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This means that the variables included in the output demand equations are: income, the price of a substitute (canned tuna), interest rates (to reflect holding costs), and inventory holdings (to reflect the scarcity value of the species. Since the majority of frozen salmon products in Alaska go to Japan or to the continental U.S., the weighted average (with populations as the weights) of U.S. and Japanese per capita incomes is used as income in the frozen demand equation. In the canned demand equation, income is the weighted average of U.S. and U.K. incomes since much of the canned salmon goes to the U.K. All prices and incomes are in real 1988 dollars. Exchange rates and interest rates have also been converted into real terms. Population is in millions and is the sum of the populations of the major consuming countries (Japan and the US for fresh/frozen and the UK and US for the canned). Inventories for fresh/frozen and canned inventories are measured in thousands of pounds of holdings on June 30 of each year.

The inverse (price dependent) demand for the two output goods are,

$$P_{f,i} = P_{f,i}(\text{Fresh/frozen Quantity, Tuna Price, Real Interest rates, Population US+Japan, Exchange rate yen/dollar, Weighted Real Income, Fresh/frozen Inventory})$$

$$P_{c,i} = P_{c,i}(\text{Canned Quantity, Tuna Price, Real Interest rates, Population US+UK, Exchange rate pound/dollar, Weighted Real Income, Canned Inventory})$$

These two equations plus the two supply equations and the demand equation at the ex-vessel level, plus the identity that the quantity demanded at the ex-vessel level equals the quantity supplied at the ex-vessel level complete the system of equations.

3 Estimation Results Using Annual Data 1964-1988

In the estimation of the models described in Section 2, we correct for first order autocorrelation when the data indicates that this type of serial correlation is significant. We test for autocorrelation by first looking at the Durbin-Watson test statistic, and then by regressing the actual residuals on the lagged residuals plus the explanatory variables in the equation. This method gives an estimate of first order autocorrelation that is asymptotically distributed as a t -distribution. Throughout the discussion we refer to the estimate of ρ , where ρ is defined as

$$Y_t = X_t\beta + e_t, \text{ where } e_t = \rho e_{t-1} + u_t, \text{ and } u_t \text{ is distributed as } N(0, \sigma^2).$$

We also look for signs of heteroskedasticity and for bias in the prediction, but this analysis is left until Section 4 where we plot the model predictions against the actual values for the ex-vessel prices. All of the ex-vessel models are estimated as price dependent models.

3.1 CFEC model estimation results

Again, it should be noted that the variables in this data set differ slightly from those used by Muse (1984). We use real interest rates and real exchange rates, and the exchange rate is defined as yen/dollar. We measure the landings quantity in millions of pounds instead of thousands of metric tons. In addition, we have used July 1 inventory data instead of January 1 inventory data. Thus the coefficients are not directly comparable. In this section we report the linear version of his model.

KING: For king salmon the estimated equation is given in Table 3.1.1. The estimated regression equation suggests that the price of king salmon is not related to the quantity of silver salmon landed since the coefficient on silver quantity is not statistically significant. An increase in the yen/dollar exchange rate is small but statistically significant. The coefficient indicates that an increase in the exchange rate of one more yen per dollar would decrease the price of king salmon by 4/1000 of a dollar, or by less than 1/2 of a cent. The Durbin-Watson (DW) statistic is low, but is in the inconclusive region.⁷ The R statistic is low, 0.402, indicating that this equation explains approximately 60% of the variance of king salmon prices.

RED: The estimated demand equation for red salmon is given in Table 3.2.2. This equation was corrected for first order autocorrelation using a point estimate of $\rho=0.684$, where ρ is the autocorrelation coefficient. The regression equation indicates that the price of pink salmon fails to predict red salmon prices.

SILVER: The estimating equation for silver salmon is given in Table 3.1.3. The silver ex-vessel price equation is also corrected for autocorrelation with an estimated $r=0.399$. The silver equation does not fit well, with all variables other than the intercept insignificant.

PINK: Both the pink and chum equations are estimated using recursively by estimating the inventory equation first and using the estimated pink inventory holdings in place of the actual holdings in the demand equation estimations. The results of the pink salmon inventory forecast equation estimation are contained in Table 3.1.4a. This equation indicates that an increase in US pink landings in the previous year by a million pounds increases the June 30 inventory holdings by 108,000 pounds. The US prime rate of interest is not statistically significant. The equation explains less than 50% of the variance in inventory holdings as measured by the R statistic.

⁷In addition to the Durbin-Watson statistic, we estimate the coefficient for first order autocorrelation by regressing the observed errors in time t on lagged errors and the independent variables. This method gives an asymptotically consistent estimate of the autocorrelation coefficient, and the estimated t -ratio for this coefficient is asymptotically normally distributed. We correct for autocorrelation if the coefficient is significant at the 10% (one-tailed) level.

The pink salmon demand equation is given in Table 3.1.4b. The coefficient for pink landings QXPINK is -0.000022, which means that an increase in the quantity of pink salmon landings by a 10^9 pounds would decrease the price by 2.2 cents. Thus price is not very responsive to changes in the quantity, although the response is significantly different from zero. The Japanese exchange rate coefficient ERJAPAN is also statistically significant, indicating that an increase in the yen/dollar ratio by 10 yen would lower the pink salmon price by 1.7 cents. The equation explains 60.9% of the variation in the pink salmon price as indicated by the R statistic.

CHUM: The estimation results for the chum equation are contained in table 3.1.5. The coefficient for the quantity landed of pink salmon is statistically significant, but is quite small (an increase in the landings by a billion pounds lowers the chum price by 3 cents). The coefficient for chum quantity is insignificant, indicating that chum prices are not affected by chum landings. However, pink inventories and Japanese exchange rates are significant, each having the expected sign. The DW statistic is low, but in the inconclusive region. Overall, the equation explains about 60% of the variation in chum prices.

Table 3.1.1: CFEC Linear Ex-vessel Demand Equation Estimation (1964-1988)

KING

Valid cases:	25	Dependent variable:	PXKING
Total SS:	6.552	Degrees of freedom:	22
R-squared:	0.452	Rbar-squared:	0.402
Residual SS:	3.590	Std error of est:	0.404
F(2,22):	9.075	Probability of F:	0.001
Durbin-Watson:	1.398		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	3.410621	0.612707	5.566477	0.000	---	---
QXSILV	-0.011570	0.009948	-1.163044	0.257	-0.278917	0.366218
ERJAPAN	-0.004403	0.001232	-3.572793	0.002	-0.856815	-0.646806

Table 3.1.2: CFEC Linear Ex-vessel Demand Equation Estimation (1964-1988)

RED

rho & asymptotic t-ratio

0.684

2.748

Valid cases:	24	Dependent variable:	PXRED
Total SS:	12.706	Degrees of freedom:	22
R-squared:	0.097	Rbar-squared:	0.056
Residual SS:	11.469	Std error of est:	0.722
F(1,22):	2.372	Probability of F:	0.138
Durbin-Watson:	2.061		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	-1.196109	0.383769	-3.116737	0.005	---	---
PXPINK	0.672787	0.436807	1.540239	0.138	0.311989	0.311989

Table 3.1.3 CFEC Linear Ex-vessel Demand Equation Estimation (1964-1988)

SILVER

rho & asymptotic t-ratio

0.398

1.853

Valid cases:	24	Dependent variable:	PXSILV
Total SS:	8.527	Degrees of freedom:	21
R-squared:	0.007	Rbar-squared:	-0.088
Residual SS:	8.471	Std error of est:	0.635
F(2,21):	0.070	Probability of F:	0.933
Durbin-Watson:	1.562		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	-1.144593	0.609983	-1.876432	0.075	---	---
QXSILV	-0.000291	0.008401	-0.034638	0.973	-0.007938	0.018331
ER:APAM	-0.000618	0.001699	-0.363679	0.720	-0.083347	-0.080845

Table 3.1.4a CFEC Model Pink Inventory Equation Estimation (1964-1988)

Valid cases:	25	Dependent variable:	Pink Inventory
Total SS:	2905321834.470	Degrees of freedom:	22
R-squared:	0.487	Rbar-squared:	0.440
Residual SS:	1490995553.156	Std error of est:	8232.407
F(2,22):	10.434	Probability of F:	0.001
Durbin-Watson:	1.430		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	35.623830	3822.151727	0.009320	0.993	---	---
USPink(t-1)	0.108164	0.037249	2.903806	0.008	0.804939	0.693849
USPrime	-485.955726	1011.934206	-0.480225	0.636	-0.133119	0.538618

Table 3.1.4b CFEC Linear Ex-vessel Demand Equation Estimation (1964-1988)

PINK

Valid cases:	25	Dependent variable:	PXPINK3
Total SS:	0.673	Degrees of freedom:	20
R-squared:	0.674	Rbar-squared:	0.609
Residual SS:	0.219	Std error of est:	0.105
F(4,20):	10.347	Probability of F:	0.000
Durbin-Watson:	1.462		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	1.635864	0.256815	6.369823	0.000	---	---
QXPINK	-0.000022	0.000005	-4.709578	0.000	-1.019604	-0.606811
QXCHUM	-0.000426	0.000496	-0.858086	0.401	-0.200345	-0.480564
PINKINV	-0.002411	0.001740	-1.385590	0.181	-0.366100	-0.254235
ERJAPAN	-0.001740	0.000437	-3.981118	0.001	-1.056478	0.126696

Table 3.1.5 CFEC Linear Ex-vessel Demand Equation Estimation (1964-1988)

CHUM

Valid cases:	25	Dependent variable:	PXCHUM3
Total SS:	1.271	Degrees of freedom:	20
R-squared:	0.522	Rbar-squared:	0.427
Residual SS:	0.607	Std error of est:	0.174
F(4,20):	5.670	Probability of F:	0.004
Durbin-Watson:	1.309		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	2.333654	0.427348	5.460782	0.000	---	---
QXPINK	-0.000030	0.000008	-3.808702	0.001	-0.998316	-0.303977
QXCHUM	0.000471	0.000826	0.570101	0.575	0.161154	-0.141874
PINKINV	-0.005878	0.002895	-2.030051	0.056	-0.649403	-0.037425
ERJAPAN	-0.002975	0.000727	-4.090826	0.001	-1.314341	-0.165513

3.2 ISER model estimation results

In this section, we present and discuss the results of estimation of the ISER models (Ronan, 1989) using 1964-1988 data. As with the CFEC models, we have estimated these models using real exchange rates rather than with nominal exchange rates. As expected, the results differ slightly from Ronan's results, however, they appear to be very similar in general terms.⁸ Two regressions were run per species, one using lagged quantities and one using contemporaneous quantities, each measured in natural units. The discussions are confined to the results using contemporaneous independent variables. The exchange rate between the US and Japan is measured as yen/dollar. The quantity variables are measured in millions of pounds for contemporaneous and lagged quantities.

KING: The king salmon equation estimation results are in Table 3.2.1. The dependent variable is the price of king salmon. Both the contemporaneous quantity and lagged quantity equations have been corrected first order autocorrelation with ρ approximately equal to 0.5. The DW statistic on the corrected model indicates that the residuals do not show signs of serial correlation. Exchange rates are statistically significant in each equation (an increase in the yen/dollar ratio by 10 yen/dollar will decrease the king price by between 3 and 4 cents). The coefficient for king landings QXKING, and LQXKING are statistically indistinguishable from zero, indicating that king salmon prices are not responsive to king landings. However, the R statistics are low ($R = 0.372$ and $R = 0.364$ for the contemporaneous and lagged quantity equations, respectively).

