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DOMESTIC LANDING OF DISTANT WATER SQUID AND ITS WELFARE EFFECTS ON PRODUCERS AND CONSUMERS *

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I. Introduction

Squid is one of the Korean people's most favorate sea foods. The on- and off-shore squid fisheries(OFSF) have played a single important role in meeting national squid demand. Until the mid 1980's the Korean government did not allow the distant water squid fishery(DWSF) to land foreign catch on the domestic ports and strictly restricted squid importation.

However, the continuous growth of per capita income and more national concern about human health have steadily changed the traditional food consumption habit toward more demand for squid along with other fish products. Such increase in demand for squid products could not be met by domestic production. Thus, since 1985 the government has permitted domestic landing of distant water squid. This policy change called for sensitive responses from the on- and off-shore squid fishery sector and the conflicts between the OFSF and DWSF sectors have developed.

Considering the present state of squid conflicts, what is important is to find a practical way for both fisheries coexistence and mutual development. In this context, the main objective of this research is to analyze the welfare effects of squid supply change on producers and consumers and to draw some policy implications upon empirical results.

This paper includes five sections. Section two develops a theoretical framework. The third section presents sample data and summary description. The fourth contains empirical model, estimation method, and

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empirical results. Summary and conclusions are given in the last section.

II. Theoretical Consideration

The welfare effects of the price (or supply)changes on producers and consumers can be measured in terms of producer's and consumer's surpluses.

Alfred Marshall(1959) defined a producer's net benefit as the excess of gross receipts which producer receives for any commodities produced over the prime(variable) cost. This concept is called quasi-rent on fixed production inputs employed by the firm or industry. Specifically, quasi-rent is defined as the excess of total revenue over the total variable costs. Marshall also suggested the area below the price line and above the supply curve.

Although he did not emphasize the distinction between quasi-rent as an economic concept and producer's surplus as a geometric area, the distinction is necessary where the long-run cost is considered. In this research, since the fixed costs are accounted, producer's surplus is defined as a long-run profit equivalent concept, which is the excess of gross revenue over the total costs rather than the total variable costs.

On the other hand, the word "consumer surplus" was actually first coined by Dupit in 1844. He postulated that the price associated with any quantity on a consumer's demand curve is the maximum price the consumer is willing to pay for the last unit consumed. If the consumer actually pays only price P_0 for the entire purchased quantity Q_0, then the consumer gains a surplus on the units consumed since willingness to pay exceeds what is actually paid by that amount. Thus, the area below the demand curve and above price obtained by subtracting costs from gross benefit is the surplus accruing to the consumer from buying the quantity at the equilibrium price. So if, given a demand curve satisfying theoretical regularities, the commodity under consideration is perfectly divisible, the Dupit consumer surplus from purchasing the amount at the market price will be given by the triangle-like area above the price line and to the left of the demand curve.

Thus, fundamental to the use of demand and supply curves for the measurement of producer's and consumer's welfare changes is the fact that prices can be marginal benefits of goods to households and of production to firms.

Before the mid 1980's, the on- and off-shore squid fisheries played a single important role in meeting the domestic comsumption under the government restriction on import and domestic landing of distant water squid.

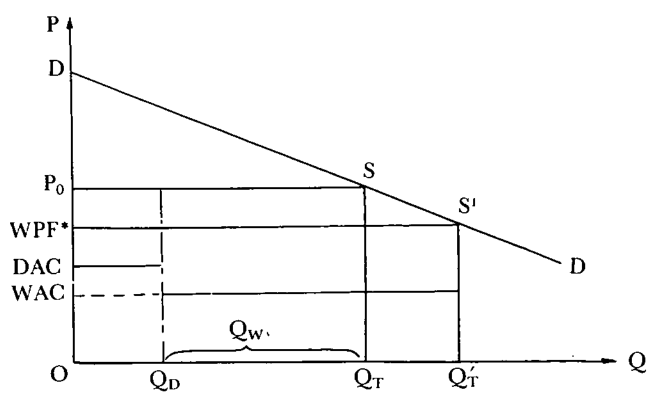
However, this single source of squid production began to put a observable degree of limitation on the supply side and the price soared up. The supply side pressure was judged due mainly to the domestic squid resource - base constraint so the government decided to allow to bring in a substantial portion of distant water catch for fresh consumption.

