Arab Journal of Administrative Sciences

2003, Vol. 10, No. 2, 229 - 249

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DEMAND FOR FISH IN KUWAIT: POLICY REFORMS AND THEIR IMPLICATIONS FOR CONSUMER WELFARE

Key Words

Demand Systems; Rotterdam Model; Expenditure and Cross-Price Elasticities; Catch Restrictions; Compensating Variation; Consumer Surplus.

Abstract

This paper estimates demand functions for eleven types of fish that are mostly consumed in Kuwait. Toward this end, quarterly time series data on retail consumption and prices from the period 1974-1998 were used to determine the factors influencing the demand for the individual fish species. The retail demands for the fish groups were analyzed via the Rotterdam model. The empirical results from the system suggest that the demand relationships for most fish species are characterized by high price elasticities meaning that the retail consumptions are highly responsive to changes in their respective prices. In addition, the finding indicates that cross-price elasticities between fish species are mostly positive but in general are moderate in the sense that the retail consumption of any specific type will increase moderately in response to an increase in prices of other species. The short-run welfare costs on the consumers from hypothetical regulatory catch restrictions were also measured and were found to be small.

Introduction

Over the past two decades the average annual per capita growth rate of fish consumed in Kuwait at the retail level was approximately 3.5 percent while the average annual growth rate of the real price was 4 percent. Empirically, fish consumption has risen even though it has become more expensive. Despite this increase in per capita fish no study has used a system of demand equations to consider the impact of total expendi-

Submitted April 2002, accepted March 2003.

ture, prices, and other economic variables on the retail demand for fish within a framework consistent with consumer demand theory in order to adequately explain the pattern of increased consumption. To date, there has been only one study that used single equation methodology with double log specification to relate quantity consumed of disaggregate species of fish to its own prices, prices of close substitutes as well as complements, and per capita income (Shaban, 1987). However, the single equation approach has two major drawbacks: First, the exogenous variables are added on an ad hoc basis. Second, this approach usually violates the conditions imposed by the consumer demand theory, in particular the adding-up and symmetry conditions.[1]

As the popularity of fish in Kuwait continues to grow, more accurate and updated estimates of the variables influencing the demand for fish will be important for producers, investors, and policy makers. Local companies that harvest fish from the Arabian Gulf require accurate information about expenditure elasticities, own- and cross-price elasticities of demand for all different types of fish so they can make more sound decisions concerning optimal quantities and prices in response to shifts in demand or supply. As an example, with little knowledge about the nature of the demand curve for fish in Kuwait, producers in the fisheries sector may assume it is relatively inelastic. Given an inelastic demand curve, an increase in the supply of fish, other things remaining constant, will result in a fall in the prices and total revenue. Producers are concerned that the expansion of the output of fisheries may put downward pressures on prices and revenue. Whether the demand curve for fish is elastic or inelastic remains an open question that needs to be answered. Estimates of demand elasticities are also useful for feasibility studies and hence, investment decisions. With increasing amount of fish being imported during the last decade, fish farming projects may be attractive for potential investors.[2] Thus, understanding consumer demand patterns for fish becomes useful in the development of new technologies and markets. Finally, policy makers need some ranges of expenditure and price elasticities to measure changes in consumer welfare under alternative scenarios. For example, the Public Authority for Agriculture and Fisheries in Kuwait has recently been considering fish

1 See Deaton and Muellbauer (1980) for details.

2 In 1998, quantities of net imports made up approximately 47 percent of the total quantities of fish coming into the market.

catch restrictions, arguing that the future fish stocks will decline in a significant rate due to fish kill crisis and over-fishing activities. Without demand estimates (own- and cross-price elasticities) it would be very difficult to measure the welfare loss to the consumer from harvest reductions. In short, lack of demand estimates would complicate the process of measuring the social benefits and costs of natural resource policies and industrial incentives programs targeting the fish commodity.

Based on these conditions, and taking into account the advantages of using a systems approach that recognizes explicitly the interrelationships among a group of commodities rather than single equation methodology (Barten, 1977), the main objectives of this study are:

(1) Estimate a system of demand functions for eleven types of fish that are mostly consumed in Kuwait using quarterly time series data from 1974-1998.

(2) Measure the consumer welfare loss resulting from harvest or catch restrictions on the individual species within the group of fish using the estimated demand functions.

Theoretical Framework

There are, in general, various specifications and functional forms of demand systems that can be used to fulfill our objectives from this study. Examples of empirically tractable demand systems include the Linear Expenditure System of Stone (1954), the Rotterdam Model (Theil, 1980), the Translog Demand System (Christensen *et al.*,1975), the Almost Ideal Demand System (AIDS) of Deaton and Muellbauer (1980), the Fourier Flexible Form (Gallant,1984), and the Miniflex Laurent (Barnett, 1983).[3]

This study adopts the absolute price version of the Rotterdam model to estimate the demand functions. This specification was chosen because it is based on consumer demand theory. In addition, the system is linear in parameters and considered to be flexible functional form (Mountain, 1988).[4]

The starting point of the Rotterdam model is to assume the existence of a system of ordinary demand functions that solves the utility maximiza-

3 For empirical studies on demand for fish, see for example: Cheng and Capps (1988); Burton (1992); and Kusumastanto and Jolly (1997).

4 Each system has its own merits and limitation. Aside from this fact, the basic criteria that have been suggested when choosing a functional form are: consistency with economic theory, simplicity of computation and statistical precision in fitting the data. See Lau (1986) for discussions.

tion problem subject to the linear budget constraint. If we let the demand function for the i^{th} commodity take the following form:

(1) $q_i = g_i(x, p)$

Where x is total consumer expenditure and p is an n-vector of prices of commodities. The total differential of (1) is:

(2) $dq_i = \frac{\partial g_i}{\partial x} dx + \sum_{j=1}^{m} \frac{\partial g_i}{\partial p_j} dp_j$

If we use the proportional change operator ($dy/y = dlogy$), then (2) can be written in a linear logarithmic differential form as:

(3) $dlogq_i = \frac{\partial g_i}{\partial x} \times \frac{x}{q_i} dlogx + \sum_{j=1}^{m} \frac{\partial g_i}{\partial p_j} \times \frac{p_j}{q_i} dlogp_j$

$$= e_i dlogx + \sum_{j=1}^{m} e_{ij} dlog\ p_j$$

Where e_i is the expenditure elasticity and e_{ij} is the uncompensated cross-price elasticity. If we substitute the Slutsky equation ($e_{ij} = e^*_{ij} - e_i w_j$; where e^*_{ij} is the compensated cross-price elasticity) into (3) and multiply both sides by w_i to ensure symmetry ($w_i e^*_{ij} = w_j e^*_{ji}$), we get:

(4) $w_i dlogq_i = w_i e_i (dlogx - \sum_{j=1}^{m} w_j dlogp_j)$

$+ \sum_{j=1}^{m} w_j e^*_{ij} dlogp_j = \eta_i (dlogx - \sum_{j=1}^{m} w_j dlogp_j)$

$+ \sum_{j=1}^{m} \theta_{ij} dlog\ p_j$

Where $\eta_i = w_i e_i$ and $\theta_{ij} = w_i e^*_{ij}$. Equation (4) is the absolute price version of the Rotterdam model. For more discussion see, for example, Theil (1980); Deaton and Muellbauer (1980). For application see Brester and Wohlgenant (1991); Brester and Schroeder (1995).