RED: The red salmon equation is given in Table 3.2.2. The red salmon equation shows much better fit than the king salmon equation. All variables are significant at the 99% confidence level, and the R are 0.587, and 0.594, respectively in the contemporaneous and lagged quantity equations. In each case, the DW is very close to 2, indicating that there is no evidence of serial correlation. In the contemporaneous landings equation, an increase in the red salmon landings by 10 million pounds will

⁸There are two other differences between the models used here and the model estimated by Ronan: first, Ronan used data from 1970-1986 to estimate his model (predicting on the observations for 1987 and 1988); second, Ronan used units which are accurate to the pound, our units have been rounded at the 1000 pound level for all data except the CFEC data (from 1975-1988).

decrease the red salmon price by 3.7 cents, and an increase in the yen/dollar ratio by 10 yen will decrease the price by about 5 cents. These parameter values hold for the equation using lagged quantities also.

SILVER: The silver salmon equation estimates are given in Table 3.2.3. The silver equations are each corrected for positive autocorrelation (with ρ approximately equal to 0.4). The parameter estimates for quantity and exchange rates in the contemporaneous quantity equation are statistically insignificant. However, when lagged quantities are used as the explanatory variable, the estimates of each of the parameters are significantly different from zero at the 99% confidence level. An increase in the lagged quantity landed by a million pounds will decrease the contemporaneous price by 2.6 cents per pound, and an increase in the exchange rate by 10 yen per dollar will decrease the price by 3.2 cents.

PINK: The pink salmon equation estimates are given in Table 3.2.4. The pink salmon equation using contemporaneous variables has an $R = 0.25$, and a DW in the inconclusive region for positive autocorrelation. The quantity of pink salmon has a significant coefficient, indicating that an increase in the quantity of pink salmon by 10 million pounds decreases the price by 1.6 cents. The Japanese exchange rate is not significant at the 10% confidence level. When lagged quantity is used as an explanatory variable, the coefficients for both quantity and exchange rates double in magnitude and significance.

CHUM: The equation estimates for chum are contained in Table 3.2.5. The chum equations are each corrected for positive autocorrelation with a ρ approximately equal to 0.6. In each case, the coefficients for chum landings (contemporaneous and lagged) and exchange rates are insignificant. Thus the equation has no explanatory power relative to a simple prediction of the mean for explaining the variance of chum salmon prices.

Table 3.2.1: ISER Q(t) model Ex-vessel Demand Equation Estimation (1964-1988)

KING

rho & asymptotic t-ratio

0.551
2.374

second order rho & asymptotic t-ratios

0.440 0.210
1.727 0.824

corrected for ar(1) since rho significant at 5% one-tail level

Valid cases:	24	Dependent variable:	PXKING
Total SS:	3.641	Degrees of freedom:	21
R-squared:	0.200	Rbar-squared:	0.124
Residual SS:	2.912	Std error of est:	0.372
F(2,21):	2.628	Probability of F:	0.096
Durbin-Watson:	2.216		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	1.384245	0.357486	3.872161	0.001	---	---
QXKING	-0.023172	0.042664	-0.543128	0.593	-0.110118	0.015808
ERJAPAN	-0.003270	0.001427	-2.291224	0.032	-0.464541	-0.434691

ISER Q(t-1) model Ex-vessel Demand Equation Estimation (1964-1988)

KING

rho & asymptotic t-ratio

0.435
2.027

second order rho & asymptotic t-ratios

0.291 0.277
1.197 1.090

corrected for ar(1) since rho significant at 5% one-tail level

Valid cases:	24	Dependent variable:	PXKING
Total SS:	3.937	Degrees of freedom:	21
R-squared:	0.293	Rbar-squared:	0.225
Residual SS:	2.785	Std error of est:	0.364
F(2,21):	4.345	Probability of F:	0.026
Durbin-Watson:	2.136		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	2.012729	0.478289	4.208185	0.000	---	---
LQXKING	-0.047743	0.044390	-1.075524	0.294	-0.223389	0.061426
ERJAPAN	-0.003834	0.001309	-2.928658	0.008	-0.608289	-0.503693

Table 3.2.2: ISER Q(t) model Ex-vessel Demand Equation Estimation (1964-1988)

RED

rho & asymptotic t-ratio

-0.110
-0.482

second order rho & asymptotic t-ratios

-0.095 -0.040
-0.405 -0.176

not corrected for ar(1) since rho not significant at 5% 1-tail level

Valid cases:	25	Dependent variable:	PXRED
Total SS:	4.074	Degrees of freedom:	22
R-squared:	0.622	Rbar-squared:	0.587
Residual SS:	1.542	Std error of est:	0.265
F(2,22):	18.062	Probability of F:	0.000
Durbin-Watson:	2.038		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	3.240162	0.419963	7.715353	0.000	---	---
QXRED	-0.003671	0.001110	-3.307628	0.003	-0.696155	0.244411
ERJAPAN	-0.004873	0.000853	-5.714257	0.000	-1.202677	-0.658242

ISER Q(t-1) model Ex-vessel Demand Equation Estimation (1964-1988)

RED

rho & asymptotic t-ratio

-0.358
-1.415

second order rho & asymptotic t-ratios

-0.576 -0.326
-2.033 -1.189

not corrected for ar(1) since rho not significant at 5% 1-tail level

Valid cases:	25	Dependent variable:	PXRED
Total SS:	4.074	Degrees of freedom:	22
R-squared:	0.628	Rbar-squared:	0.594
Residual SS:	1.517	Std error of est:	0.263
F(2,22):	18.530	Probability of F:	0.000
Durbin-Watson:	2.224		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	3.250536	0.414200	7.847746	0.000	---	---
LQXRED	-0.003720	0.001099	-3.386869	0.003	-0.715779	0.247340
ERJAPAN	-0.004952	0.000856	-5.783406	0.000	-1.222262	-0.658242

Table 3.2.3: ISER Q(t) model Ex-vessel Demand Equation Estimation (1964-1988)

SILVER

rho & asymptotic t-ratio

0.398
1.853

second order rho & asymptotic t-ratios

0.315 0.192
1.315 0.759

corrected for ar(1) since rho significant at 5% one-tail level

Valid cases:	24	Dependent variable:	PXSILV
Total SS:	2.703	Degrees of freedom:	21
R-squared:	0.049	Rbar-squared:	-0.042
Residual SS:	2.572	Std error of est:	0.350
F(2,21):	0.537	Probability of F:	0.592
Durbin-Watson:	1.490		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	1.061642	0.342936	3.095744	0.005	---	---
QXSILV	-0.003884	0.008807	-0.441071	0.664	-0.112091	0.030412
ERJAPAN	-0.001302	0.001269	-1.026264	0.316	-0.260808	-0.199563

ISER Q(t-1) model Ex-vessel Demand Equation Estimation (1964-1988)

SILVER

rho & asymptotic t-ratio

0.383
1.724

second order rho & asymptotic t-ratios

0.365 0.129
1.536 0.563

corrected for ar(1) since rho significant at 5% one-tail level

Valid cases:	24	Dependent variable:	PXSILV
Total SS:	2.735	Degrees of freedom:	21
R-squared:	0.381	Rbar-squared:	0.322
Residual SS:	1.693	Std error of est:	0.284
F(2,21):	6.468	Probability of F:	0.006
Durbin-Watson:	1.729		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	1.770006	0.298946	5.920827	0.000	---	---
LQXSILV	-0.026184	0.007692	-3.404273	0.003	-0.733620	-0.345037
ERJAPAN	-0.003172	0.001063	-2.982644	0.007	-0.642759	-0.199246

Table 3.2.4: ISER Q(t) model Ex-vessel Demand Equation Estimation (1964-1988)

PINK

rho & asymptotic t-ratio

0.313
1.369

second order rho & asymptotic t-ratios

0.218 0.197
0.907 0.795

not corrected for ar(1) since rho not significant at 5% 1-tail level

Valid cases:	25	Dependent variable:	PXPINK
Total SS:	0.673	Degrees of freedom:	22
R-squared:	0.313	Rbar-squared:	0.250
Residual SS:	0.462	Std error of est:	0.145
F(2,22):	5.009	Probability of F:	0.016
Durbin-Watson:	1.355		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	0.951299	0.202818	4.690408	0.000	---	---
QXPINK	-0.001606	0.000521	-3.082982	0.005	-0.755818	-0.480564
ERJAPAN	-0.000654	0.000404	-1.619958	0.119	-0.397146	0.126696

ISER Q(t-1) model Ex-vessel Demand Equation Estimation (1964-1988)

PINK

rho & asymptotic t-ratio

-0.045
-0.197

second order rho & asymptotic t-ratios

-0.028 0.337
-0.122 1.574

not corrected for ar(1) since rho not significant at 5% 1-tail level

Valid cases:	25	Dependent variable:	PXPINK
Total SS:	0.673	Degrees of freedom:	22
R-squared:	0.638	Rbar-squared:	0.605
Residual SS:	0.244	Std error of est:	0.105
F(2,22):	19.386	Probability of F:	0.000
Durbin-Watson:	2.047		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	1.314862	0.164775	7.979768	0.000	---	---
LQXPINK	-0.002577	0.000419	-6.147925	0.000	-1.211327	-0.609606
ERJAPAN	-0.001306	0.000324	-4.023466	0.001	-0.792745	0.126696

Table 3.2.5: ISER Q(t) model Ex-vessel Demand Equation Estimation (1964-1988)

CHUM

rho & asymptotic t-ratio

0.653
2.848

second order rho & asymptotic t-ratios

0.431 0.229
1.334 0.746

corrected for ar(1) since rho significant at 5% one-tail level

Valid cases:	24	Dependent variable:	PXCHUM
Total SS:	0.593	Degrees of freedom:	21
R-squared:	0.027	Rbar-squared:	-0.066
Residual SS:	0.577	Std error of est:	0.166
F(2,21):	0.288	Probability of F:	0.752
Durbin-Watson:	1.713		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	0.278422	0.118440	2.350742	0.029	---	---
QXCHUM	-0.000114	0.001920	-0.059347	0.953	-0.014226	0.060219
ERJAPAN	-0.000554	0.000784	-0.706020	0.488	-0.169246	-0.162988

ISER Q(t-1) model Ex-vessel Demand Equation Estimation (1964-1988)

CHUM

rho & asymptotic t-ratio

0.617
2.760

second order rho & asymptotic t-ratios

0.504 0.170
1.800 0.660

corrected for ar(1) since rho significant at 5% one-tail level

Valid cases:	24	Dependent variable:	PXCHUM
Total SS:	0.600	Degrees of freedom:	21
R-squared:	0.038	Rbar-squared:	-0.054
Residual SS:	0.577	Std error of est:	0.166
F(2,21):	0.414	Probability of F:	0.666
Durbin-Watson:	1.719		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	0.337368	0.120502	2.799682	0.011	---	---
LQXCHUM	-0.000988	0.002012	-0.491113	0.628	-0.112817	-0.038387
ERJAPAN	-0.000641	0.000719	-0.892333	0.382	-0.204982	-0.164019

3.3 2SLS model estimation results

In this section, we present results for the ex-vessel demand equations estimated from a systems of equations in which the ex-vessel demand curve is estimated as a price dependent function, and the system of demand and supply functions at the processing level are estimated using the quantity of ex-vessel landings as an exogenous variable. The other four equations (fresh/frozen demand and supply and canned demand and supply) are contained in Appendix B. These equations are the foundation of the model estimated by Zhang (1990), although Zhang estimated his model on data transformed by natural logarithms (we use natural units so that we may ask questions about where the quantity is such that the elasticity of demand is unitary, which is impossible in a double-logged or constant elasticity model).⁹

The ex-vessel demand equations are price dependent rather than quantity dependent as the landings are assumed to be determined exogenous to the system. (However, the canned supply and fresh/frozen supply equations are estimated as quantity dependent.) The variables in each ex-vessel demand (and wholesale supply) equation are the output prices for canned and fresh frozen, and the landings quantity. Each price coefficient is expected to have a positive sign since an increase in the output price of either product should increase the amount that processors are willing to pay for the raw product. The quantity coefficient is expected to have a negative sign.