This policy change caused the current serious conflicts between the on- and off-shore squid fisheries and the distant water squid - angling sector. After the allowance of distant water squid entry in the domestic market, the DWSF accounted for about 80 percent of the total fresh squid supply.

Differently from the manufactured goods and the agricultural commodities, it has been generally known that fishery production(or supply) has little relationship with prices because catch is dominantly affected by the oceanic, climatic conditions. This characteristic of fishery production may make plausible the following assumptions on its supply and cost structures : (i) supply is perfectly inelastic and vertical and (ii) average cost curve is horizontal, which is equal to margial cost curve.

As shown in Figure 1, the total supply of fresh squid (Q_T) comprises of the OFSF production (Q_D) and the DWSF catch (Q_W). The equilibrium price at Q_T is given by P_0. In this setting, the domestic producer surplus(according to the definition above) is determined by $Q_D(Po - DAC)$, while the distant water fishery sector's net benefit is computed by $(Q_T - Q_D)(Po - WAC)$. the consumer surplus is the area under the demand curve DD and above the price line Po.

FIGURE 1 The Structures of Demand, Supply, and Costs



Now, an important question is about why the OFSF sector can be severely affected by allowing to bring in distant water squid. Observing the structures of demand, supply, and average costs, we can see that (i) the domestic squid resource base is limited, (ii) the OFSF accounts for a relatively small portion of the total market supply, and (iii) the average cost line of the OFSF may be lower than that of the DWSF. These suggest that a marginal increment of distant water squid supply can easily pull down the price line to the average total cost level so the domestic producer surplus may be entirely dissipated even if there is a small increase in total market supply. But the DWSF may not experience such a drastic profit reduction with respect to a small supply change.

III. Sample Data

The data set used in this research is fourteen year aggregated time-series information from 1975 to 1988. In the following statistical analysis, six variables are utilized. They include per capita consumptions for fresh, dried, and seasoned squid, auction prices for fresh and wholesale prices for dried, and per capita disposable income. The statistical outline for the variables is presented in Tabel 1.

TABLE 1 Summary Statistics

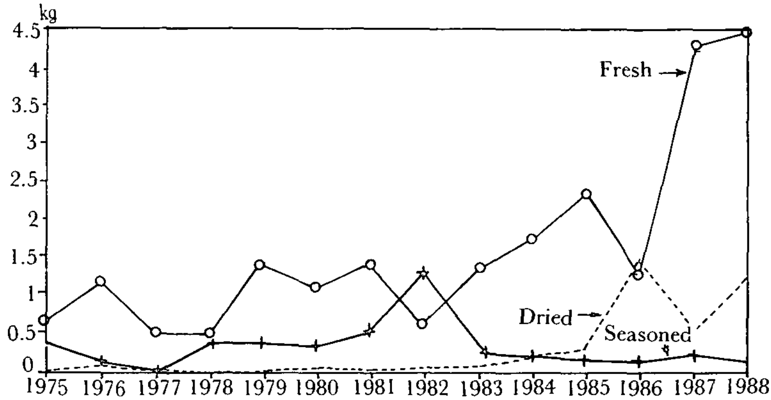
Variable	Mean	S. D.	Minimum	Maximum
FS	1.6054	1.3036	0.48214	4.5337
DS	0.52641	0.44630	0.13730E−02	1.4073
SS	0.0575	0.0489	0.0016	0.17175
WPF	1357.9	241.58	904.36	1785.6
WPD	9682.5	1945.2	5771.0	12035.0
Y	1381.2	474.88	694.70	2361.6

Note : *FS*, *DS* and *SS* are per capita fresh, dried, seasoned squid consumptions, respectively ; *WPF* denotes fresh squid auction price ; *WPD* represents dried squid wholesale price ; *Y* denotes per capita disposable income.