The restrictions on the parameters are:

(5) (A) Adding up: $\sum_{i=1}^{n} n_i = 1$ and $\sum_{i=1}^{n} \theta_{ij} = 0$

(6) (B) Homogeneity: $\sum_{j=1}^{m} \theta_{ij} = 0$

(7) (C) Symmetry: $\theta_{ij} = \theta_{ij}$ for all i and j

(8) (D) Negativity $\theta_{ij}/w_i = e^*_{ii} < 0$

The expenditure, compensated and uncompensated price elasticities are given respectively as:

(9) $e_i = \frac{\eta_i}{w_i}$

(10) $e^*_{ij} = \frac{\theta_{ij}}{w_i}$

and, from the Slutsky equation the expression for the uncompensated price elasticity is:

(11) $e_{ij} = \frac{\theta_{ij} i}{w_i} - \frac{\eta_i}{w_i} w_j$

Data and Empirical Specification

Quarterly time series data covering 1974.1-1998.4 on per capita consumption of eleven types of fish and their retail prices were used to estimate the demand system. The data were obtained from various publications of the Annual Statistical Abstract and Fisheries Statistics issued by the Central Statistical Office-Ministry of Planning in the State of Kuwait. The data are seasonally unadjusted. As pointed out by Wallis (1974) adjusted data could yield a misleading representation of the underlying relation between variables. Thus, by using seasonally unadjusted data we hope to show better structural relationships among variables.[5]

The eleven types of commercial fishes used in this research are: (1) Silvery pomfret (Zobaidy), (2) River shad (Suboar), (3) Silvery grunt (Nakroor), (4) Brown spotted grouper (Hamoor), (5) Blue spotted mullet (Maid), (6) Silvery croaker (Newaiby), (7) Barred Spanish mackerel (Chanied), (8) Crimson snapper (Hamrah), (9) Large-scale mullet (Beyah), (10) Yellow finned black porgy (Sheim), and (11) Others types of fish. Table 1 shows descriptive statistics on the variable used to estimate the demand system. As can be seen in the table, Silvery pomfret and Brown spotted grouper are the dominant types. Figures 1 show the consumption levels and prices for the dominant four types of fish over the whole sample period. Both consumption and prices show wide ranges; part of the variation is explained by seasonality and part of it is explained by trend. However, by visual inspection one can argue that consumption displays a wider range than prices. It is important to note that consumption of each type of fish is not determined solely by consumer demand but by the interaction of the supply as well. The supply of each type is variable by nature and may affect consumption patterns. Not only are fish species seasonally determined, but they also fluctuate in abundance through time as we have seen in the figure. In addition, cultural and religious factors can also affect the consumption patterns.

Nevertheless, a detailed disaggregate study such as what we intend to report relies heavily on the assumptions of weak separability in this case between the eleven types of fish and all other consumption commodities. Assuming a separable group allows for multistage budgeting and thus, we can estimate a system of conditional demand functions for the individual species within the group of fish using only consumption levels, prices, and budget allocation to the fish group.[6]

Prior to the econometric estimation, the Rotterdam model specification [equation (4)] has to be modified in several respects. We have added constant terms and disturbance terms to the system. Seasonal dummy vari-

5 In other words, consumption patterns for fish species represent possible structural changes rather than seasonal fluctuations.

6 Pudney (1981) provides a formal discussion on separability concepts.

Table 1
Descriptive Statistics: Species within the Group of Fish

Variable Name	Sample Average	Standard Deviation	Maximum Value	Minimum Value
Total Retail Consumption				
Silvery Pomfret (q_1)	247,669	210,351	1,007,189	38,320
River Shad (q_2)	88,785	85,327	448,034	11,128
Silvery Grunt (q_3)	88,578	70,041	379,268	31,793
Brown Spotted Grouper (q_4)	153,293	107,451	439,153	17,813
Blue Spotted Mullet (q_5)	79,604	50,884	315,200	8,950
Silvery Coraker (q_6)	92,826	115,843	573,066	4,806
Barred Spanish Mackerel (q_7)	15,663	11,602	58,910	60
Crimson Snapper (q_8)	40,503	21,892	109,560	8,456
Large-Scaled Mullet (q_9)	19,988	12,764	52,152	3,172
Yellow Finned Black Porgy (q_{10})	40,651	43,372	251,975	3,413
Retail Price				
Silvery Pomfret (p_1)	1.95	0.79	4.45	0.49
River Shad (p_2)	1.00	0.46	1.99	0.32
Silvery Grunt (p_3)	1.33	0.32	2.25	0.39
Brown Spotted Grouper (p_4)	1.43	0.51	2.48	0.34
Blue Spotted Mullet (p_5)	0.41	0.12	1.04	0.18
Silvery Coraker (p_6)	1.03	0.36	1.78	0.33
Barred Spanish Mackerel (p_7)	1.14	0.37	1.69	0.34
Crimson Snapper (p_8)	0.72	0.23	1.21	0.16
Large-Scaled Mullet (p_9)	1.21	0.41	2.06	0.39
Yellow Finned Black Porgy (p_{10})	1.72	0.69	2.95	0.40
Budget Share (%)				
Silvery Pomfret (w_1)	32.56	13.00	60.92	8.53
River Shad (w_2)	5.59	3.25	17.35	1.11
Silvery Grunt (w_3)	9.52	4.79	29.88	2.59
Brown Spotted Grouper (w_4)	15.04	5.86	27.41	3.76
Blue Spotted Mullet (w_5)	2.91	2.08	9.24	0.23
Silvery Coraker (w_6)	5.35	3.34	13.34	0.98
Barred Spanish Mackerel (w_7)	1.39	1.08	7.30	0.03
Crimson Snapper (w_8)	2.52	1.60	7.40	0.48
Large-Scaled Mullet (w_9)	2.08	1.39	7.99	0.23
Yellow Finned Black Porgy (w_{10})	4.49	3.15	14.09	0.75
Total expenditure on fish (x)	**1,470,705**	**1,077,109**	**3,939,119**	**259,034**

Figure 1. (a)
Variation in Retail Consumtion of Silvery Pomfret (SP), and River Shad (RS)