⁹There are some other differences between the models estimated in this paper and that in Zhang's thesis. One set of differences is in the variables used as proxy variables for income, population, interest rates, fresh/frozen and canned inventories, and for dummy variables. Here, we use population weighted average per capita income with the populations being the US and Japan for fresh/frozen products and the US and UK for canned products. Zhang used US per capita income. We use the sum of populations of the US and Japan in the fresh/frozen market and the US and UK in the canned market. The inventory data in Zhang's thesis were aggregated across species. We have completely disaggregated canned inventory data, and have constructed disaggregated indices for fresh/frozen inventory data. Zhang did not use interest rate data. Our interest rate data is real prime rates for Japan and the UK, for the fresh/frozen and canned markets, respectively.

Following Muse (1984) both Zhang's model and the model estimated here use a dummy variable for 1979 (a price shock occurred in 1979 that does not appear to be related to any other variable). Zhang used a dummy variable which equalled one for 1979 and was zero elsewhere. Following Ronan (1989), we note that this essentially eliminates the observation from the regression equation; therefore, we use a geometrically declining dummy variable ($D_{1979} = 2^4$, $D_{1980} = 2^3$, $D_{1981} = 2^2$, etc.). We also use a dummy variable for canned inventory for the years 1975-1981, where the inventory data is for June 1 rather than for July 1.

Finally, Zhang estimated his model using an additional substitute variable in the demand equations. His substitutes were the other species of salmon (red for king, king for silver, silver for red, pink for chum, and chum for pink). However, he treated these variables as exogenous variables, and did not estimate the models using an instrumental variable, so he probably introduced simultaneous equation bias into the model. Another difference is that Zhang left exchange rates in the ex-vessel demand equation, which is only correct if the Japanese also buy unprocessed salmon directly from the harvesting sector. This author has not been able to determine whether or not this is true.

The regression estimates are obtained using 2SLS regression methods. This method creates an instrumental variable for the fresh/frozen and canned prices by regressing these variables against all of the exogenous variables in the system of equations. The estimated fresh/frozen and canned prices from these regressions are used as explanatory variables in the ex-vessel demand equations.

KING: The king ex-vessel demand equation results are in Table 3.3.1. Although the DW statistic is low (DW = 1.403), it is in the inconclusive region and the estimate for ρ is not significantly different from zero. The fit appears to be good, as the $R = 0.855$. However, only the fresh/frozen price (PFKING) is statistically significant of the slope coefficients. An increase in the price of fresh/frozen king salmon raises the ex-vessel price by 0.58 cents.

RED: The red salmon equation estimates are given in Table 3.3.2. The red salmon ex-vessel price equation has a low DW (DW = 1.571, in the inconclusive region), but the estimate of ρ could not be distinguished from zero. The coefficient for quantity landed (QXRED) and for fresh/frozen price (PFRED) are each insignificant, but the coefficient for canned red salmon is significant and positive. An increase in the price of canned red salmon by one cent will increase the ex-vessel price by 0.18 cents. The equation explains only 51.4% of the variance of red salmon ex-vessel prices as given by the R .

SILVER: The silver salmon results are contained in Table 3.3.3. The silver salmon ex-vessel price equation also has a low DW (DW = 1.365, in the inconclusive region), but the estimate of ρ was statistically indistinguishable from zero, so no correction was made for autocorrelation. The landings variable and the intercept each had statistically insignificant coefficients, but both of the wholesale price variables were significant and positive. An increase in the price of fresh/frozen silver salmon by one cent will increase the ex-vessel price by 0.32 cents, and an increase in the canned price will increase the ex-vessel price by 0.25 cents.

PINK: The pink salmon ex-vessel demand equation results are contained in Table 3.3.4. The pink salmon ex-vessel demand equation was not corrected for autocorrelation (DW = 2.221 implies no autocorrelation, and ρ was statistically zero). Landings of pink salmon were significant at the 90%

confidence level, indicating that an increase of a million pounds of pink landings would decrease pink price by 0.04 cents. Thus pink salmon prices are not very responsive, but the response is distinguishable from zero. Canned pink prices were statistically insignificant, but fresh/frozen prices were positive and significant (an increase in the fresh/frozen price by one cent increases ex-vessel prices by 0.32 cents). The R was relatively high, $R = 0.697$.

CHUM: The chum ex-vessel demand equation results are in Table 3.3.5. The chum equation was also not corrected for autocorrelation. The DW statistic was in the inconclusive region ($DW = 1.461$), and the estimated ρ was statistically indistinguishable from zero. The intercept was negative and statistically significant. Landings (QXCHUM) were statistically insignificant, implying no price response to increased landings, but the ex-vessel price was statistically positively correlated with both canned and fresh/frozen chum prices. An increase in canned prices by one cent would increase ex-vessel price by 0.18 cents, and an increase in fresh/frozen chum prices will increase ex-vessel chum prices by 0.33 cents. This equation had an $R = 0.772$, which is the second highest of the five species (behind king).

In general, the ex-vessel demand equations show that the price is perfectly elastic, or close to it (pink is the only one that is not completely elastic. Thus as a first order approximation, small changes in the ex-vessel landings has no effect upon price according to these results. In Section 5 we shall compare this result with the estimates of the price flexibility when larger changes in the quantity landed occur by considering secondary effects through the wholesale markets. In addition, price at the ex-vessel level is positively related to the price at the wholesale level. However, the amount that gets passed on is quite small. This could be an indication that the market power is in the hands of the processors, although it is not by itself sufficient evidence of this hypothesis. It is interesting to note that in none of the ex-vessel demand equations did the results change sign or magnitude (none by even a factor of 2) in the 2SLS relative to the OLS estimates (which are not reported).

Table 3.3.1: 2SLS Linear Ex-vessel Demand Equation Estimation (1964-1988)

KING

rho & asymptotic t-ratio

0.284

1.225

second order rho & asymptotic t-ratios

0.339 -0.146

1.355 -0.644

not corrected for ar(1) since rho not significant at 5% 1-tail level

Valid cases:	25	Dependent variable:	QXKING
Total SS:	6.552	Degrees of freedom:	21
R-squared:	0.873	Rbar-squared:	0.855
Residual SS:	0.834	Std error of est:	0.199
F(3,21):	48.008	Probability of F:	0.000
Durbin-Watson:	1.403		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	-0.987387	0.383736	-2.573092	0.018	---	---
QXKING	0.033175	0.022709	1.460888	0.159	0.158486	0.282298
PCKING	0.124785	0.096642	1.291207	0.211	0.154907	0.472011
PFFING	0.586356	0.078989	7.423219	0.000	0.814600	0.926697

Table 3.3.2: 2SLS Linear Ex-vessel Demand Equation Estimation (1964-1988)

RED

rho & asymptotic t-ratio

-0.073

-0.211

second order rho & asymptotic t-ratios

-0.170 0.272

-0.452 1.004

not corrected for ar(1) since rho not significant at 5% 1-tail level

Valid cases:	25	Dependent variable:	QXRED
Total SS:	4.074	Degrees of freedom:	21
R-squared:	0.575	Rbar-squared:	0.514
Residual SS:	1.731	Std error of est:	0.287
F(3,21):	9.477	Probability of F:	0.000
Durbin-Watson:	1.571		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	0.133252	0.198905	0.669929	0.510	---	---
QXRED	0.001017	0.000812	1.251670	0.224	0.192866	0.244411
PCRED	0.180551	0.060011	3.008653	0.007	0.545858	0.683535
PFRED	0.083151	0.063289	1.313822	0.203	0.248844	0.622514

Table 3.3.3: 2SLS Linear Ex-vessel Demand Equation Estimation (1964-1988)

SILVER

rho & asymptotic t-ratio

0.293
1.373

second order rho & asymptotic t-ratios

0.415 -0.260
1.748 -1.083

not corrected for ar(1) since rho not significant at 5% 1-tail level

Valid cases:	25	Dependent variable:	QXSILV
Total SS:	4.527	Degrees of freedom:	21
R-squared:	0.698	Rbar-squared:	0.655
Residual SS:	1.365	Std error of est:	0.255
F(3,21):	16.211	Probability of F:	0.000
Durbin-Watson:	1.365		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	-0.203175	0.286609	-0.708894	0.486	---	---
QXSILV	-0.002779	0.004203	-0.661314	0.516	-0.080609	-0.089380
PCSILV	0.245699	0.097737	2.513889	0.020	0.321117	0.538238
PFSILV	0.319582	0.059913	5.334140	0.000	0.674984	0.767979

Table 3.3.4: 2SLS Linear Ex-vessel Demand Equation Estimation (1964-1988)

PINK

rho & asymptotic t-ratio

-0.294
-1.158

second order rho & asymptotic t-ratios

-0.392 -0.425
-1.539 -1.705

not corrected for ar(1) since rho not significant at 5% 1-tail level

Valid cases:	25	Dependent variable:	QXPINK
Total SS:	0.673	Degrees of freedom:	21
R-squared:	0.735	Rbar-squared:	0.697
Residual SS:	0.178	Std error of est:	0.092
F(3,21):	19.404	Probability of F:	0.000
Durbin-Watson:	2.221		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	0.156744	0.089483	1.751664	0.094	---	---
QXPINK	-0.000460	0.000258	-1.782325	0.089	-0.216554	-0.480564
PCPINK	0.011484	0.035694	0.321731	0.751	0.054195	0.660030
PFPINK	0.324697	0.075565	4.296947	0.000	0.716672	0.830295

Table 3.3.5: 2SLS Linear Ex-vessel Demand Equation Estimation (1964-1988)

CHUM

rho & asymptotic t-ratio

0.231

1.048

second order rho & asymptotic t-ratios

0.266 -0.530

1.026 -2.320

not correct for ar(1) since rho not significant at 5% 1-tail level

Valid cases:	25	Dependent variable:	QXCHUM
Total SS:	1.271	Degrees of freedom:	21
R-squared:	0.801	Rbar-squared:	0.772
Residual SS:	0.253	Std error of est:	0.110
F(3,21):	28.122	Probability of F:	0.000
Durbin-Watson:	1.461		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	-0.316812	0.137304	-2.307385	0.031	---	---
QXCHUM	0.000484	0.001077	0.449408	0.658	0.053491	-0.037425
PCCHUM	0.185220	0.084678	2.187353	0.040	0.373481	0.780111
PFCHUM	0.332136	0.089980	3.691206	0.001	0.591936	0.863843

4. Comparisons of the models

In this section we discuss the ability of each of the models to predict within the sample period 1964-1988, and within the more recent period of 1978-1988. We present statistical and graphical evidence of the how well each model predicts. The statistical evidence is in the form of mean squared error (MSF) estimates, Theil's U^1 statistic, and Theil's decomposition of the MSE into the U^M , U^R , and U^D statistics. The graphical evidence is given by plotting the actual and predicted price series over time, and by plotting the actual versus the predicted values against each other. The plotting of the time series allows one to examine how well each model predicts increases and decreases in prices, and the plotting of the actual values versus the predicted values shows how well each model predicts over the range of values of the ex-vessel prices.

