An analysis of local fresh fish demand and supply of Sri Lanka to assess the impact of fuel subsidies

K.P.G.L. Sandaruwan* and D.W.L.U.De. Silva

National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo15, Sri Lanka

Abstract

The purpose of this paper is to assess the factors affecting demand and supply for fresh fish in Sri Lanka and modelling demand and supply Functions. A partial-equilibrium analysis performed to understand fish supply response for significant change of the fuel subsidy policy. The time series data of per capita fish consumption of thirty years (1987-2016) were collected from published official data for the analysis. The autoregressive lag model based on linear-log functional form was used as the most appropriate model to estimate the demand and supply. The fish demand is a function of the consumers' income; own price (fresh fish price) and price of substitutes (dried fish and chicken price). Lower cross price electricity of fish for other animal protein foods emphasised fresh fish has a weaken substitutability. Fresh fish price, number of boats registered for the fishing purpose and previous year fish harvest quantity motivate fishermen to catch more fish hence those variables have positive relationship with fish supply. The effectiveness of fuel subsidy to boost fisheries industry is questionable because 1% of fuel price subsidy only increases 0.030% of fish production and only truncate 0.021% of fish price in the market.

Keyword: Elasticity, Annual fresh fish demand and Supply, Determinants, Partial-equilibrium, Fuel subsidy.

*Corresponding author- E. mail: sandaruwan@nara.ac.lk

Introduction

A unique combination of high quality protein and comparatively affordable price make fish is the most important animal protein source for many developing countries including Sri Lanka (Food and Agriculture Organisation (FAO), 2015). Fish contributes nearly 56.1 % of animal protein consumed in Sri Lanka (FAO, 2011). The government of Sri Lanka aims to increase the per capita fish consumption from 17.2 kg to 22 kg by 2020 and therefore the fish production needs to be increased to meet the demand and subsequent increase in the per capita consumption (MFARD, 2010). Sri Lankan fresh fish industry attributed some characteristics of perfect competition such as large number Of producers (fishermen) large number of consumers, free entry and exit of fishermen (because of the open access nature of fishery resources), perfect factor mobility and homogenous product quality.

The Government of Sri Lanka has introduced a number of policies and programs to increase fish production since independence. The fuel subsidy program is one of the long-lasting, most expensive and most politically sensitive policy implemented to promote fisheries in Sri Lanka. It is widely accepted that the fuel subsidy has encouraged fishing at long distance fishing grounds and increased duration per fishing trip. The fisheries sector provides livelihood opportunities for more than 0.2 million fishermen in the country, and hence the government has a constant pressure to continue the fuel subsidies under fuel price hiking. From the year 2010 onwards the fuel price had increased rapidly. As a response for that government offered fuel subsides from 2012 to 2014. The subsidy has been withdrawn after reducing the fuel price of the world market in 2015. Again the fuel price has increased since 2017 and fishermen have demanded fuel subsides. Wimalasena *et al.,* (2014) have found that, the fuel price increased in 2012 had negative impact on profitability of Sri Lankan fisheries industry. And they have estimated break even catch to recover the increased fuel cost and finally this research has been recommended to provide fuel subsides. But this research has not included comprehensive welfare analysis to understand the economic impact of important stakeholders and it has not paid an attention to the total cost of fuel subsides for the government and ability of fisheries industry to increase fish supply to cover that cost.

The Sustainable Development goals of United Nation discuss the subsidy issues under goal 14- “life below water”. The target of 14.6 is set to prohibit certain forms of fisheries subsidies which contribute to overcapacity and overfishing, subsidies those contribute to illegal, unreported and unregulated fishing. However, the provision of the subsidy has become customary, and successively governments have been suffering under tremendous pressure to continue the subsidy despite of budgetary constraints.

The economists have recommended that a welfare analysis should be done to understand the consequences of policy changes prior to the granting of subsidies. The major problem of policymakers is that they don't have sufficient information to take decisions. It is very difficult to evaluate impact of the policies without knowing the demand and supply function or elasticity of the fish products.