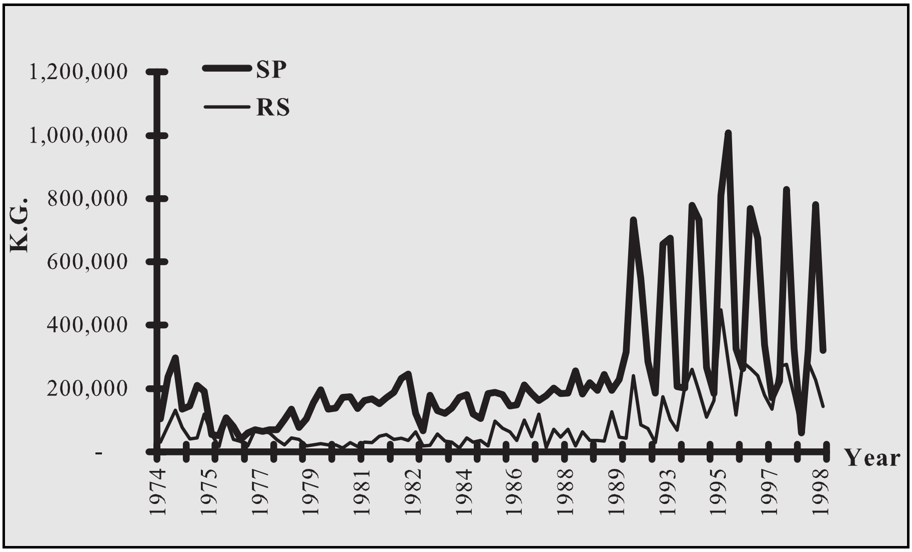


Figure 1. (b)
Variation in Retail Consumtion of Brown Spotted Grouper (BSG), and Sivery Coraker

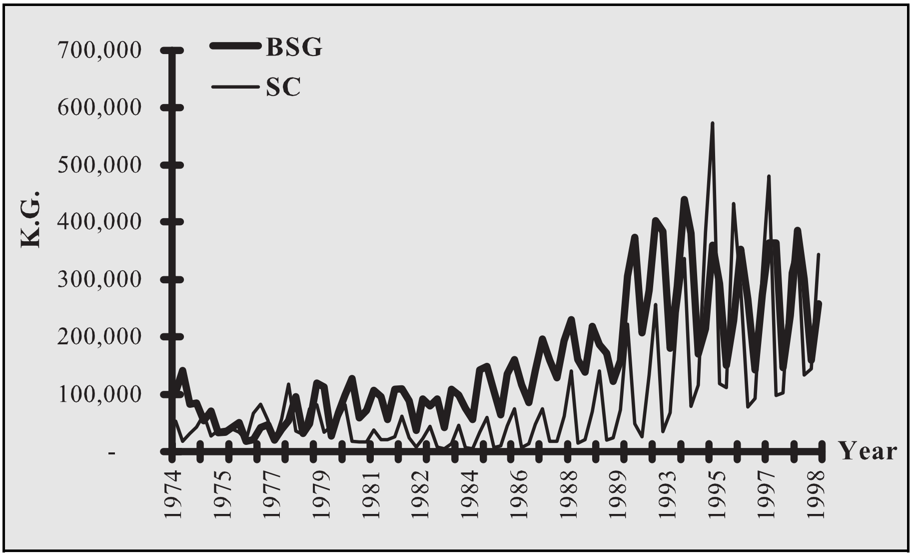


Figure 1. (c)
Variation in Retail Pricese of Silvery Pomfret (SP), and River Shad (RS)

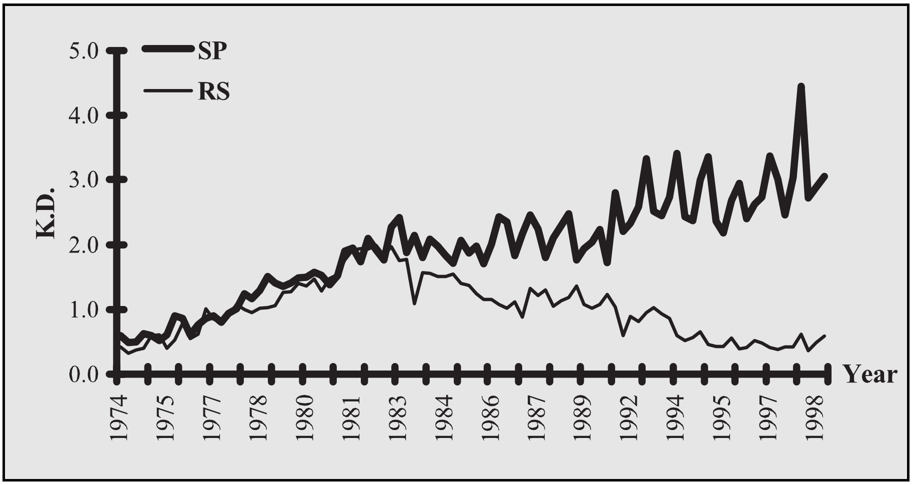
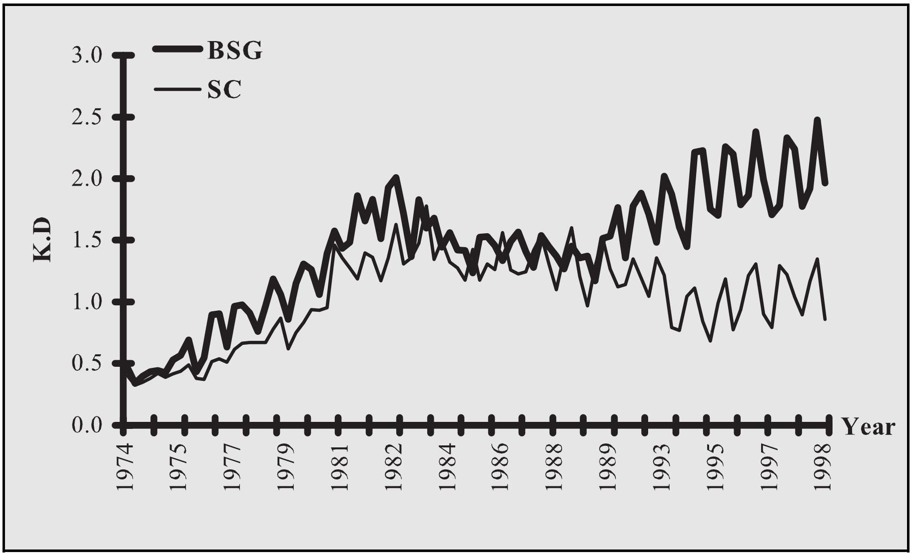


Figure 1. (d)
Variation in Retail Consumtion of Brown Spotted Grouper (BSG), and Sivery Coraker



ables were also added to account for seasonality in demand. In addition, finite time differences are used in place of differentials. Thus, the resulting demand equation for the i^{th} type of fish takes the following form:

$$(12)\ \overline{w}_{i,t}\Delta log q_{i,t} = \gamma_i + \eta_i \Delta log \tilde{x}_t + \sum_{j=1}^{11} \theta_{ij} \Delta log p_{j,t} + \sum_{k=2}^{4} \varphi_{ik} S_{k,t} + u_{i,t}$$