1. Consumption

The per capita consumption of squid including fresh, dried, and seasoned increaed 4.8 times from 0.71kg in 1975 to 4.41kg in 1988(Figure 2). The fresh consumption accounts for about 87 percent of the total. Only 1 - 2 percent is consumed for the seasoned. The dried squid consumption has been on the increasing trend since 1983.

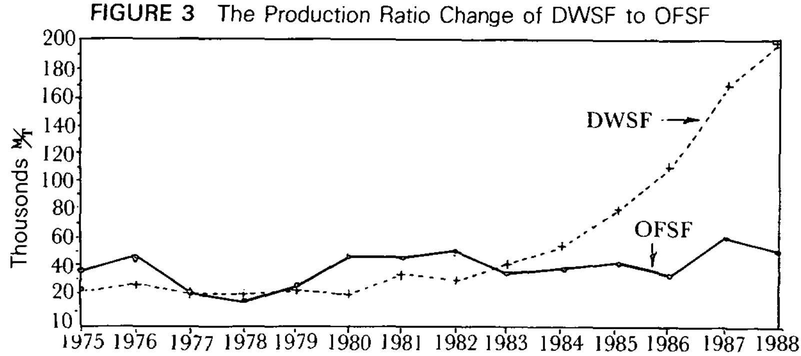
FIGURE 2 The Squid Consumption Patterns



2. Supply

The total squid supply increased 4.2 times between 1975 and 1988. In 1975, the on - and off - shore fisheries produced 63.3 percent out of the total. However, the production ratio of DWSF to OFSF began to be reversed in 1983 and thereafter the ratio increased to 4.98 in 1988(Figure 3).

FIGURE 3 The Production Ratio Change of DWSF to OFSF

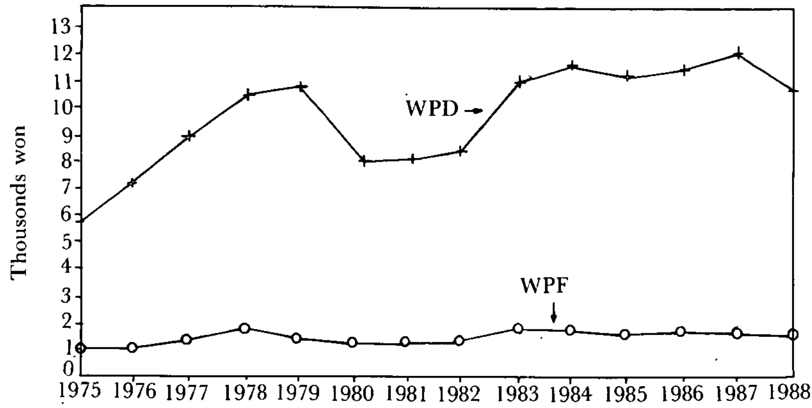


3. Prices

The squid auction price is the most important economic variable from the fishermen's point of view. Since it is directly related to the fishing household income which has the same characteristics as the farm gate prices recieved by farmers, its fluctuation and magnitude have a diverse ramification of fishermen's economic status and wellbeing.

In 1983, the landing price of fresh squid reached at the peak and then has become much stable (Figure 4). The dried squid wholesale price also has shown the pattern similar to the fresh squid.

FIGURE 4 Auction and Wholesale Prices



4. Income

The per capita disposable income is employed as a demand shifting variable. It has increased consistently during the period(1975 – 1988).

It is generally recognized that since the early 1980's Korean people's preference for fish products has been much responsive to income level. It is believed that the income variable will play an important part in the changing food consumption pattern for a next decade or so in Korea.