Statistical tests

The statistical tests used to examine the forecasts are the following.¹⁰ The first, and most general is the root mean squared error (MSE) statistic. This measures the sum of the squared differences between the relative change in the actual and the relative change in the predicted variable. If we let A_t be the actual value at time t and P_t be the predicted value at time t , the relative changes are given by $a_t = [A_t - A_{t-1}]/A_{t-1}$, and $p_t = [P_t - P_{t-1}]/P_{t-1}$. The MSE is thus

$$\begin{aligned} \text{MSE} &= \sum_{t=1}^n (p_t - a_t)^2 \\ &= (\bar{p} - \bar{a})^2 + S_{p-a}^2, \end{aligned}$$

where the S_{p-a}^2 term is the variance of the prediction errors. Maddala (p. 344) shows that MSE can be broken down by the following decompositions,

$$S_{p-a}^2 = (S_p - rS_a)^2 + (1 - r^2)S_a^2,$$

where r is the correlation between a_t and p_t , and the following statistics can be derived

$$U^M = \frac{(\bar{p} - \bar{a})^2}{\text{MSE}} = \text{bias proportion}$$

$$U^R = \frac{(S_p - rS_a)^2}{\text{MSE}} = \text{regression proportion}$$

$$U^D = \frac{(1 - r^2)S_a^2}{\text{MSE}} = \text{disturbance proportion}$$

The interpretation of the statistics is as follows. "If U^M is large, it means that the average predicted change deviates substantially from the average actual change. *This is clearly a serious error, because we should expect that forecasters must be able to reduce such errors in the course of time*" (Maddala, p.

¹⁰This section follows the discussion in Maddala (1977).

345, emphasis added). The statistic U^R gets its name from the fact that if a regression were to be run with

$$A_t = \alpha + \beta P_t,$$

then the statistic U^R , the 'regression proportion', goes to zero as $\beta \rightarrow 1$. Thus an ideal predictor will have the statistics U^R and U^M as small as possible (note that $U^M + U^R + U^D = 1$)

We also report the U^I statistic as well as the mean absolute error (MAE) statistic as defined in Maddala (1977).¹¹ Table 4.1 reports the MSE, MAE, U^I , U^M , U^R , and U^D statistics for the entire period of the sample (1964-1988) for each of the above models. Table 4.2 reports the same statistics for the period 1978-1988. Our analysis will proceed by species. The ISER models are listed as ISER1 and ISER2 for the contemporaneous and lagged quantity models, respectively.

King: The 2SLS appears to be superior to any of the other models by any one of the statistics chosen. The 2SLS model has an MSE that is more than 5 times lower than the CFEC model, and more than 25 times lower than either of the ISER models. The ISER models are the poorest fit in terms of the U^M , U^R , and U^D statistics. Neither the 2SLS nor the CFEC model appear to show systematic bias according to the Theil statistics.

Red: The 2SLS model and the quantity model each appear to be close in MSE, MAE, and U statistics, although the CFEC models are not much worse. None of the models shows systematic bias or regression error.

Silver: The ISER models each show the highest MSE and signs of persistent bias as indicated by the high U^M statistic. The 2SLS model has a MSE of 0.041, compared to a MSE of 0.074 for the CFEC model. Neither the 2SLS nor the CFEC models show any signs of either bias or systematic regression error.

¹¹ The U^C and U^S statistics were calculated but are not reported. Maddala, pp. 344-7, gives strong evidence that these two statistics are devoid of meaningful interpretation.

Pink: None of the models shows signs of systematic bias as given by the U^M statistic. However, the models differ markedly in the regression proportion given by U^R . The 2SLS model has the lowest U^R (and U^M) statistics, with an U^R statistic of 0.192 compared to an U^R between 0.369 and 0.456 for the other models. The 2SLS model also has the lowest MSE, MAE, and U^I statistics.

Chum: As with the king and silver salmon, the ISER models have a large U^M statistic, indicating a systematic bias over time. The CFEC model has a low U^M statistic ($U^M = 0.056$), but a large U^R statistic ($U^R = 0.505$). The 2SLS model has the lowest MSE, MAE, U^I , U^M , and U^R statistics of all of the models.

Table 4.2, which displays the same set of statistics calculated over the period 1978-1988, shows that the 2SLS model also out-performs the other models for this period. An exception to this generalization is for red salmon. In this case, the ISER1 model (contemporaneous quantities) has a lower MSE and MAE than the 2SLS model. Another observation is that for red salmon, the CFEC has a fairly large U^M statistic ($U^M = 0.394$), showing that there appears to be systematic bias over the period 1978-1988 for the CFEC model.

Table 4.1: Goodness of fit statistics (1964-1988)

KING

model	MSE	MAE	U^1	U^M	U^R	U^D
2SLS	0.014	0.141	0.369	0.000	0.002	0.997
CFEC	0.072	0.326	0.837	0.009	0.105	0.886
ISER1	0.384	0.775	1.906	0.732	0.014	0.254
ISER2	0.457	0.885	2.081	0.785	0.009	0.205

RED

model	MSE	MAE	U^1	U^M	U^R	U^D
2SLS	0.047	0.188	0.732	0.001	0.003	0.996
CFEC	0.089	0.249	0.985	0.157	0.044	0.799
ISER1	0.059	0.197	0.822	0.002	0.235	0.763
ISER2	0.050	0.188	0.756	0.000	0.127	0.873

SILVER

model	MSE	MAE	U^1	U^M	U^R	U^D
2SLS	0.041	0.180	0.645	0.004	0.030	0.965
CFEC	0.074	0.264	0.874	0.003	0.059	0.938
ISER1	0.211	0.439	1.478	0.644	0.003	0.353
ISER2	0.417	0.674	2.075	0.872	0.000	0.128

PINK

model	MSE	MAE	U^1	U^M	U^R	U^D
2SLS	0.054	0.076	0.7	0.006	0.192	0.802
CFEC	0.059	0.076	0.802	0.041	0.384	0.576
ISER1	0.116	0.126	1.128	0.035	0.456	0.509
ISER2	0.065	0.082	0.841	0.021	0.369	0.610

CHUM

model	MSE	MAE	U^1	U^M	U^R	U^D
2SLS	0.050	0.077	0.702	0.003	0.072	0.925
CFEC	0.111	0.128	1.050	0.056	0.505	0.438
ISER1	0.226	0.193	1.467	0.594	0.002	0.404
ISER2	0.262	0.214	1.579	0.654	0.001	0.345

Note: ISER1 uses contemporaneous quantities and ISER2 uses lagged quantities as explanatory variables.

Table 4.2. Goodness of fit summary statistics (1978-1988).

KING

model	MSE	MAE	U^1	U^M	U^R	U^D
2SLS	0.020	0.190	0.600	0.162	0.017	0.821
CFEC	0.034	0.275	0.777	0.034	0.133	0.832
ISER1	0.197	0.709	1.880	0.775	0.002	0.222
ISER2	0.241	0.813	2.081	0.819	0.000	0.181

RED

model	MSE	MAE	U^1	U^M	U^R	U^D
2SLS	0.041	0.211	0.648	0.029	0.014	0.956
CFEC	0.099	0.323	1.004	0.394	0.004	0.602
ISER1	0.031	0.173	0.566	0.202	0.002	0.797
ISER2	0.047	0.202	0.691	0.094	0.012	0.894

SILVER

model	MSE	MAE	U^1	U^M	U^R	U^D
2SLS	0.038	0.182	0.623	0.040	0.109	0.850
CFEC	0.148	0.314	1.222	0.519	0.040	0.441
ISER1	0.148	0.314	1.222	0.519	0.040	0.441
ISER2	0.335	0.573	1.838	0.893	0.003	0.104

PINK

model	MSE	MAE	U^1	U^M	U^R	U^D
2SLS	0.089	0.091	0.725	0.052	0.212	0.737
CFEC	0.122	0.100	0.849	0.067	0.390	0.543
ISER1	0.193	0.135	1.068	0.145	0.366	0.489
ISER2	0.091	0.078	0.733	0.117	0.189	0.695

CHUM

model	MSE	MAE	U^1	U^M	U^R	U^D
2SLS	0.033	0.074	0.521	0.016	0.032	0.952
CFEC	0.108	0.131	0.950	0.061	0.506	0.433
ISER1	0.174	0.138	1.203	0.407	0.075	0.518
ISER2	0.204	0.154	1.304	0.502	0.034	0.465