Where $\Delta log \tilde{x}_t = (\Delta log x_{(F)t} - \sum_{j=1}^{11} \overline{w}_{j,t} \Delta log p_{j,t})$ and $\overline{w}_{i,t} = (\overline{w}_{i,t} + \overline{w}_{i,t-1})/2$. The adding-up condition associated with specification (12) implies the following restrictions on the parameters:

$$(13)\ \sum_{j=1}^{11}\gamma_i = 0;\ \sum_{j=1}^{11}\eta_i = 1;\ \sum_{j=1}^{11}\theta_{ij} = 0;\ \text{and} \sum_{j=1}^{11}\varphi_{ik} = 0, k = 2, 3, 4$$

Nonetheless, if a complete demand system is to be estimated, then the adding-up property implies singularity of the error variance-covariance matrix. This problem can be treated by dropping one of the equations in the system prior to estimation (Barten, 1969). As a result, the other types of fish equation was deleted from the system in which, the omitted parameters were recovered via the adding-up condition.

The demand system (13) has been estimated using the Zeller's seemingly unrelated regression (SUR) estimator, with homogeneity and symmetry imposed.[7]

However, the graphical analysis of the time series data suggests that preferences for seafood have strengthened since 1992, and therefore tastes for fish have changed (there is structural change). Factors that contributed positively to the pattern of increased consumption include greater fish supplies due to advanced production and marketing schemes, higher disposable income, higher prices of other food commodities, and new information on nutrition and food safety. As a result, the demand systems were tested for structural change on the hypothesis of one time shift in the demand curves occurring in the year 1992.[8] The null hypothesis of the test is that there is no structural change and the alternative that, there is a structural change wich occurred in 1992.

A multivariate Chow test that allows the slopes to change was applied on the demand system to test the preceding hypothesis. The time varying parameters took the form:

$$(14)\ \beta_{i,t} = \begin{cases} (\beta_i + \delta D_t) Y_t\ When D_t = 1[t \leq 1.1992] \\ \beta_i Y_t \quad when D_t = 0 \end{cases}$$

In which the new variable $(D_t Y_t)$ is often called an interaction variable. Hence, the i^{th} demand equation can be written as:

7 The parameter estimates obtained by using iterated SUR are invariant to the choice of deleted equation; see for example Greene (1997).

8 Iraq invaded Kuwait in August 1990, and the invasion ended in February 1991.

$$(15) \quad \overline{w}_{i,t}\Delta log q_{i,t} = \gamma_i + \eta_i \Delta log \tilde{x}_t + \sum_{j=1}^{11} \theta_{ij} \Delta log p_{j,t} + \sum_{k=2}^{4} \varphi_{ik} S_{k,t} + D_t + \delta_i (D_t \times \Delta log \tilde{x}_t) + \sum_{j=1}^{11} \delta_{ij} (D_t \times \Delta log\ p_{j,t}) + u_{i,t}$$

The p-value from the associated F-distribution is < 0.0001, therefore, we reject the null hypothesis in favor of the alternative.

Estimation Results

The estimated regression coefficients for the demand system [equation (15)] are presented in Table 2, and the related expenditure and price elasticities [evaluated at the sub-sample (1992.1-1988.4) mean] are presented in Table 3.

The estimated expenditure elasticities which show the potential response of a commodity consumption to a relative (or infinitesimal) change in expenditure are all positive,[9] as expected, and they vary greatly from 0.012 for Silvery grunt to 1.837 for Crimson snapper. This suggests that consumers distinguish between different fish species and their preferences for fish types differ. As can be seen from Table 3, four types of fish including Silvery pomfret and River shad have expenditure elasticity greater than unity meaning that the consumption of those species are highly responsive to changes in consumer expenditure (income). As an example, the expenditure elasticity for Silvery pomfret is 1.835 indicating that 10% increase in consumer expenditure would increase Silvery pomfret consumption by approximately 18%, holding other variable constant. Technically speaking those fish species are considered luxuries by consumers.[10] The estimated expenditure elasticities for the remaining seven types of fish (Silvery grunt, Brown spotted grouper, Blue spotted mullet, Silvery croaker, Large-scale mullet, and other) are less than unity implying that consumption of those species is less responsive to changes in consumer expenditure. That is, changes in the consumption of those species, other factor remaining unchanged, with will be moderate to changes in consumer expenditure.

The compensated and uncompensated own price elasticities which show the potential response of a commodity consumption to a relative change in the price of that commodityare all negative and mostly greater than one in absolute

9 Positive (negative) expenditure elasticity for a commodity indicates that the commodity is considered to be normal (inferior) by consumers.

10 Luxury and necessity commodities can be defined by reference to the base case of homothetic preferences, under which all expenditure elasticities are equal to unity. If the expenditure elasticity is grater than unity, then the commodity is considered to be a luxury, and, if it is less than unity, then the commodity is necessity.

value with exceptions of Brown spotted grouper and Other types of fish.[11] This suggests elastic demand curves for nine types of fish, and hence, any increase in the retail prices of those species, other things remaining unchanged, will reduce consumptions substantially.[12] As an example, the estimated compensated and uncompensated own price elasticities for Silvery pomfret are -1.492 and -2.207 respectively, indicating that a 10% increase in the price of Silvery pomfret decreases Silvery pomfret consumption by approximately 15% and 22% holding all other variables constant. Similar interpretations can be applied to all other fish commodities. With the exception of Silvery pomfret, River shad, and Brown spotted grouper there are no major differences between compensated and uncompensated own price elasticities due to the small budget share of other species within the fish group.

Finally, the compensated and uncompensated cross-price elasticities which show the potential response of commodity consumption to a relative change in the price of other commodities between fish items have mixed signs but are mostly positive implying that the fish species are pairwise net and gross substitutes.[13] The finding indicates that the consumption of any specific type of fish will increase in response to changes in the prices of other fish species. As an example, According to the Silvery pomfret equations the compensated and uncompensated cross price elasticities between Silvery pomfret and Brown spotted grouper are 0.747 and 0.418 respectively, indicating that a 10% increase in the price of Brown spotted grouper increases Slivery pomfret consumption by approximately 7.5% and 4% respectively. Therefore, Brown spotted grouper is a net and a gross substitute commodity for Silvery pomfret. In addition, an increase in the prices of all substitutes and complements by 10% will increase Silvery pomfret consumption by approximately 4%, using the uncompensated cross-price elasticities. Note that positive and negative signs of cross-price elasticities usually cancel each other, so that the net effect in general is moderate. As pointed out by Barten and Bettendorf (1989), the negative cross effect between species does not agree with the notion that most types of fish are mutual substitutes.

11 The compensated and uncompensated own price elasticities are obtained from the Hicksian and Marshallian demand functions respectively. The percentage change along the Hicksian demand curve is known as the substitution effect, and, the percentage change along the Marshallian demand curve is known as the full effect which includes in addition to the substitution effect the income effect.

