049.46	2.49**	-	48160.73	3.10***	-
GDP per capita	-	-	-	-	-	-	-	-	-
Population	-	-	-	-	-	-	-	-	-
SARS dummy	-	-	-	-19024.24	2.59**	-	-	-	-
Model *F* statistic:	10.44			5.45			8.89		
Model *p*-value:	0.00			0.01			0.00		
Adj-R^2:	0.17			0.17			0.26		
No of observations:	47			45			47		

Note: ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Table 9: Estimated demand coefficients for the medium-value live reef fish species

Variable	*Other groupers*		*Tiger grouper*		*Giant grouper*		*Spotted coral trout*		*Leopard coral trout*	
	Est. coeff.	*t-stat*	*Est. coeff.*	*t-stat*	*Est. coeff.*	*t-stat*	*Est. coeff.*	*t-stat*	*Est. coeff.*	*t-stat*
Own-price	-380.21	1.08	-363.04	3.89***	-15.31	0.28	-26.82	0.96	775.39	1.01
Price - Low	775.87	0.44	451.38	1.56	15.41	0.10	192.82	1.62	-173.67	0.10
Price - High	-42.87	0.48	-14.97	1.07	2.77	0.40	2.62	0.46	72.52	0.88
CNY dummy	42168.71	1.97*	6270.76	1.77*	-124.15	0.05	497.70	0.34	47365.59	1.93*
GDP per cap	-4.95	1.88*	-0.68	1.41	-0.08	0.34	0.13	0.72	7.40	2.85***
Population	-0.62	3.10***	0.14	4.81***	0.00	0.34	-0.02	1.23	0.23	1.17
SARS dummy	-8327.79	0.40	-8265.35	2.21**	3092.77	2.02**	-580.01	0.40	-27084.00	1.27
Model F stat:	6.44		6.6		1.47		1.47		3.97	
Mod p-value:	0.00		0.00		0.24		0.21		0.00	
Adj-R^2:	0.49		0.50		0.12		0.08		0.34	
Number of obs:	41		41		26		41		41	

Note: ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Table 10: Calculated elasticities for the medium-value live reef fish species

Variable	*Other groupers*	*Tiger grouper*	*Giant grouper*	*Spotted coral trout*	*Leopard coral trout*
Own-price	-0.26	-2.87	-0.74	-0.48	0.64
Price - Low value	0.19	1.23	0.25	0.82	-0.03
Price - High value	-0.08	-0.30	0.33	0.08	0.10
GDP per capita	-1.76	-2.70	-1.76	0.83	2.02
Population	-30.34	75.37	14.76	-13.70	8.78

Table 11: Estimated demand coefficients for the medium-value live reef fish species - preferred model

Variable	*Other groupers*		*Tiger grouper*		*Spotted coral trout*		*Leopard coral trout*	
	Est. coeff.	t-*stat*	*Est. coeff.*	t-*stat*	*Est. coeff.*	t-*stat*	*Est. coeff.*	t-*stat*
Own-price	-850.52	2.63**	-312.94	3.89***	-	-	1699.20	3.05***
Price - Low value	4790.85	2.88***	-	-	340.64	3.32***	-	-
Price - High value	177.43	2.14**	-	-	-	-	-	-
CNY dummy	-	-	8529.79	2.41**	-	-	-	-
GDP per capita	-	-	-	-	-	-	6.50	3.06***
Population	-	-	0.13	5.19***	-	-	-	-
SARS dummy	-	-	-6581.05	2.19**	-	-	-	-
Model *F* statistic:	6.50		9.44		11.04		10.47	
Model *p*-value:	0.00		0.00		0.00		0.00	
Adj-R^2:	0.27		0.45		0.18		0.32	
Number of obs:	46		42		47		42	

Note: ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Table 12: Calculated elasticities for the medium-value live reef fish species - preferred model

Variable	*Other groupers*	*Tiger grouper*	*Spotted coral trout*	*Leopard coral trout*
Own-price	-.059	-2.47	-	1.39
Price - Low value	1.16	-	1.44	-
Price - High value	0.32	-	-	-
GDP per capita	-	-	-	1.78
Population	-	69.52	-	-

Table 13: Estimated demand coefficients and calculated elasticities for the high-value live reef fish species

Variable	*Humphead wrasse*			*Humpback grouper*		
	Est. coefficient.	t-*statistic*	*Calc. elasticity*	*Est. coefficient.*	t-*statistic*	*Calc. elasticity*
Own-price	0.49	0.20	0.07	1.42	1.61	0.60
Price - Low value	-132.27	2.68**	-2.93	-17.38	0.67	-0.88
Price - Med value	27.75	1.42	2.28	22.20	2.48**	4.15
CNY dummy	275.61	0.46	-	667.03	2.23**	-
GDP per capita	-0.11	1.48	-3.53	0.02	0.39	1.13
Population	0.00	0.36	-11.58	0.00	0.18	-6.58
SARS dummy	-747.26	1.15	-	247.88	0.77	-
Model *F* statistic:	2.19			3.03		
Model *p*-value:	0.06			0.02		
Adj-R^2:	0.17			0.27		
Number of obs:	41			39		