In theory, demand explains the behaviour of consumers to meet their needs confronted by choice problems, whereas demand functions can be derived from utility functions with constraint of maximisation of satisfaction and consumers' income (Henderson and Quandt, 1980). This function is known as the Marshallian request function (Rahim and Hastuti, 2017). The demand function is influenced by the price itself, the price of other goods, the level of income, the taste, and the population. So far there is very little information in Sri Lanka regarding demand determinants of fish. When concern the international literature the numbers of studies have been conducted to understand the determinants of fish demand. The own price of fish is the common determinant for all demand functions (Madan, 2008). Alexandri (2015) has concerned the per capita GDP as a good determinant to represents the income. Carlucci in 2015 quantitatively assessed the substitution effects of dried fish, canned fish, and other processed foods for fresh fish. In addition to that changes in demand for fresh fish are influenced by availability of fish, socio-economic of fishing practices (Moses *et al.,* 2015), the culture of consumers (Dey *et al.,* 2008), characteristics of behaviour and consumption habits (Erdogen *et al.*, 2011), as well as demographics and attitudes in decision-making to purchase marine fish (Ahmed *et al.*, 2011).

The supply function expresses a relationship between the price of products and the quantity supplied of that product. The demand function can be derived from production function and cost function. Hotelling's Lemma can be used to drive supply equation system through profit maximisation (Tocco *et al.*, 2013). Compared to demand analysis it is very rare to find the literature regarding supply analysis. Some determinants introduced by different authors are as follows: Price per tonne of fish landed (Jaffry, 1997), fixed costs and running costs of a vessels, number of boats present in the country and their respective days at sea (Concerted Action on Fisheries Economics 1997), crew wages, and gear types (Frost *et al.,* 1993). In fisheries, estimating the supply response is less straight forward. The level of catch is generally taken as a function of the combination of inputs employed and the level of stock (Hannesson 1993). Stock size (in density) varies by spatially and temporally. As fish stocks are a mobile resource, the stock density varies from place to place and day to day. In addition, the fish stocks are often influenced by environmental conditions (e.g. rainfall, water temperature, tides and currents), exhibiting seasonal migratory patterns as well as seasonal aggregation and dispersion. As a result, the ability of fishers to increase supply in response to changes in price may be affected by the relative abundance of the species available for harvest. As a result, the supply has a large stochastic element. Due to unavailability of sufficient data we have to omit important variables such as fish stock and weather conditions. In this study, we have concerned fish price, number of boats operated in each year and fuel price.

The purpose of this paper is to estimate the consumer demand and supply for fish through the year 1987 to year 2017 in Sri Lanka to assess the impact of fuel subsidy on supply of fish in Sri Lanka. The specific objectives of this paper are to understand key determinants of the annual per capita fresh fish demand and supply in Sri Lanka, estimate elasticity value for those determinants, and simulate impact of fuel subsidies through estimated equations.

Materials and Methods

The research was based on secondary data of thirty year period (1987-2017). The annual domestic fish production quantity and price data were obtained from fisheries statistic reports of Ministry of Fisheries and Aquatic Resources Development (MFARD, 1990, 1995, 2000, 2011,2018). The population figures were taken from statistical abstracts of census and statistic department of Sri Lanka (1996, 2006, 2017). The GDP and Consumers' Price Index (CPI) values were obtained from annual report of the Central Bank from 1987 to 2017. Fish trade data and the wholesale price data for substitute products were refereed from Central Bank- Economic and Social Statistics books of 1989, 1995, 2006 and 2017. All the real values are measured using the 2010 as the base year and CPI of each year used to convert the value in to base year value. The Sri Lankan rupee value of per capita Gross Domestic Product (GDP) was considered as income. The substitute products were identified by using the utility tree.

The fish market consists with multiple fish species hence conventional fish demand analysis used only high demanded fish species and developed different elasticity for those. Sumaila *et al.*, (2007) has applied novel method to calculate weighted average price to represent all the fish species. To calculate the weighted fish price all the fish species were categorized in to main six groups based on the cluster analysis of fish price for 30 years. The six groups are as follows: group 1: Seer, Prawns and Sail fish / group 2: Sardinella and other shore seine fish/ group 3: Yellow-fin tuna and Travelly / group 4: Herrings, Tilapia and Indian mackerel / group 5: Skipjack tuna, other blood fish and squids / group 6: Sharks, skates and rock fish

Total quantity of each group was calculated. The weight was assigned according to the percentage of group out of total fish production in each year.