12 Note that an increase in the price of a commodity with elastic (inelastic) demand curve will reduce consumption more (less) than proportionately.

13 Note that, if cross-price elasticity between two related commodities is positive (negative) then the pair is considered to be substitute (complement) by consumers.

Table 2
The Estimated Rotterdam Model

	dLog q_1	dLog q_2	dLog q_3	dLog q_4	dLog q_5	dLog q_6	dLog q_7	dLog q_8	dLog q_9	dLog q_{10}	dLog q_{11}
Intercept	0.0090	-0.0393	-0.0166	0.0140	-0.0287	0.0283	0.0074	-0.0096	-0.0122	0.0402	0.0073
	(0.70)	(-5.73)	(-1.59)	(1.83)	(-7.01)	(6.24)	(2.12)	(-3.6)	(-4.34)	(8.13)	(---)
dLog $X_{(Fish)}$	0.1653	0.1456	0.1854	0.0773	0.0441	0.0548	0.0248	0.0199	0.0330	0.0590	0.1938
	(4.56)	(11.21)	(12.8)	(5.38)	(5.19)	(6.46)	(3.77)	(3.18)	(6.09)	(6.22)	(---)
dLog p_1	-0.2923	0.0681	0.0474	0.0122	0.0177	0.0268	0.0168	0.0279	0.0350	0.0175	0.0230
	(-5.69)	(3.17)	(1.93)	(0.64)	(1.44)	(1.75)	(1.74)	(2.88)	(3.44)	(1.01)	(---)
dLog p_2	0.0681	-0.1088	0.0194	-0.0044	0.0212	-0.0081	0.0087	0.0092	-0.0210	-0.0068	0.0225
	(3.17)	(-6.72)	(1.55)	(-0.39)	(2.15)	(-0.71)	(1.24)	(1.11)	(-2.91)	(-0.44)	(---)
dLog p_3	0.0474	0.0194	-0.1192	-0.0003	0.0421	-0.0016	0.0138	0.0135	0.0087	0.0094	-0.0332
	(1.93)	(1.55)	(-3.91)	(-0.05)	(3.04)	(-0.06)	(1.15)	(1.00)	(0.84)	(0.80)	(---)
dLog p_4	0.0122	-0.0044	-0.0003	-0.1766	-0.0143	0.0680	-0.0185	0.0241	-0.0359	0.0193	0.1264
	(0.64)	(-0.39)	(-0.05)	(-5.46)	(-0.99)	(4.62)	(-1.78)	(2.58)	(-3.25)	(1.16)	(---)
dLog p_5	0.0177	0.0212	0.0421	-0.0143	-0.0204	-0.0032	-0.0130	-0.0038	0.0060	-0.0450	0.0127
	(1.44)	(2.15)	(3.04)	(-0.99)	(-1.67)	(-0.50)	(-2.30)	(-0.59)	(0.95)	(-5.29)	(---)
dLog p_6	0.0268	-0.0081	-0.0016	0.0680	-0.0032	-0.0791	0.0026	0.0104	-0.0036	-0.0077	-0.0046
	(1.75)	(-0.71)	(-0.06)	(4.62)	(-0.50)	(-5.95)	(0.46)	(1.30)	(-0.59)	(-0.74)	(---)
dLog p_7	0.0168	0.0087	0.0138	-0.0185	-0.0130	0.0026	-0.0286	0.0123	-0.0113	0.0059	0.0113
	(1.74)	(1.24)	(1.15)	(-1.78)	(-2.30)	(0.46)	(-3.90)	(2.55)	(-1.91)	(0.84)	(---)
dLog p_8	0.0279	0.0092	0.0135	0.0241	-0.0038	-0.0036	0.0123	-0.0577	0.0141	0.0113	-0.0473
	(2.88)	(1.11)	(1.00)	(2.58)	(-0.59)	(-0.59	(2.55)	(-8.29)	(2.21)	(1.42)	(---)
dLog p_9	0.0350	-0.0210	0.0087	-0.0359	0.0060	-0.0036	-0.0113	0.0141	-0.0254	-0.0067	0.0400
	(3.44)	(-2.91)	(0.84)	(-3.25)	(0.95)	(-0.59)	(-1.91)	(2.21)	(-2.4)	(-0.88)	(---)
dLog p_{10}	0.0175	-0.0068	0.0094	0.0193	-0.0450	-0.0077	0.0059	0.0113	-0.0067	-0.0117	0.0144
	(1.01)	(-0.44)	(0.80)	(1.16)	(-5.29)	(0.74)	(0.84)	(1.42)	(-0.88)	(-0.69)	(---)
dLog p_{11}	0.0230	0.0225	-0.0332	0.1264	0.0127	0.0094	0.0113	-0.0612	0.0400	0.0144	-0.1652
	(1.18)	(0.98)	(-1.57)	(4.93)	(0.96)	(0.44)	(0.80)	(-5.33)	(2.75)	(0.72)	(---)
D	-0.0123	-0.0024	0.0036	-0.0003	-0.0007	0.0004	0.0012	-0.0004	-0.0001	0.0012	0.0097
	(-0.63)	(-0.00)	(0.61)	(0.01)	(-0.31)	(-0.29)	(0.34)	(0.32)	(-0.31)	(0.17)	(---)
D-dLog $X_{(Fish)}$	0.5493	-0.0954	-0.1847	-0.0111	-0.0421	0.0118	-0.0086	0.0085	-0.0249	-0.0338	-0.1691
	(10.20)	(-4.13)	(-7.33)	(-0.40)	(-2.70)	(-0.03)	(-1.24)	(0.49)	(-2.85	(-1.90)	(---)