IV. Empirical Model, Estimation Method and Results

1. Empirical Model

A general method, which leads to standard statistical inferences about the choice of transformation, was analyzed by Box and Cox(1964) who considered the parametric family of power transformations :

$$(1) \qquad Y(\lambda) = \begin{cases} (Y^{\lambda} - 1)/\lambda & (\lambda \neq 0) \\ \log(Y) & (\lambda = 1) \end{cases}$$

In the absence of a transformation $\lambda = 1$. The value of the transformation for $\lambda = 0$ is found as the limit of equation(1) as levels to zero.

The intension is that, for some λ ,

$$(2) \qquad E[Y(\lambda)] = XB$$

with $Y(\lambda)$ satisfying the second-order assumption of consistency of variance, independence and additivity. It is also hoped that, to an adequate degree of approximation, $Y(\lambda)$ will be normally distributed. If the requirement of additivity is met, then the structure of XB will be relatively simple. For the transformation (1) to be generally applicable it is necessary that the model include a constant(Schlesselman 1971). It will be assumed that this condition is met.

The Box-Cox transformation method has several merits : (i) providing flexible functional form which meets the economically reasonable restrictions, (ii) presenting a reasonable number of parameters to be estimated, and (iii) making little presentation of unreasonably complex estimation problems.

In this study, three Box-Cox demand relationships are specified for fresh, dried, and seasoned squid as follow :

⟨ fresh squid ⟩

(3) $(FS_t^{\lambda} - 1) / \lambda = a_0 + a_1 WPF_t + a_2 WPD_t + a_3 I_t$

FS_t = per capita fresh squid comsumption(kg)
WPF_t = fresh squid real auction price(won/kg)
WPD_t = dried squid real whole-sale price(won/kg)
I_t = per capita real disposable income(won)
t = 1975, 1976, ··· 1988
λ = Box-Cox transformation parameter
a_i = regression parameters(i = 0, 1, 2, 3)

⟨ dried squid ⟩

(4) $(DS_t^{\lambda} - 1) / \lambda = b_0 + b_1 WPF_t + b_2 WPD_t + b_3 I_t$

DS_t = per capita dried squid consumption(kg)
b_i = regression parameters(i = 0, 1, 2, 3)

⟨ seasoned squid ⟩

(5) $(SS_t^{\lambda} - 1)/ \lambda = r_0 + r_1(I_t^{\lambda} - 1)/ \lambda$

SS_t = per capita seasoned squid consumption(kg)
r_i = regression coefficients(i = 0, 1)

Note that the seasoned-squid demand is postulated as a function of only income because its price data are not available.

2. Estimation Method

In the estimation process of Box-Cox models, first, it is necessary to compare the likelihood in relation to the original observations, Y, which is

$$(2\pi\sigma^2)^{n/2} \exp[- Y(\lambda) - XB)' (Y(\lambda) - XB)/2\sigma^2] J$$

Where the Jacobian is

$$(6) \qquad J = \prod_{i=1}^{n} \left| \frac{\partial Y_i(\lambda)}{\partial Y_i} \right|$$

The Jacobian allows for the change of scale of the response due to the operation of the power transformation $Y(\lambda)$.

The maximum likelihood estimates (MLE) of the parameters are found in two stages. For fixed λ, (6) is, apart from the Jacobian which does not involve B or σ^2, the likelihood for a least squares problem with response $Y(\lambda)$.

For fixed λ, we can find the log-likelihood maximized over both B and $\hat{\sigma}^2$. Substitution of the maximum likelihood estimates of $\hat{\sigma}^2(\lambda)$ into the logarithm of the likelihood given by(6) yields, apart from a constant,

$$(7) \qquad \text{Lmax}(\lambda) = -(n/2)\log\hat{\sigma}^2(\lambda) + \log(J)$$

This partially maximized log-likelihood is therefore a function of λ which depends both on the residual sum of squares and on the Jacobian J.

The MLE is the value of the transformation parameter for which the partially maximized log-likelihood is a maximum. Usually values of λ between -1 and 1 suffice. An approximate $100(1-\alpha)$ percent confidence region for λ is found from those values for which

$$(8) \qquad 2\,[\,\text{Lmax}(\hat{\lambda}) - \text{Lmax}(\lambda)\,] \leq \chi^2_{1,\alpha}$$

The approximate 95 percent confidence intervals for λ's of the three demand functions included all the values of the differences in twice the log-likelihood on the left-hand side of equation(8).