Following equation was used to calculate the fresh fish price for supply function.

$$SP_t = \left(\frac{\sum_{i=1}^{n=6} GQ_{i,t} \times GP_{i,t}}{TP_t}\right) \times CPI_t$$

SP= Supply fish price in given year “t”, GQ_i= Total quantity of i^{th} group in time “t”, GP_i= Average annual price of i^{th} group in time “t”, TP= total production in given year “t”

To represent the fishing effort and production capacity changes, number of boats registered in the year was taken in to the supply function. There are two types of mechanized craft can be seen in fisheries industry as diesel driven boats (IMUL- Multiday fishing boats) and kerosene driven boats (OFRP-out board engine reinforced fibre glass boat and MTRB- mechanized traditional boat). A common fuel price was estimated for all the craft types.

$$FP = \frac{(DB \times Dq \times DP) + (KB \times Kq \times Kp)}{(DB + KB)}$$

DB = Number of diesel driven boat, Dq= Average fuel consumption of a boat, DP= Diesel price of each year, KB = Number of kerosene driven boats, Kq = Average kerosene consumption of a boat, KP = Kerosene price.

The most appropriate variables were selected through the statistical tools such as normality test, Durbin Watson test, Unit root test, co-relation test for dependent and independent variable. Those variables regressed in different logarithmic forms with lag values and highly applicable model was selected. STATA (Version 11) statistical software package was used for data analysis.

Result and Discussion

The data were analysed separately for linear, double logarithmic, log-linear and linear-logarithmic models. In the analysis, linear- logarithmic functional form recorded the largest correlation coefficient and smallest standard deviation. As well as the highest R-square value and F-statistics proved that linear- logarithmic model is highly reliable compare to other models. Since autocorrelation issues were recorded according to Durbin Watson test results, linear- logarithmic autoregressive lag model was selected as the best model.

$$Y_t = \alpha + \beta_p lnX_t + \beta_q lnY_{(t-1)}$$

Y_t= Dependent variable, X_t = Vector of independent variables, $Y_{(t-1)}$ = Lag value of dependent variable, α, β_p and β_q confidents to be estimated.

Demand function

The R^2 value of the equation representing the quality of the approximation is 0.792 of demand model. The model has reliable good fit. And the overall model significant under F= 64.32 and P= 0.00. The model has 1.522 of Durbin Watson value and it concludes that there was no auto correlation problem. The coefficients of the model were given under Table 1.

Table 1: The coefficients of annual per capita fish demand

Variable	α	P_d	I_d	Chi	DP	Qd
Coefficient	-114.10**	-3.04***	10.64**	4.12**	2.28**	0.14*
SD	43.71	1.34	5.63	1.15	1.02	0.12

***,**and* denoted significant level 1%, 5% and 10% respectively

Source: Self calculation by author based on secondary data

Q_d= Annual fish demand per person (kg), α = constant, P_d= Fresh fish price (Rs.), I_d =Monthly income (Rs.), Chi =Chicken price (Rs.), DP =Dried fish price (Rs.), $D_{(t-1)}$ = Lag value of annual per capita fish consumption (kg), The standard errors are given in the parenthesis

The estimated equations imply that annual per capita fish demand was a function of the consumer income, own price (fresh fish price), price of substitutes (dried fish and chicken price) and one year lag value of per capita fish consumption. Canned fish price was removed from the function because it has shown high multi-correlation with fresh fish price. Even though the Tsunami in 2004 showed a consumption shock for four years period, in long run it was not significant. Because of the selected model was a linear-log function, following equation was used to calculate the elasticity and those values given in bellow table 2.

$$\varepsilon = \frac{dy}{dx} \times \frac{x}{y} = \beta \frac{1}{y}$$

ε =elasticity, β= Coefficient of the particular variable in demand function. y = the log value of the variable for concerned year.

Table 2: The estimated elasticities for the last decade (2008 -2017)

Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Own price	-0.55	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57
Chicken	0.48	0.52	0.68	0.74	0.74	0.77	0.76	0.76	0.77	0.78
Dried fish	0.51	0.49	0.43	0.40	0.40	0.40	0.40	0.39	0.38	0.37
Income	0.85	0.83	0.82	0.81	0.79	0.79	0.78	0.78	0.77	0.77

Source: Self calculation by author based on secondary data

Due to linear-logarithmic nature of the demand function, the elasticity values vary with the time. According to the estimated demand values, fresh fish demand was inelastic for the all determinants in the model. That emphasises fish is a very important food item for Sri Lankans and they try to consume relatively constant amount of fresh fish disregarding the changes in the demand determinants. The fresh fish is a normal good because own price showed a negative elasticity. The own price elasticity is constant over time and it has maintained a 0.57% of demand reduction for 1% of fresh fish price increment. The income has the highest positive elasticity value and that implied a continuous growth of income which is the major determinant to increase per capita fish consumption. The income has become more inelastic for fresh fish demand over the time. The fish doesn't have a close substitute hence all cross price elasticity values were less than one. During the last decades dried fish elasticity value has been gradually decreased while elasticity of chicken has increased. That means substitutability of chicken for fresh fish has increased over dried fish.