Cont. Table 2
The Estimated Rotterdam Model

	dLog q_1	dLog q_2	dLog q_3	dLog q_4	dLog q_5	dLog q_6	dLog q_7	dLog q_8	dLog q_9	dLog q_{10}	dLog q_{11}
D-dLog P_1	-0.2889	0.0424	0.0261	0.2788	0.0134	-0.0112	-0.0225	-0.0125	0.0031	0.0248	-0.0535
	(-2.79)	(-1.21)	(-0.44)	(3.88)	(0.56)	(0.98)	(-0.20)	(0.94)	(0.35)	(0.99)	(---)
D-dLog P_2	0.0424	0.0590	-0.0398	-0.0796	-0.0215	0.0309	-0.0033	-0.0049	0.0040	-0.0073	0.0199
	(2.78)	(1.47)	(-1.68)	(-1.95)	(-1.92)	(0.56)	(-0.79)	(-1.38)	(0.12)	(-1.06)	(---)
D-dLog P_3	0.0261	-.0398	-0.0144	-0.0994	-0.0142	0.0684	-0.0222	-0.0282	-0.0274	0.0144	0.1366
	(2.71)	(-1.17)	(-1.38)	(-2.68)	(-0.18)	(0.74)	(-1.59)	(-1.13)	(-2.35)	(-0.44)	(---)
D-dLog P_4	0.2788	-0.0796	-0.0994	0.0754	-0.0314	-0.0111	0.0299	-0.0189	0.0305	0.0364	-0.2105
	(-0.31)	(-2.01)	(-0.42)	(0.91)	(-0.53)	(1.46)	(0.82)	(-0.45)	(1.59)	(1.48)	(---)
D-dLog P_5	0.0134	-0.0215	-0.0142	-0.0314	0.0023	-0.0104	0.0155	-0.0109	0.0011	0.0311	0.0249
	(0.41)	(0.56)	(-0.29)	(-0.68)	(0.73)	(-0.10)	(0.09)	(-1.64)	(0.04)	(1.70)	(---)
D-dLog P_6	-0.0112	0.0309	0.0684	-0.0111	-0.0104	-0.0687	0.0091	0.0255	0.0126	-0.0216	-0.0234
	(0.71)	(-0.71)	(1.66)	(-0.99)	(-0.28)	(-2.33)	(1.00)	(2.47)	(-0.04)	(-0.97)	(---)
D-dLog P_7	-0.0225	-0.0033	-0.0222	0.0299	0.0155	0.0091	-0.0046	-0.0266	0.0027	-0.0079	0.0299
	(0.80)	(-0.25)	(020)	(1.32)	(0.47)	(-1.39)	(-0.36)	(-2.16)	(0.19)	(-1.42)	(---)
D-dLog P_8	-0.0125	-0.0049	-0.0282	-0.0189	-0.0109	0.0126	-0.0266	0.0007	-0.0012	0.0037	0.0861
	(1.22)	(0.03)	(-2.30)	(-0.59)	(0.82)	(0.23)	(-0.61)	(0.52)	(1.68)	(-0.67)	(---)
D-dLog P_9	0.0031	0.0040	-0.0274	0.0305	0.0011	0.0126	0.0027	-0.0012	0.0047	0.0066	-0.0367
	(-1.23)	(1.07)	(2.13)	(1.06)	(-0.73)	(0.40)	(0.01)	(-1.72)	(0.37)	(0.26)	(---)
D-dLog P_{10}	0.0248	-0.0073	0.0144	0.0364	0.0311	-0.0216	-0.0079	0.0037	0.0066	-0.0895	0.0093
	(0.80)	(0.16)	(-0.72)	(0.53)	(0.61)	(-0.23)	(0.06)	(0.51)	(0.89)	(-2.00)	(---)
D-dLog P_{11}	-0.0340	-0.1086	0.1014	-0.1564	0.0277	0.0286	0.0066	0.0939	-0.0040	0.0128	0.0320
	(-0.11)	(0.48)	(0.68)	(-1.06)	(0.41)	(-0.32)	(0.21)	(1.88)	(-0.67)	(0.19)	(---)
S_2	0.0802	0.0517	0.0838	-0.0453	0.0616	-0.0860	-0.0243	-0.0060	-0.0032	-0.1012	-0.0113
	(4.56)	(4.65)	(6.50)	(-3.95)	(9.33)	(-12.52)	(-5.00)	(-0.88)	(-0.71)	(-13.28)	(---)
S_3	0.0420	0.0966	-0.0161	-0.0505	0.0423	-0.0372	-0.0105	0.0113	0.0189	-0.0470	-0.0497
	(1.00)	(9.60)	(-1.38)	(-3.61)	(6.12)	(-4.56)	(-1.77)	(2.27)	(3.89)	(-5.48)	(---)
S_4	-0.1617	0.0101	-0.0026	0.0495	0.0104	0.0080	0.0039	0.0336	0.0320	-0.0077	0.0246)
	(-7.77)	(0.51)	(-0.89)	(4.75)	(2.225)	(1.42)	(1.35)	(9.03)	(8.44)	(-1.40)	(---)