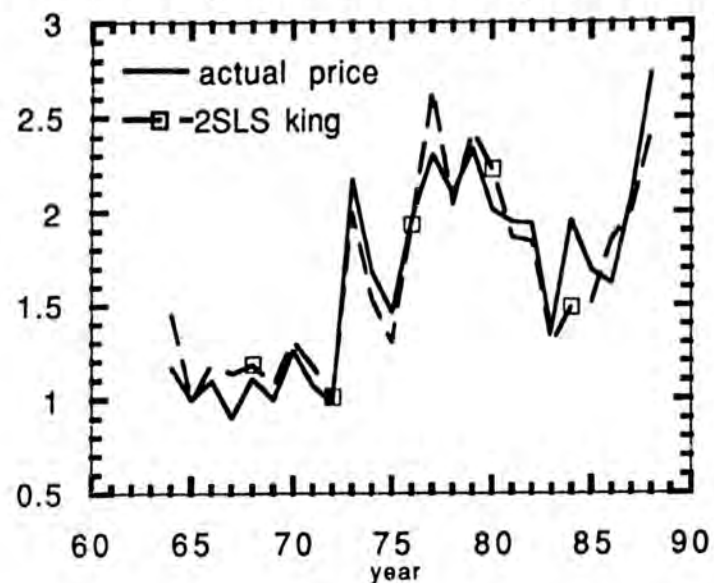
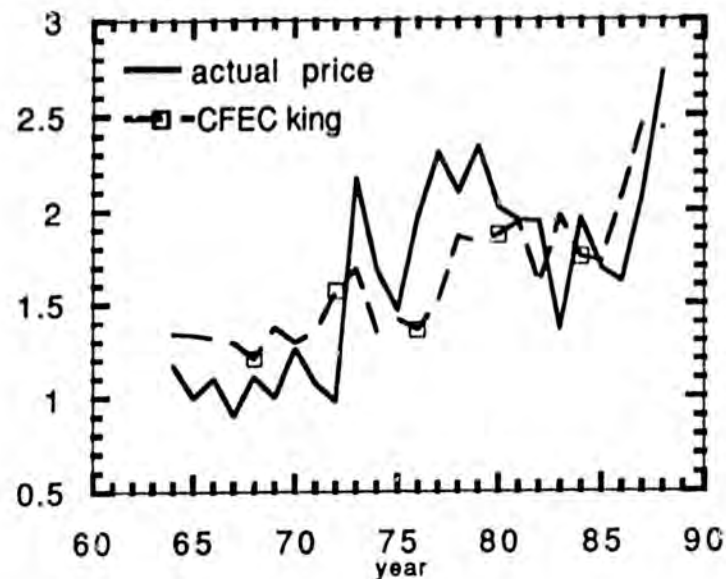
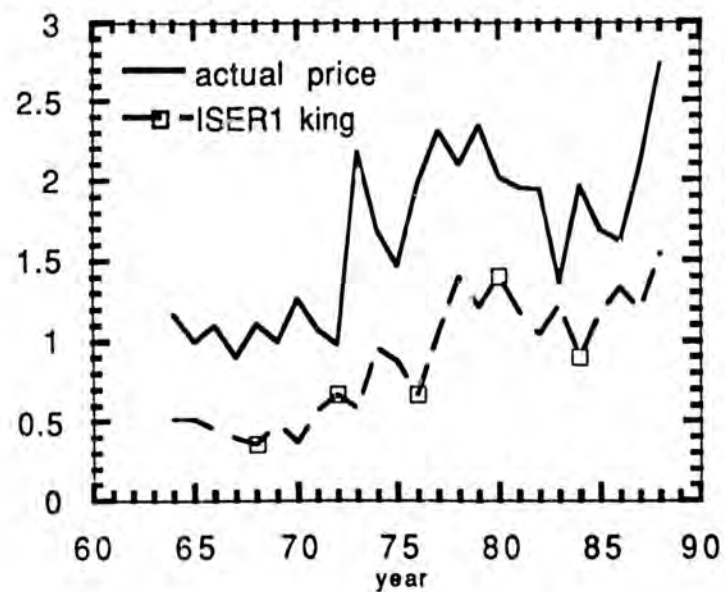
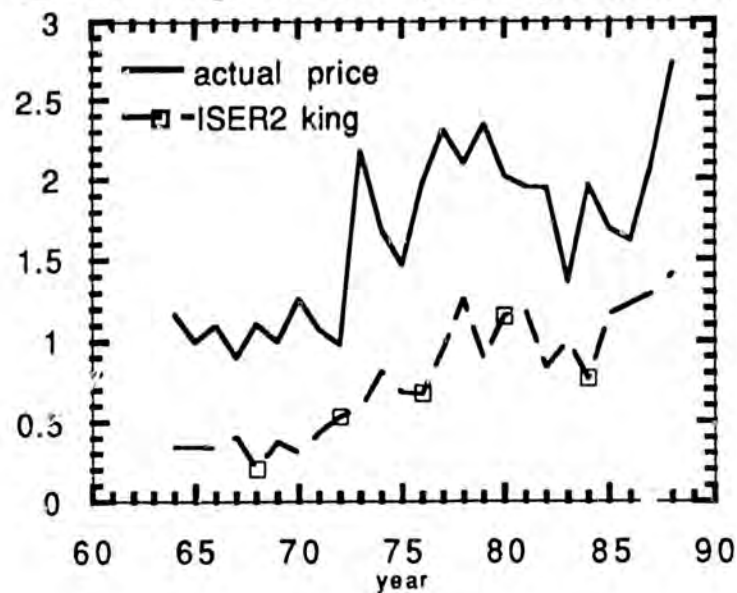
Note: ISER1 uses contemporaneous quantities and ISER2 uses lagged quantities as explanatory variables.

Graphical Analysis

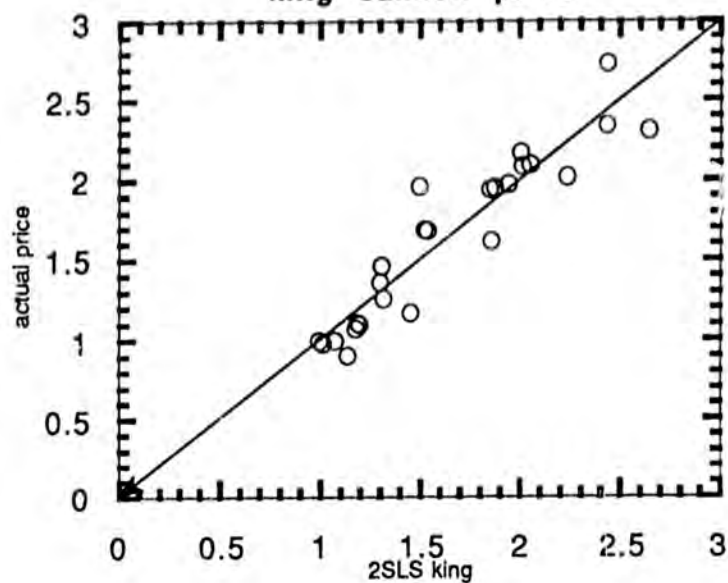
We have plotted two graphs for each model for each species. The first graph shows the actual and predicted ex-vessel price series over time. This allows the reader to see how well each model tracks the data over time.

The second graph plots the predicted price against the actual price. A 45 degree line is also provided as a reference. If the models predicted exactly, the plot of predicted versus actual values would line up exactly along these lines. A point plotted above the line means that the actual value is larger than the predicted value, a point below the 45 degree line means that the actual value is smaller than the predicted value. This graph allows the reader to see how well the various models perform at different levels of prices. Biases in the prediction are readily evident by observing that most of the data points lie on one side of the 45 degree line (an unbiased predictor will have roughly equal numbers of misses on each side of the 45 degree line). An example of bias is the two ISER models for king salmon, where the data points all appear above the 45 degree line indicating that the predictions are all lower than the actual values (compare with the time series plots for the same series). The variance of the predictions are also apparent from these diagrams. A model which has most of the predictions close to the 45 degree line has a lower variance than a model which has data points dispersed throughout the diagram. A striking example of this phenomenon is in a comparison of the king salmon diagrams for 2SLS and the CFEC models. This diagram also allows one to see whether or not the model exhibits signs of heteroskedasticity, which means that the standard error of the estimate is not constant across values of the dependent variable. About the only example of heteroskedasticity is with the 2SLS red salmon model in which for low prices the plots appear close to the 45 degree line, but for the higher prices, the data points are much farther from the 45 degree line.

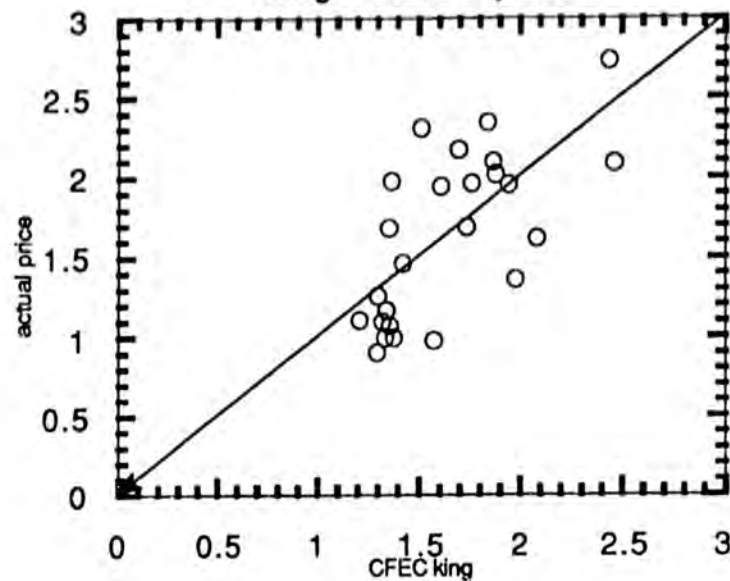
In general, the results of the graphical analysis concur with the statistical analysis contained in Table 4.1 and 4.2. The reader is invited to confirm this claim for themselves.

2SLS king salmon price predictions**CFEC king salmon price predictions****ISER1 king salmon price predictions****ISER2 king salmon price predictions**

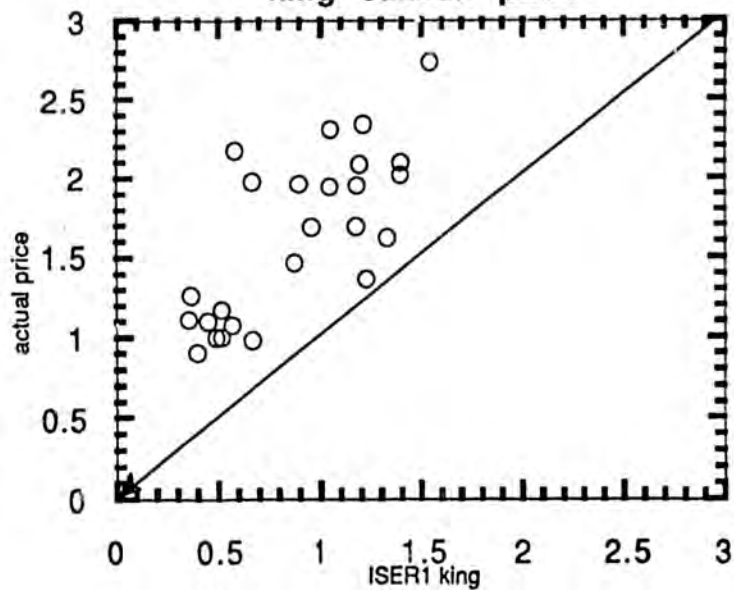
**2SLS predicted vs. actual
king salmon price**



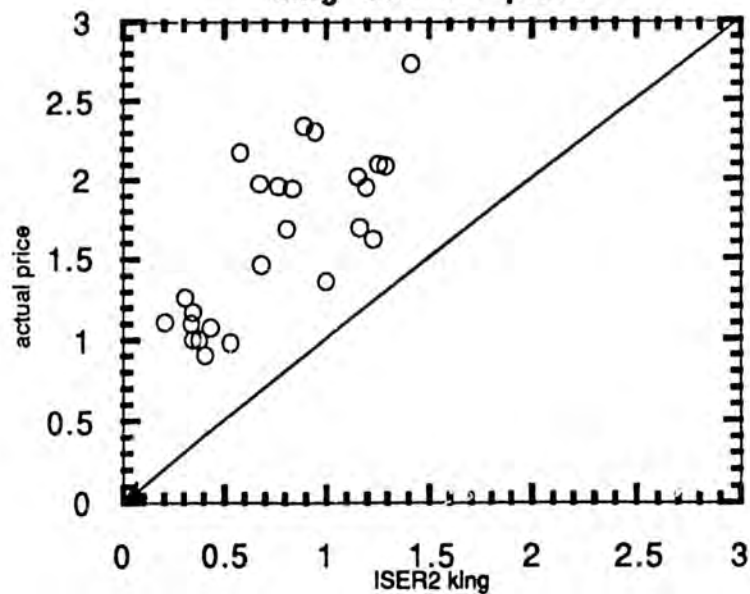
**CFEC predicted vs. actual
king salmon price**