Supply Function

The R^2 value of the equation representing the quality of the approximation is 0.818 of supply model. The model has reliable good fit. And the overall model significant under F= 74.51 and P= 0.00. The model has 1.892 of Durbin Watson value and it concludes that there was no auto correlation problem. The coefficients of the model were given in Table 3.

Table 3: The coefficients of annual fresh fish supply of the country

Variable	α	P_q	F_p	B	L_q
Coefficient	-3,797,455**	6,076,000***	- 956,150**	2,1857,300**	1,9081,700**
SD	-2,017,720	668,360	-78,176	10,404,303	843,8987

***,**and* denoted significant level 1%, 5% and 10% respectively

Source: Self calculation by author based on secondary data

Qs = (Kg), α = constant, P_q = Fish price at wholesale level (Rs.), F_p = Fuel price (Rs.), B=Number of boats, L_q= lag of fish production of the country (Kg)

In general, fish supply-quantity increases with increasing price. The same scenario could be observed with the fresh fish prices and fish supply. As an indicator of increased fishing effort with time, the number of boats registered for fishing purpose has been increased during last twenty years. Continuous increment of fishing effort would be negatively impact on the fisheries resource but in short time we could observe an increment in fish production when number of boats increased. The lag value of supply quantity also has positive relationship with current supply quantity. The scatter plots illustrated negative production shock from year 2005 to year 2009 because of Tsunami. The effect of Tsunami added as dummy variable but it was not significant.

Fuel is a major component of fishing operation. Fishermen were very sensitive for the fuel prices. Using the estimated models, the aim in this part of the study was to measure the changes in the supply of fish attributable to the imaginary fuel subsidy policy. Both estimated models were used for partial equilibrium analysis. Before that, it should be noted demand and supply functions were not in equal status because supply function estimate for total fish production of the country and demand function estimated per capita fish demand. To bring the demand function in to supply function's level, the demand function should be multiplied by population size and recalculate the elasticity values of demand function. At the analysis phase, necessary precautions were taken to eliminate the impact of export and demand by deducting those from fish availability data base. Here, we assume import and export are equal to each other and the impact of net trade of fish is negligible for demand and supply functions. The demand and supply simultaneous equation system has two endogenous variables as price and quantity. The income, dried fish price, canned fish price, number of boats, fuel price, lag of supply quantity and the parameters of demand and supply function served as exogenous variables.

Briefly, the procedure involved raising the fuel subsidy values from zero to 25 per cent, holding all other exogenous variables at their real values of year 2017, and calculating the perturbed values of the quantity and price variables. The results of Table 4 are interpreted as follows: when fuel subsidy increases fish production increases and fish price decreases. As a result of 1% increase in fuel subsidies, the average fish price decreases by 0.021% and fish production increases by 0.030%.

Table 4: The changes of fish price and fish supply quantity as result of fuel subsidy

Fuel subsidy Percentage	Percentage change of average fish price (Rs.)	Percentage change of fish production (Mt)
5	0.264	0.247
10	0.265	0.259
15	0.265	0.273
20	0.266	0.289
25	0.267	0.325

Source: Self calculation by author based on secondary data

Conclusion

The income of the consumer, own price of fish, price of chicken and dried fish are the most statistically significant determinants for the annual per capita fresh fish demand. All the determinants (concerned for this research) are inelastic and that emphasised fresh fish is an essential food item for Sri Lankans. The Annual per capita fresh fish demand has increased due to the income growth of the country. Lower cross price elasticity of fish for other animal protein foods emphasised that fresh fish has a weak substitutability. The consumer has been switched to chicken as a close substitute for fresh fish rather than move on to dried fish. To ensure the sufficient per capita protein intake the policy should be focused on fulfilling the individual demand of fresh fish through an affordable price. Fresh fish price, number of boats registered for the fishing purpose and previous year fish harvest quantity are the motives for fishermen to catch more fish due to those variable has positive relationship with fish supply quantity. Fuel subsidy is not an effective policy measure to increase fish production because 1% of fuel subsidy can contribute only for increase in fish production in 0.030% and decrease in fish price in 0.021%.

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