Table 14: Estimated demand coefficients and calculated elasticities for the high-value live reef fish species - preferred model

Variable	*Humphead wrasse*			*Humpback grouper*		
	Est. coefficient.	t-*statistic*	*Calc. elasticity*	*Est. coefficient.*	t-*statistic*	*Calc. elasticity*
Own-price	-	-	-	1.81	2.79***	0.76
Price - Low value	-80.96	2.14**	-1.8	-	-	-
Price - Med value	24.01	2.08**	1.97	21.08	3.50***	3.94
CNY dummy	-	-	-	649.73	2.44**	-
GDP per capita	-	-	-	-	-	-
Population	-	-	-	-	-	-
SARS dummy	-	-	-	-	-	-
Model *F* statistic:	5.40			8.08		
Model *p*-value:	0.01			0.00		
Adj-R^2:	0.16			0.34		
Number of obs:	46			42		

Note: ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

4. Conclusions

Import demand functions for live reef fish in Hong Kong were estimated using single equation linear regression analysis. The aim of the paper is to conduct initial data exploration before estimating demand systems for the fishery. Monthly time-series data from July 2000 to May 2003 were obtained from the Hong Kong Agriculture, Fisheries and Conservation Department. A number of independent variables were used, including prices (own-price as well as prices of other live reef fish species), income (GDP per capita), population of Hong Kong and dummy variables to account for the month in which the Chinese New Year festival is held and the outbreak of SARS.

Estimation was performed in three stages. First, import demand was estimated for all live reef fish species in aggregate. The own-price elasticity for the estimated demand function was inelastic and insignificant. The only significant variable in the estimated function was the Chinese New Year dummy variable, indicating that quantity demanded increases by approximately 250 tonnes during Chinese New Year.

In the second stage, the live reef fish species were categorised as either low, medium and high-value species, and three separate demand functions were estimated. In the case of the low and medium-value species, the own-price elasticities were negative, inelastic and insignificant. Quantity demanded for these low and medium-value species was affected by the occurrence of Chinese New Year alone. In the case of the high-value species, the own-price elasticity was positive, elastic and strongly significant. Quantity demanded was also shown to be affected by the price of substitutes (low and medium-value live reef fish species).

The third stage of the analysis was to estimate demand functions for each species separately. Of the eleven species estimated, the eight lowest priced species all exhibited negative own-price elasticities and the three highest priced species (Leopard coral trout, Humphead wrasse and Humpback grouper) all exhibited positive own-price elasticities. A preferred model (defined as the most significant model where all independent variables are significant and explicable) was estimated for each species. The own-price and cross-price elasticities and Chinese New Year impacts were significant for many of the low, medium and high-value species. There was evidence of significant negative impacts of SARS on Mangrove snapper and Tiger grouper. Leopard coral trout showed significant and positive impact from its own-price and GDP per capita.

In summary, the own-price elasticity was not as strong an indicator of import demand as was expected. Chinese New Year was a stronger indicator of import demand than price, and income had very little influence (although there was very little trend in income over the time period making it difficult to draw out any trends). This may be a result of problems with data (the number of observations ranged from 35 to 47 depending on the species). It also may indicated the unique nature of live reef fish, where consumption is determined by cultural events and is largely unrelated to price and income.

The positive impact of price on import demand for the three highest valued species may be a result of data limitations, or it may be reflecting the "prestige" nature of these species. They are consumed in especially high quantities in celebration of a lunar festival (in the case of Chinese New Year) or to celebrate other occasions such as the closing of a business deal or to honour a favoured visitor. In these cases, the level of honour placed upon the occasion is positively related to the price of the live reef fish consumed. This positive correlation is evidenced in a significant positive impact of price on import demand for these species in Hong Kong. As such they are Veblen goods - goods where consumption increases as a direct function of price. In our analysis, they include Leopard coral trout (which is especially favoured due to its bright red colour which symbolises good fortune in Chinese culture), Humphead wrasse (the most endangered species) and Humpback grouper.

Further analysis must be conducted to verify these findings. Demand systems should be estimated in case changes in the price of goods omitted from the specification are causing changes in demand for the commodity in question through changes in expenditure. Moreover, this estimation should be repeated in the future when more observations are available. Lastly, there is evidence that the price received for live reef fish depends on the country of origin. Estimation of demand systems by origin would provide useful information on these price differences.

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