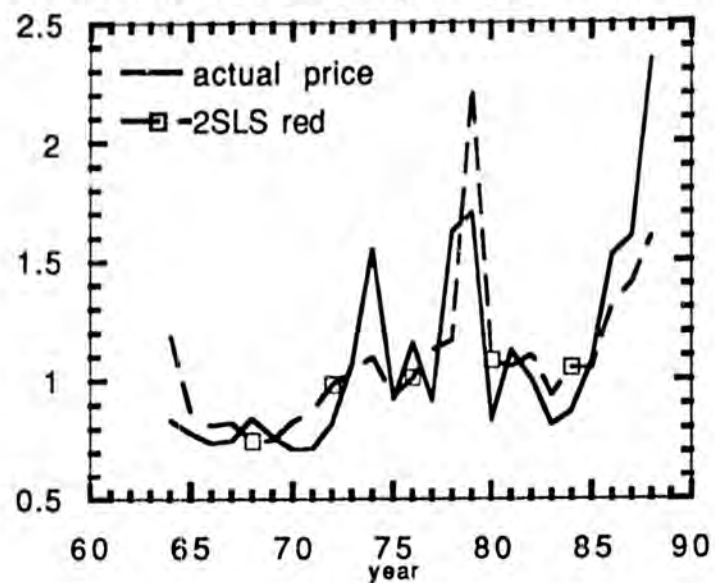
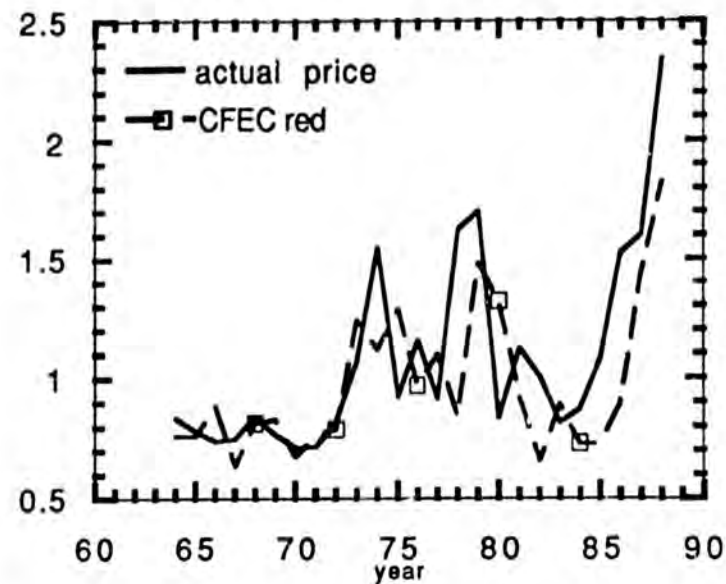
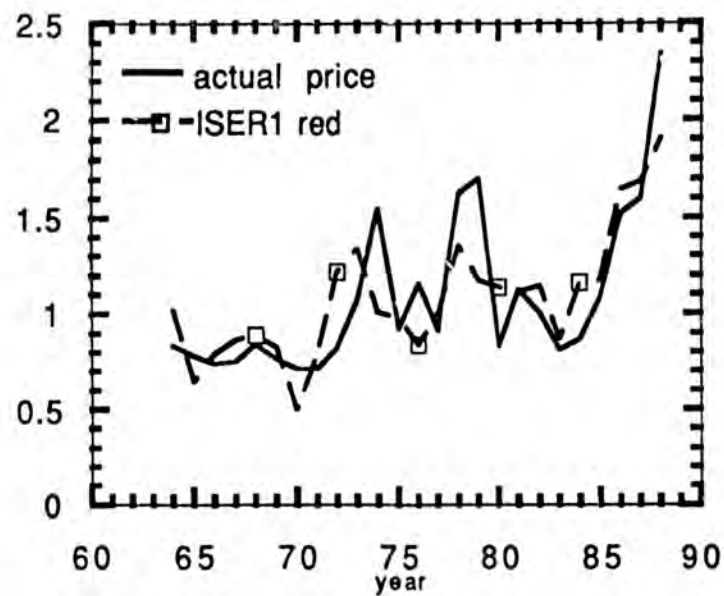
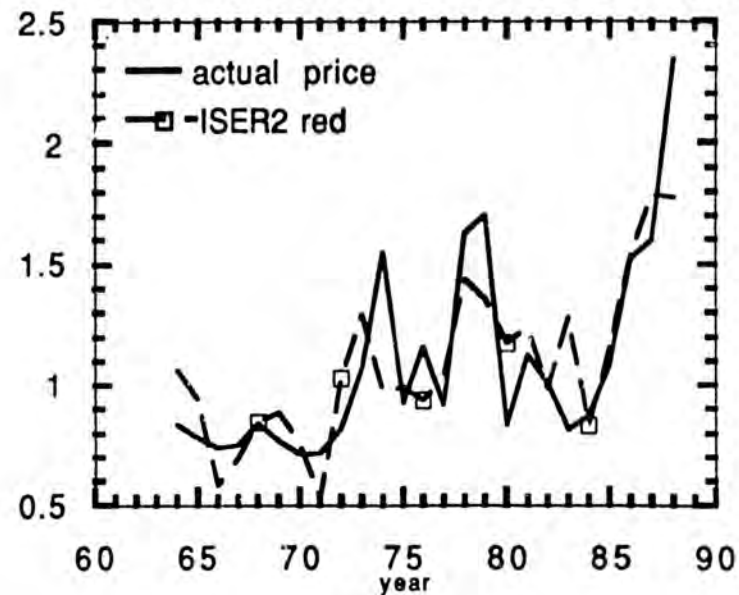


**ISER1 predicted vs. actual
king salmon price**

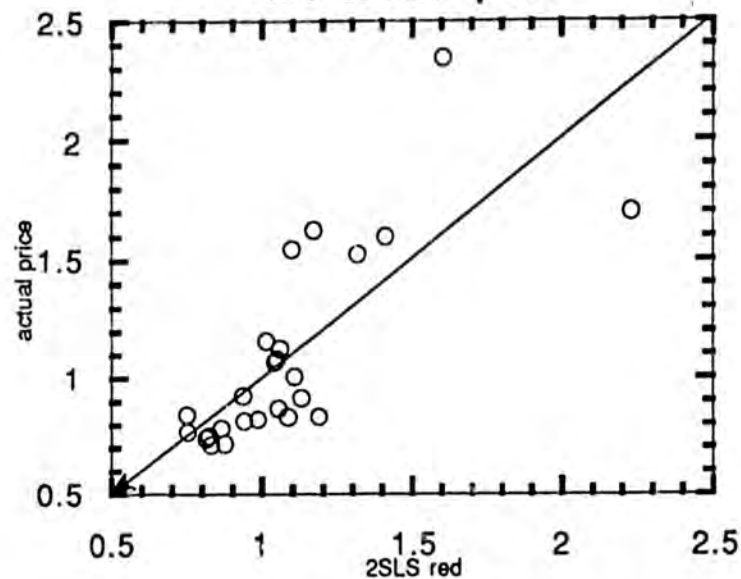


**ISER2 predicted vs. actual
king salmon price**

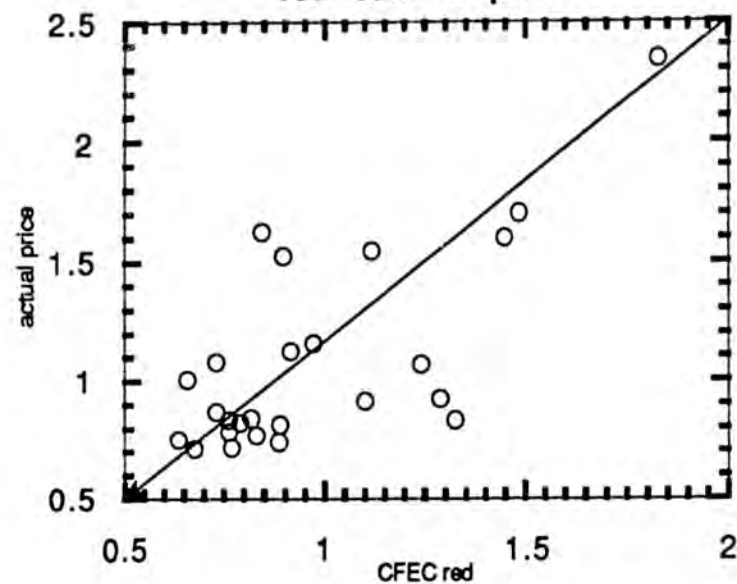


2SLS red salmon price predictions**CFEC red salmon price predictions****ISER1 red salmon price predictions****ISER2 red salmon price predictions**

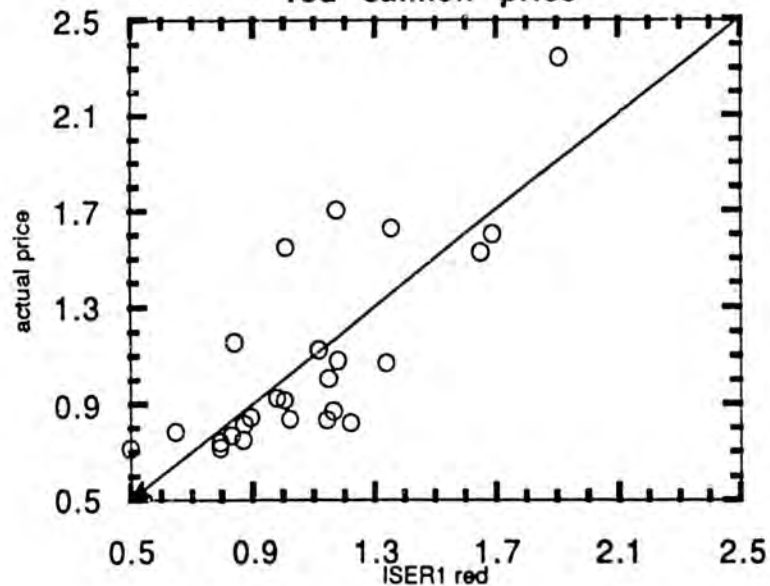
**2SLS predicted vs. actual
red salmon price**



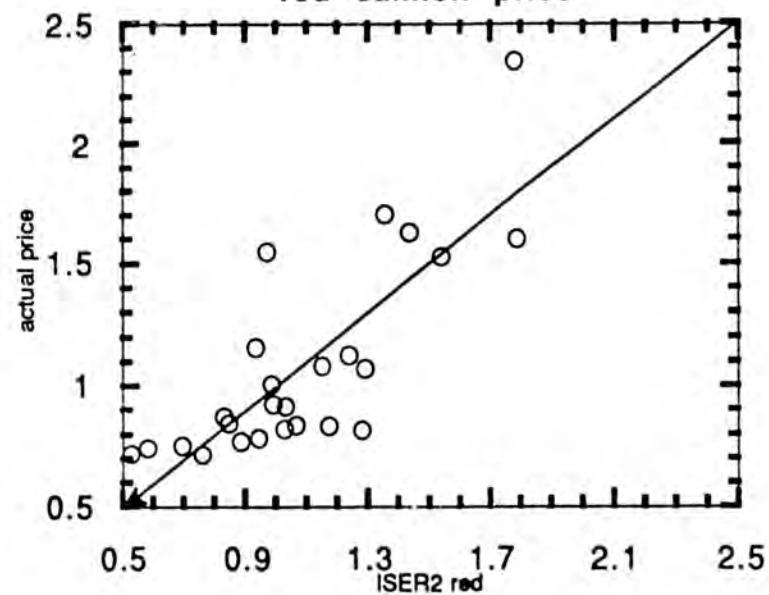
**CFEC predicted vs. actual
red salmon price**