However, the estimation of squid demand functions encounters two important econometric problems : one is the autocorrelation in the fresh squid demand function and another is the correlation among the equation error terms.

In order to purge the autocorrelation problem of equation (3), the autocorrelation coefficient is estimated with the OLS residuals and then a Prais-Winsten transformation matrix has to be formed so that the first observation is able to be kept(Prais and Winsten 1954).

The second problem can be observed from the correlation matrix of the three equation disturbances *E1, E2,* and *E3*. As seen in Table 2, the correlation coefficient between *E1* and *E2* is much higher than those of other combinations. This problem is solved by the seemingly unrelated regression (SUR) technique suggested by Zellner in 1962. Since the SUR estimator is equivalent to that of Aitken's generalized least squares formula, the SUR parameter estimates of the squid demand functions have all the asymptotic statistical properties(Kmenta 1971).

TABLE 2 The Correlation Matrix among Equation Errors

	E1	E2	E3
E1	1.0	-0.4878	0.3527
E2		0.1	-0.3312
E3			1.0

3. Empirical Results

The parameter estimates of own prices and incomes were highly significant but the substitute coefficients showed relatively low probabilities (Table 3). Since the price and income elasticities can not be directly observed, they must be calculated based on the parameter estimates and the quantity-price(or income) ratios. The elasticity estimates are presented in Table 4.

TABLE 3 The Estimates of Model Parameters

variable	$(FS^{\lambda}-1)/\lambda$	$(DS^{\lambda}-1)/\lambda$	$(SS^{\lambda}-1)/\lambda$
constant	-0.9709	-0.0268	-4.8624
WPF	-0.0012	0.0002	
	(-2.08)**	(0.23)	
WPD	0.0001	-0.0002	
	(0.92)	(-1.31)*	
I	0.0016	0.0013	0.1142
	(8.15)***	(3.55)***	(3.63)***
R^2	0.8692	0.4793	0.4710
$\hat{\rho}$	-0.1632	-0.1949	-0.1578

Note : $\hat{\rho}$ =autocorrelation coefficient ; ( )=asymptotic t values ;
*** =significant at the 1 percent level ;
** =significant at the 5 percent level ;
* =significant at the 10 percent level .

In terms of absolute values, the own price elasticities were higher than unity, while the cross elasticities were much less responsive with respect to the substitute price changes. All the squid products under consideration showed high income elasticities with the range of 2.0285 to 2.3780.

Given the demand infomation and the assumptions on supply, and costs the squid producer's and consumer's surpluses can be calculated by using a little calculus. Note that the only fresh squid producer's net

TABLE 4 Elasticity Estimates

	fresh	dried	seasoned
own price	-1.4824	-2.3311	
cross price	0.8348	0.4054	
income	2.0285	2.3780	2.1339

Note : fresh(dried) own - price elasticity = $a_1 \times [WPF/(FS)^{\lambda}]$
$b_2 \times [WPD/(DS)^{\lambda}]$

fresh(dried) cross elasticity = $a_2 \times [WPD/(FS)^{\lambda}]$
$b_1 \times [WPF/(DS)^{\lambda}]$

fresh(dried) income elasticity = $a_3 \times [Y/(FS)^{\lambda}]$
$b_3 \times [Y/(DS)^{\lambda}]$

and seasoned squid income elasticity = $r_1 \times [Y/SS]^{\lambda}$.

benefit(PS) and the consumer's surplus(CS) are measured since most of the total squid supply is consumed for the fresh.