Values in Parentheses are t-statistics
See table 1 for variable definitions

Table 3
Estimated Demand Elasticities

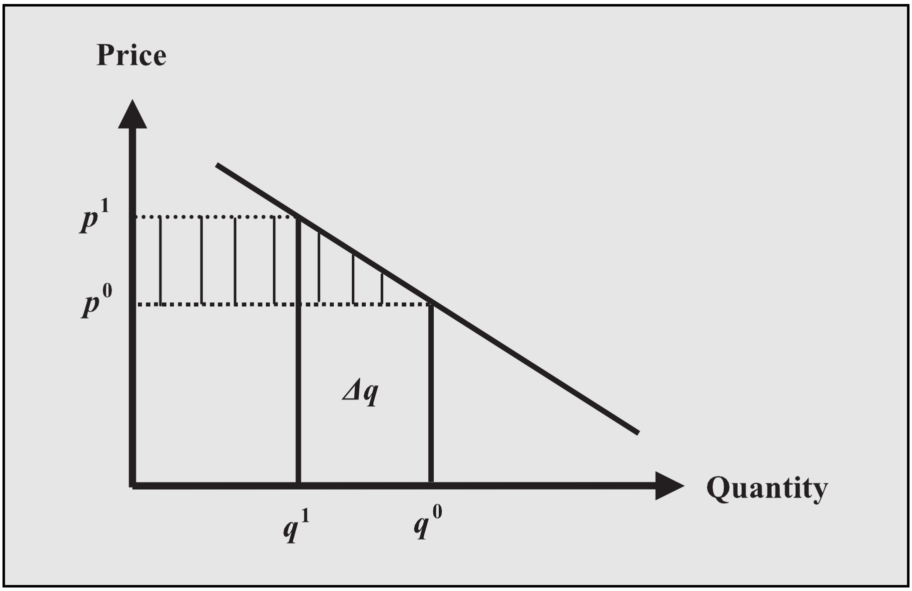
	Pomfret $dLog P_1$	Shad $dLog P_2$	Grunt $dLog P_3$	Grouper $dLog P_4$	Mullet $dLog P_5$	Coraker $dLog P_6$	Mackerel $dLog P_7$	Snapper $dLog P_8$	L.Mullet $dLog P_9$	Porgy $dLog P_{10}$	Others $dLog P_{11}$
Budget Share (mean: 1992.1-198.4)	0.389	0.032	0.063	0.180	0.013	0.068	0.010	0.015	0.013	0.058	0.160
Expenditure Elasticities	1.835	1.480	0.012	0.369	0.163	0.973	1.661	1.837	0.648	0.438	0.155
Compensated Price Elasticities											
(1) Silvery Pomfret	-1.492	0.284	0.189	0.747	0.080	0.040	-0.015	0.039	0.098	0.109	-0.028
(2) River Shad	3.468	-1.562	-0.639	-0.637	-0.009	0.715	0.171	0.137	-0.531	-0.444	-2.702
(3) Silvery Grunt	1.169	-0.324	-2.124	-1.585	0.444	1.062	-0.134	-0.235	-0.298	0.380	1.084
(4) Brown Spotted Grouper	1.620	-0.468	-0.555	-0.564	-0.254	0.317	0.063	0.029	-0.030	0.310	-0.167
(5) Blue Spotted Mullet	2.481	-0.022	2.227	-3.644	-1.440	-1.086	0.196	-1.171	0.567	-1.112	3.227
(6) Silvery Coraker	0.288	0.333	0.976	0.832	-0.199	-2.160	0.171	0.132	0.132	-0.428	0.556
(7) Barred Spanish Mackerel	-0.580	0.558	-0.860	1.160	0.251	1.194	-3.396	-1.462	-0.871	-0.201	1.823
(8) Crimson Snapper	0.994	0.281	-0.954	0.340	-0.950	2.322	-0.924	-3.687	0.838	0.968	2.114
(9) Large-Scaled Mullet	3.042	-1.355	-1.501	-0.435	0.569	0.720	-0.681	1.037	-1.651	-0.008	2.885
(10) Yellow Finned Black Porgy	0.735	-0.246	0.414	0.965	-0.242	-0.507	-0.034	0.260	-0.002	-1.754	0.471
(11) Other Types	-0.191	0.265	0.647	-0.527	0.236	-0.175	0.257	0.243	0.021	0.148	-0.834
Uncompensated Price Elasticities											
(1) Silvery Pomfret	-2.207	0.225	0.073	0.418	0.057	-0.086	-0.032	0.011	0.075	0.003	-0.322
(2) River Shad	2.892	-1.609	-0.732	-2.902	0.027	0.614	0.157	0.114	-0.550	-0.530	-2.938
(3) Silvery Grunt	1.164	-0.324	-2.125	-1.587	0.444	1.061	-0.134	-0.235	-0.299	0.379	1.082
(4) Brown Spotted Grouper	1.477	-0.480	-0.578	-0.630	-0.259	0.292	0.060	0.024	-0.035	0.289	-0.226
(5) Blue Spotted Mullet	2.418	-0.027	2.217	-3.673	-1.442	-1.097	0.194	-1.174	0.565	-1.212	3.201
(6) Silvery Coraker	-0.151	0.302	0.915	0.657	-0.211	-2.227	0.161	0.116	0.119	-0.484	0.400
(7) Barred Spanish Mackerel	-1.227	0.505	-0.964	0.862	0.230	1.081	-3.412	-1.488	-0.892	-0.297	1.558
(8) Crimson Snapper	0.279	0.223	-1.070	0.010	-0.973	2.197	-0.942	-3.716	0.815	0.862	1.821
(9) Large-Scaled Mullet	2.789	-1.375	-1.542	-0.551	0.561	0.676	-0.688	1.027	-1.659	-0.046	2.781
(10) Yellow Finned Black Porgy	0.564	-0.259	0.386	0.887	-0.247	-0.537	-0.038	0.253	-0.007	-1.779	0.401
(11) Other Types	-0.251	0.260	0.637	-0.555	0.234	-0.186	0.256	0.241	0.019	0.139	-0.858

Measures of Consumer Welfare Change

In order to meet the second objective of this study, the econometric welfare evaluation of regulatory fishing restrictions using the estimated demand systems, we present in the section the empirical consumer welfare measurements.[14] In doing so, we will consider a change in policy (catch restrictions) that alters the consumption bundle available to consumers and calculate the welfare loss to the consumers from that new policy. The welfare effects on consumer from regulatory fishing restrictions are analyzed via the partial equilibrium analysis and dealt with in a manner similar to the imposition of quotas.

Suppose that allowable commercial harvest of one type of fish, say, Grouper is reduced by 10 %. If we assume that the demand curve is locally linear, at least for small price changes, then we can ask the following question: by how much does the price of grouper have to increase in order to reduce grouper consumption by 10%, while holding other variables constant? The answer to this question is shown in Figure 2.

Figure 2
The Amount of Price Changes Induced by Regulatory Catch Restrictions



14 Theories of welfare measurement are well established, see for example: Chipman and Moore (1980) for welfare measurements, and Creedy (1998) for applications.

As seen in the figure, the initial quantity and price are given by q^0 and p^0 respectively, and since we know the quantity change we can also know the post-change prices using estimated elasticities. We now have all the information required to estimate the consumer welfare effects.

The new price is given via the following relationship:

$$(16) p^1 = p^0 + \Delta p = p^0\left[1 + \frac{1}{[Price\ elasticity]} \times \frac{\Delta q}{q^0}\right]$$

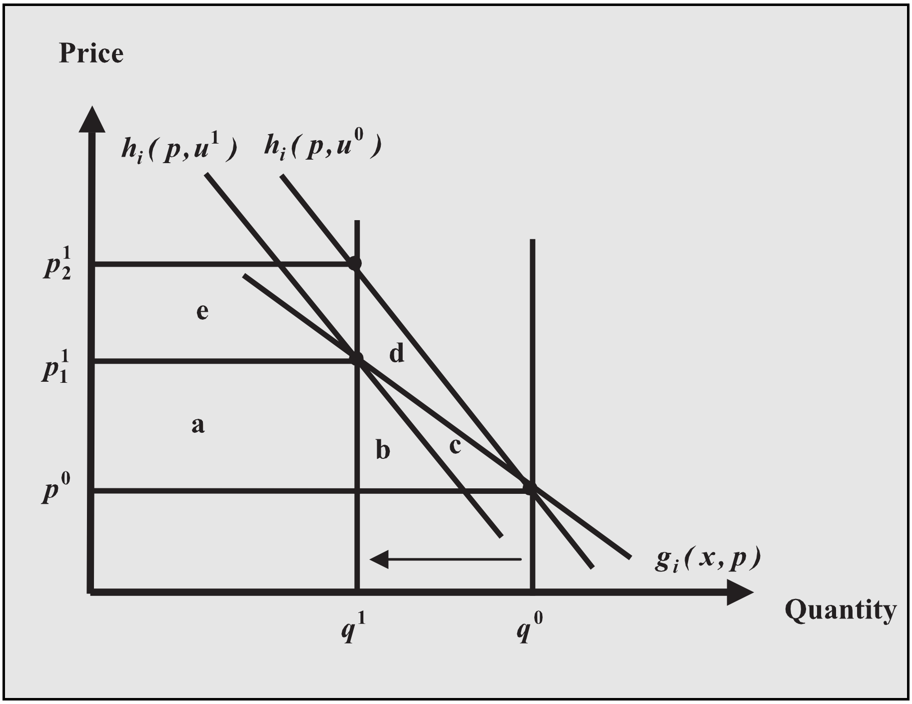
Where $\Delta q = q^1 - q^0$. The rectangular part of the shaded area of Figure 2 equals $\Delta p \times q^1$, and the triangular part is estimated as $[(\Delta p \times \Delta q)/2]$. Summing up those areas yields the estimate of consumer welfare effects.