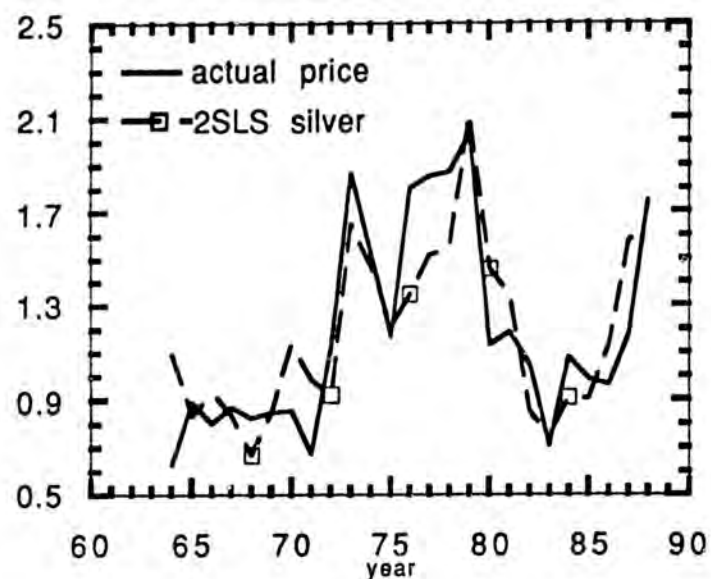
**ISER1 predicted vs. actual
red salmon price**



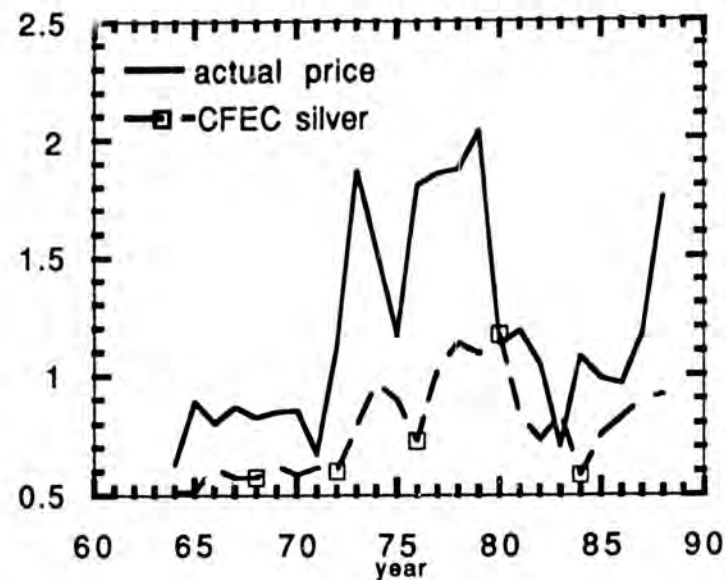
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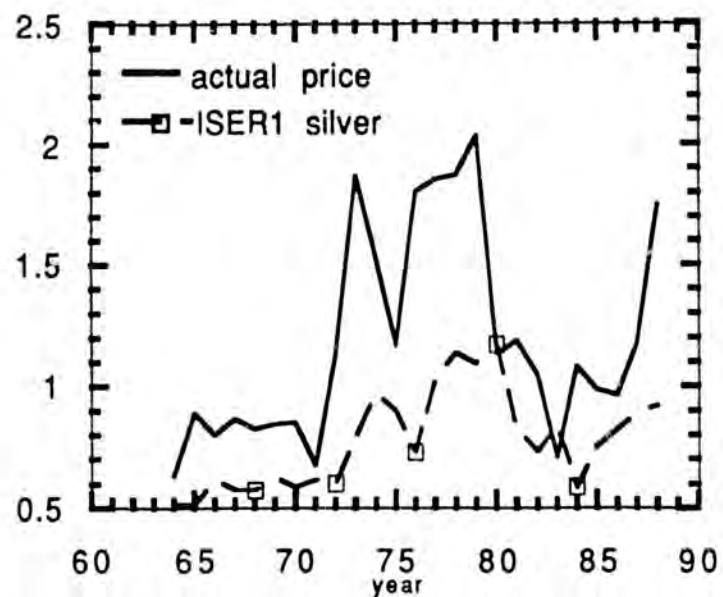
2SLS silver salmon price predictions



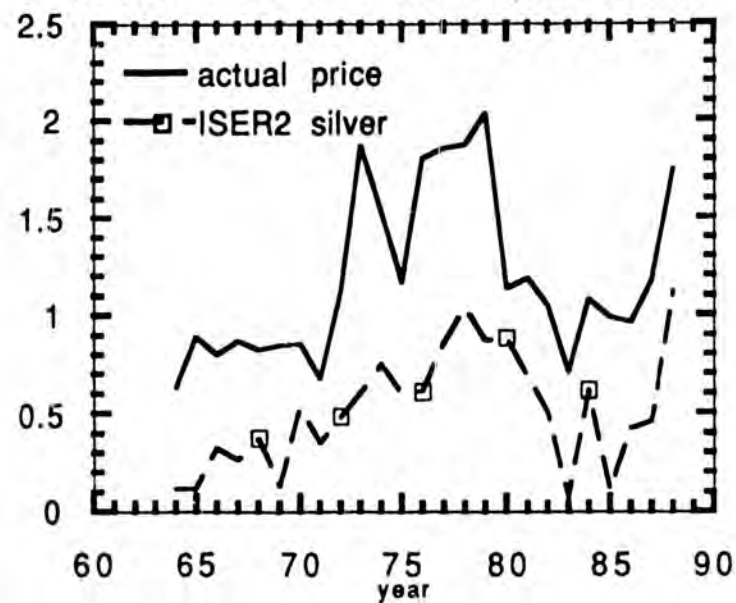
CFEC silver salmon price predictions



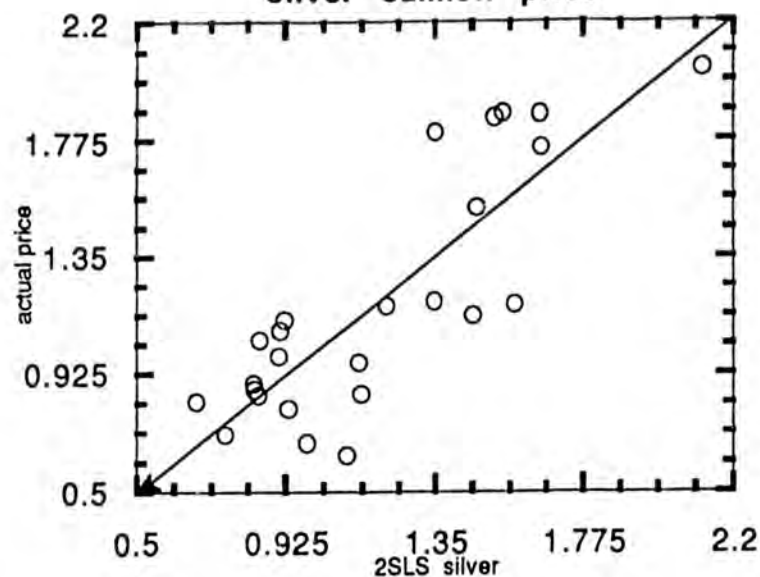
ISER1 silver salmon price predictions



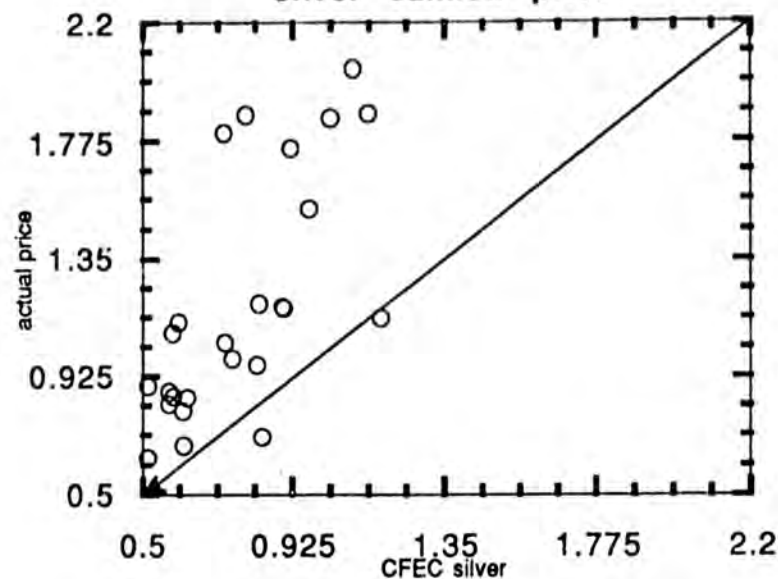
ISER2 silver salmon predictions



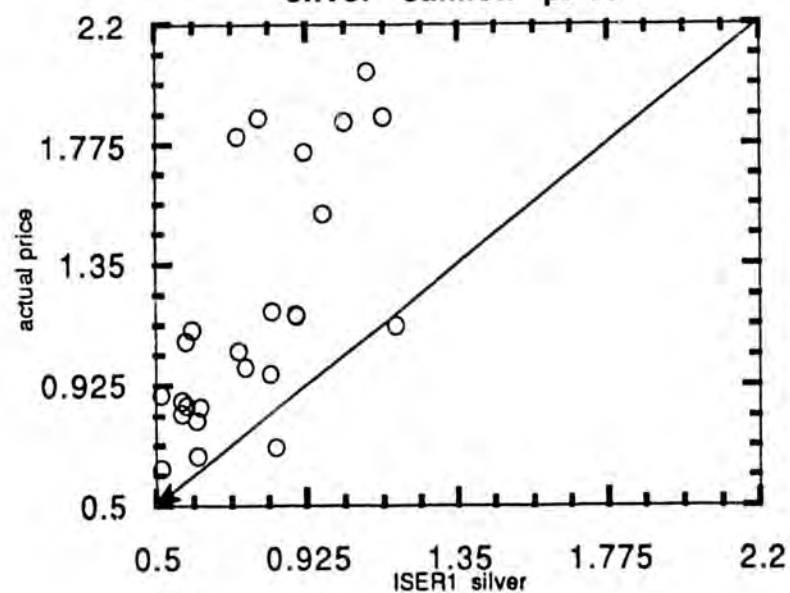
**2SLS predicted vs. actual
silver salmon price**



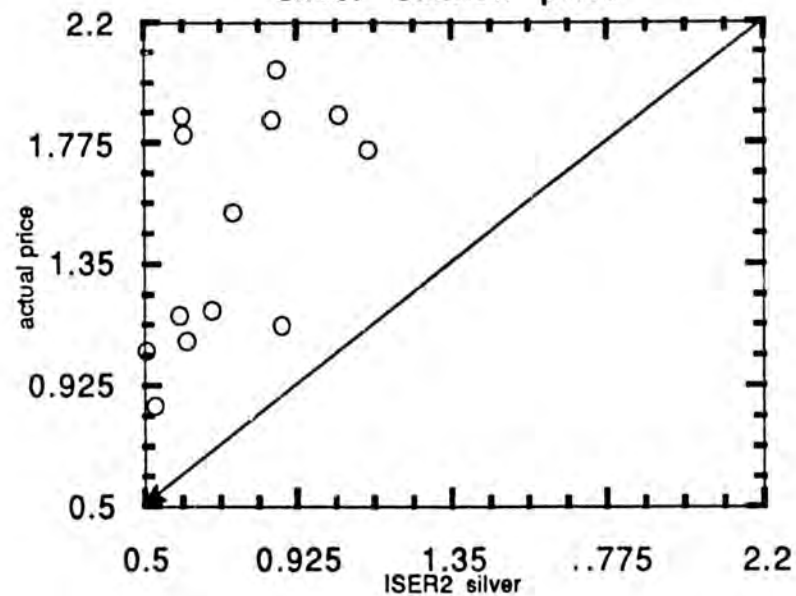
**CFEC predicted vs. actual
silver salmon price**