First, it is convenient to derive the inverse demand function for the fresh squid :

(8) $$\text{WPP} = (1/a_1) \left[(Q^{\lambda} - 1)/ \lambda - (a_0 + a_2 WPD + a_3 I) \right]$$

If the DWSF increases the market supply from Q_T to Q_T', the equilibrium auction price would be decreased to WPF. Under this supply increment, the PS and CS changes can be calculated by the following formulae :

(9) $$DPS = \int_{Q_T}^{Q_T'} (WPF^* - DAC)dQ = [Q(WPF^* - DAC]_{Q_T}^{Q_T'}$$

(10) $$WPS = \int_{Q_T}^{Q_T'} (WPF^* - DAC)dQ = [Q(WPF^* - WAC]_{Q_T}^{Q_T'}$$

(11) $$CS = \int_{Q_T}^{Q_T'} (WPF)dQ - \int_{Q_T}^{Q_T'} (WPF^*)dQ = [K_0 Q^{K'} - T_0(T_1 + a_2 WPD + a_3 I)Q]_{Q_T}^{Q_T'} - [WPF^* \times Q]_{Q_T}^{Q_T'}$$

Note : DPS = domestic producer's surplus,
WPS = distant water producer's surplus,
$K_0 = 1/(a_1 \lambda (\lambda + 1))$, $K_1 = \lambda + 1$, $T_0 = 1/a_1$, and $T_1 = a_0 + 1/ \lambda$

Substituing the 1988 data of prices and costs (Tabel 5) into equations(9), (10), and (11), we can obtain the DPS, WPS, and CS. The total real PS in 1988 amounted to 113 billion won. The OFSF share was only 2.4 billion won ; the rest (110.6 billion won) went to the DWSF sector(Table 6). Given the supply condition and the cost structure, only 2.7 percent increase in market supply will completely dissipate the current level of OFSF's profit. However, the DWSF's surplus will be negatively affected by only 3 percent. The break-even point of the DWSF sector will not be reached until the market supply is expanded by as much as 49.3 percent.

TABLE 5 Prices and Costs(1988)

Unit : won/kg, thousand won

WPF	WPD	DAC	WAC	DI	POPULATION (thousand)
1,511	10,648	1481	850	2,633	41,978

TABLE 6 Producer's and Consumer's Surpluses

Unit : billion won

supply increment	social net benefit	consumer surplus(cs)	producer surplus		
			T P S	D P S	W P S
1988 level	508.8	395.8	113.0	2.4	110.6
2.7%	515.6	408.3	107.3	0.0	107.3
20 %	554.8	491.8	63.0	-14.5	77.5
49.3%	600.4	635.8	-35.4	-35.4	0

Note : *TPS*=total producer suplus ;
DPS=domestic producer surplus;
WPS=distant water fishery's surplus.

V. Summary and Conclusions

The main objective of this study was to measure the welfare effects of squid supply increase and the resulting price change, based on the concepts of clarified marshallian producer's net benefit and Dupit's consumer's surplus.

The demand functions for three squid products(i.e., fresh, dried, and seasoned) were specified, following the Box-Cox parametric family of power transformation and they were tested. The Chi-square test statistics accepted the functional specifications at the 5 pcrtent significance level.

The empirical models had two econometric problems : autocorrelation in the fresh squid demand function and correlation among the equation error terms. These problems were solved by the Prais-Winsten data transformation and by the seemingly unrelated regression technique, respectively.

The signs of the model parameter estimates were consistent with economic theories and the own price elasticities of fresh and dried squid were greater than unity. Three squid products' demands showed large responses with respect to price changes.

In 1988, the producers surpluses for OFSF and DWSF were measured 2.4 and 110.6 billion won, respectively. There is no doubt that, under the present cost structure, the OFSF has a high probability to experience zero profit by a small change in supply but the DWSF would not face such a worse economic situation until a substantial increase(more than 49 percent) is made.

These empirical results suggest (i) that domestic landing of distant water squid is inevitable to provide squid products at reasonable prices, while the cost-saving technology development for the on - and off - shore fisheries need be made under the governmental financial provisions and (ii) that the structural changes of the OFSF should be supported by the cooperative efforts of both government and distant water squid fishery sector.

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