We illustrate all the welfare measure with the help of Figure 3. As seen there, the equivalent variation is the area (a + b) and can be approximated by:

$$(17)\ EV_p = \Delta p_1\left[q^1 - 0.5 \times \left[(compensated\ price\ elasticity)\frac{q^0}{p^0}\right]\Delta p_1\right]$$

The compensating variation is the area (a + b + c + d + e) and is calculated by:

Figure 3
Consumer Welfare Measures



$$(18)\ CV_p = \Delta p_2 \left[q^1 - 0.5 \times \left[(\textit{compensated price elasticity}) \frac{q^0}{p^0} \right] \Delta p_2 \right]$$

The consumer surplus which is bounded by EV_p and CV_p is given by the area (a + b + c) and is calculated as:

$$(19)\ CS_p = \Delta p_1 \left[q^1 - 0.5 \times \left[(\textit{uncompensated price elasticity}) \frac{q^0}{p^0} \right] \Delta p_1 \right]$$

Where:

$$\Delta p_1 = p^0 \left[\frac{1}{(\textit{uncompensated price elasticity})} \times \frac{\Delta q}{q^0} \right], \text{ and}$$

$$\Delta p_2 = p^0 \left[\frac{1}{(\textit{compensated price elasticity})} \times \frac{\Delta q}{q^0} \right],$$

Table 4 shows the annual welfare loss resulting from a 10% catch restriction on each type of fish. For example, the valued compensating variation and consumer surplus attained after the 10% catch restriction on Silvery pomfret are K.D 278,428 and K.D 188,226 loss per year respectively. The loss in the consumer surplus however, as a percentage of total consumer expenditure on fish is equal to 1.52%. This indicates that the welfare attained after the reduction is equivalent to 15 fils loss per K.D spent on fish. Similar interpretations can be applied to all other fish commodities.

However, in the former analysis we have estimated the welfare loss to consumer from catch restrictions based on the assumption of a single quantity change, while holding other variables constant. These results can be extended to the case of multiple quantity changes using the so-called path dependent approach (see for example, Just *et al*, 1982). The methodology that we have adopted can be summarized as follows.

Table 4
The Estimated Welfare Measures (1998 Quantities and Prices)

Types of Fish	Compensating Variation	Consumer Surplus
(1) Silvery Pomfret	278,428	188,226
(2) River Shad	20,991	20,378
(3) Silvery Grunt	36,194	36,177
(4) Brown Spotted Grouper	363,902	325,779
(5) Blue Spotted Mullet	15,278	15,257
(6) Silvery Coraker	42,585	41,303
(7) Barred Spanish Mackerel	4,947	4,924
(8) Crimson Snapper	5,568	5,525
(9) Large-Scaled Mullet	8,570	8,529
(10) Yellow Finned Black Porgy	38,440	37,900
(11) Other Types	281,014	273,153

We first imposed a 10% catch restrictions on fish 1 and estimated the consumer welfare loss from that policy, say L_1. Next, we adjusted the quantities of fish 2 for changes in the price of fish 1 and then imposed a 10% catch restriction on fish 2 and estimated the consumer welfare loss, L_2. After that, we adjusted the quantities of fish 3 for changes in the price of fish 1 and fish 2 and then imposed a 10% catch restrictions on fish 3 and estimated the consumer welfare loss, L_3. Proceeding in this manner, the path dependent welfare loss to consumer from a 10% catch restriction on all species within the group was estimated as: $\sum_{i=1}^{11} L_i$.

Welfare estimates using path dependent approach are generally small. The estimated compensating variation and consumer surplus for a 10% catch reduction in all species within the group of fish are K.D 1,128,325 and K.D 964,149 respectively. The loss in the consumer surplus however, as a percentage of total consumer expenditure on fish is equal to 7.65%. This indicates that the welfare attained after the reduction is equivalent to 77 fils loss per K.D spent on fish.

Summary and Conclusion

This paper examined demand for fish in Kuwait by estimating complete demand systems for eleven individual fish species that are mostly consumed. The estimated demand parameters were then used to measure consumer welfare loss resulting from hypothetical catch restrictions policies on the individual fish species.

Prior to the econometric estimation, the study presented the empirical consumer allocation model used in this analysis, the absolute price version of the Rotterdam model. The estimation of the model was based on quarterly time series data on retail consumption and prices from the period 1974-1998. Overall, the Rotterdam model was found to fit the data very well. The results indicate that most of the fish items are characterized by high own price elasticities (or elastic demand curves) implying that prices of those species are expected to increase less than proportionately as a result of catch restriction policies. In addition, expenditure elasticities are all positive meaning that consumption will increase with rising standard of living. Thus, an increase in income, holding the supply of fish constant, will result in an increase in the retail prices.

The study then presented the empirical consumer welfare measurements to analyze the welfare loss to the consumer resulting from a 10% catch restriction on the individual fish species. In the case of single quantity changes (holding other variables constant), results showed that on average welfare losses to consumers from catch restrictions are generally small. The consumer surplus indicates that 10% reductions in the quantity of Brown spotted grouper (had the highest welfare loss value) would generate the same welfare as that of a 2.6% reduction in expenditure spent on fish group. Results showed that welfare estimates based on multiple quantity changes are still small. As an example, the welfare attained after a 10% catch reduction on the total fish group is equivalent to 77 fils loss per K.D spent on fish using the consumer surplus estimates. The study therefore, showed that consumers in Kuwait would not be greatly harmed in the short-run from adopting the proposed policy to increase the future fish population.

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الملخص

الطلب على الأسماك في دولة الكويت: سياسات إصلاحية وأثرها على رفاهية المستهلك

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معهد الكويت للأبحاث العلمية

يهدف هذا البحث إلى تقدير دوال الطلب لأحد عشر صنفاً من الأسماك الأكثر استهلاكاً في الكويت. ولتحديد العوامل والمتغيرات المؤثرة في الطلب على صنف معين من الأسماك ضمن المجموعة السمكية استخدم نموذج روتردام (Rotterdam Model) مع بيانات السلاسل الزمنية الفصلية لكميات التجزئة المستهلكة وأسعارها للفترة من ١٩٧٤-١٩٩٨. هذا، وقد أظهرت النتائج أن الطلب على معظم الأصناف من الأسماك يعد مرناً (ذا مرونة سعرية مرتفعة)، مما يعني أن الاستهلاك سوف يتأثر بدرجة كبيرة نسبيًّا بالتغيرات السعرية. كما أوضحت النتائج أن المرونات السعرية التبادلية بين الأصناف المختلفة هي في العموم موجبة، ولكنها غير مرتفعة، وهو ما يعني أن استهلاك صنف معين من الأسماك سوف يزداد زيادة معتدلة نتيجة لزيادة أسعار الأصناف الأخرى. وقد أشارت الدراسة أيضا إلى أن الانخفاض أو التكلفة في رفاهية المستهلك الناتجة عن فرضية تقييد كميات الأسماك المصيدة يعد محدوداً.

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