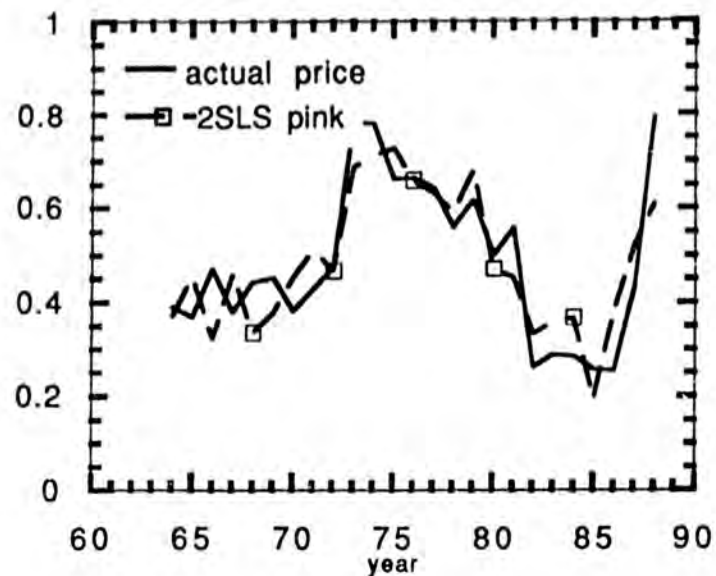
**ISER1 predicted vs. actual
silver salmon price**



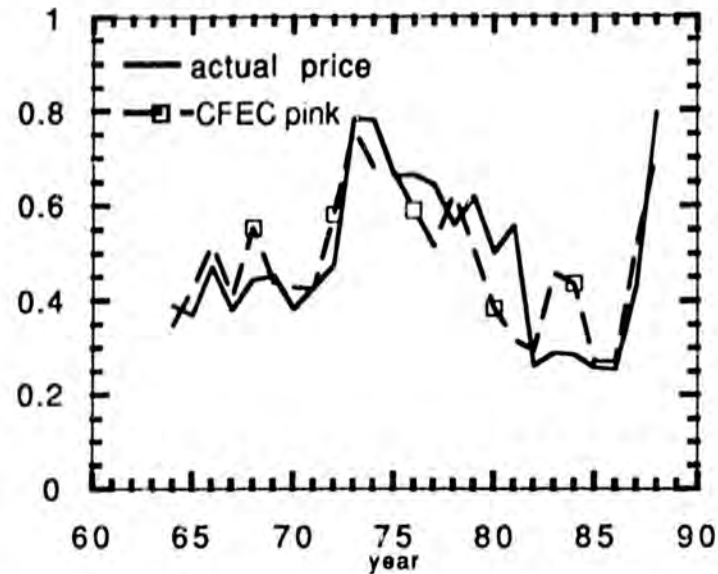
**ISER2 predicted vs. actual
silver salmon price**



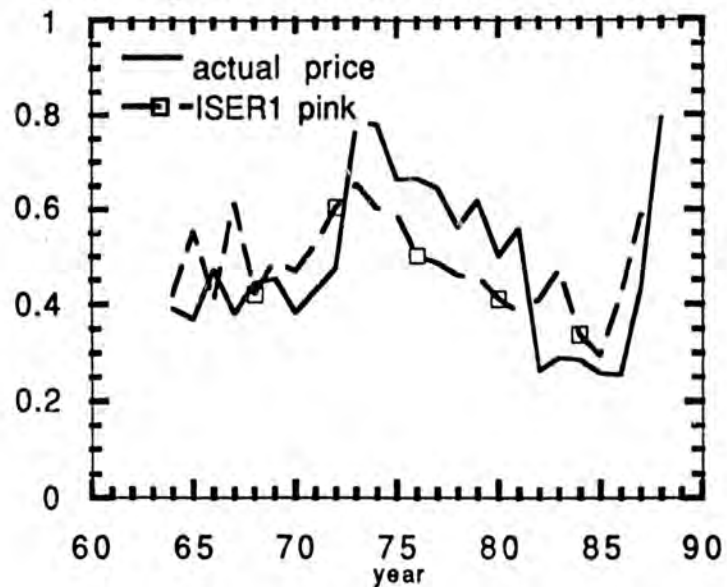
2SLS pink salmon price predictions



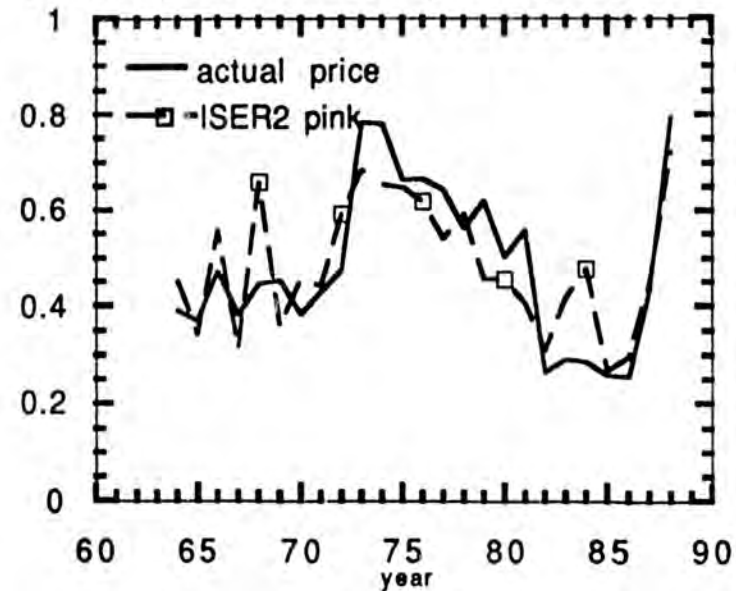
CFEC pink salmon price predictions



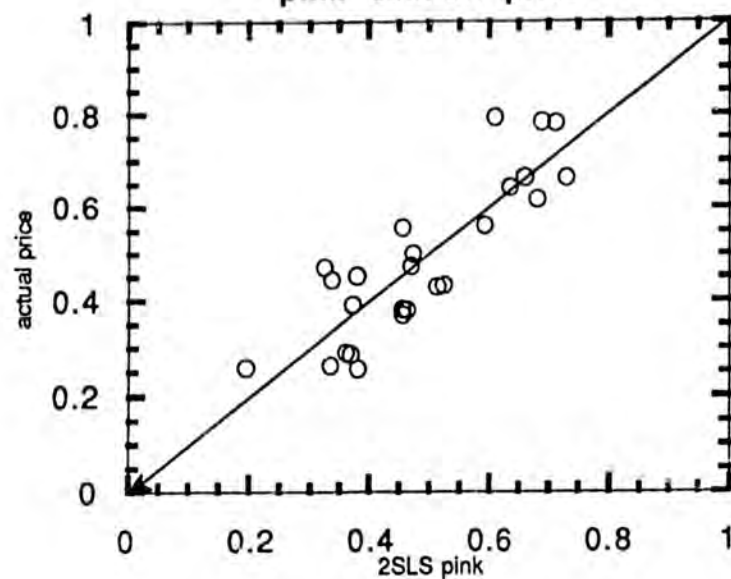
ISER1 pink salmon price predictions



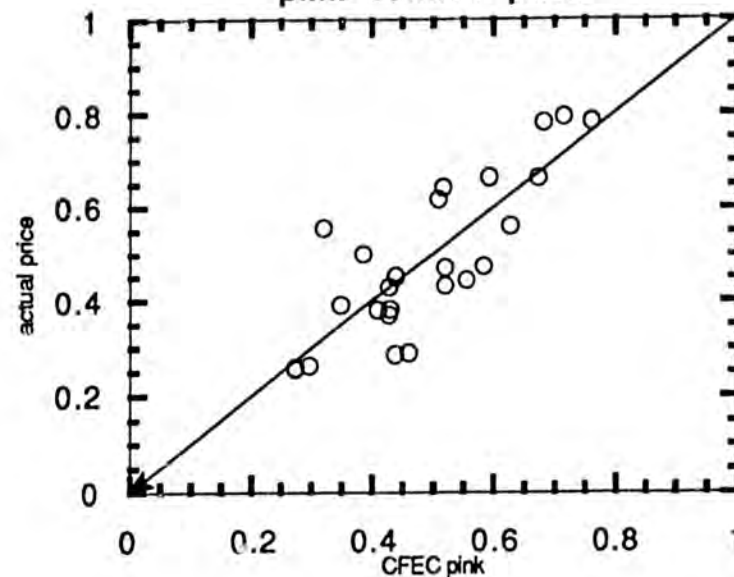
ISER2 pink salmon price predictions



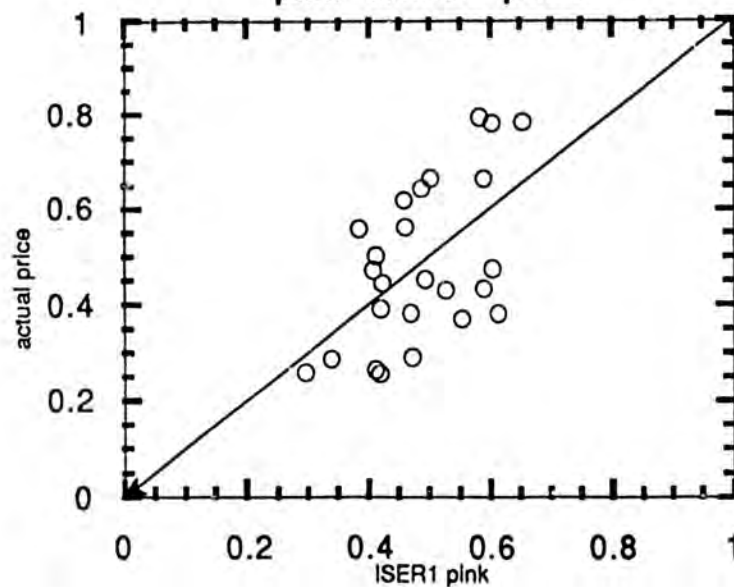
**2SLS predicted vs. actual
pink salmon price**



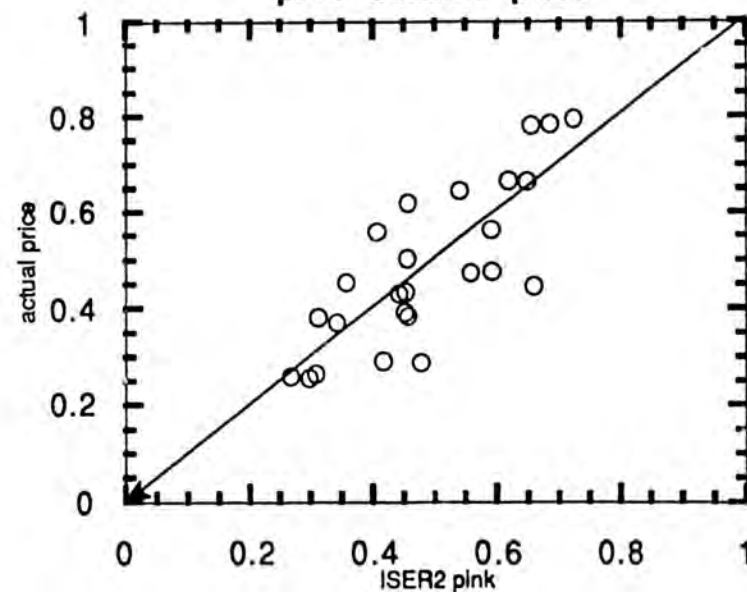
**CFEC predicted vs. actual
pink salmon price**



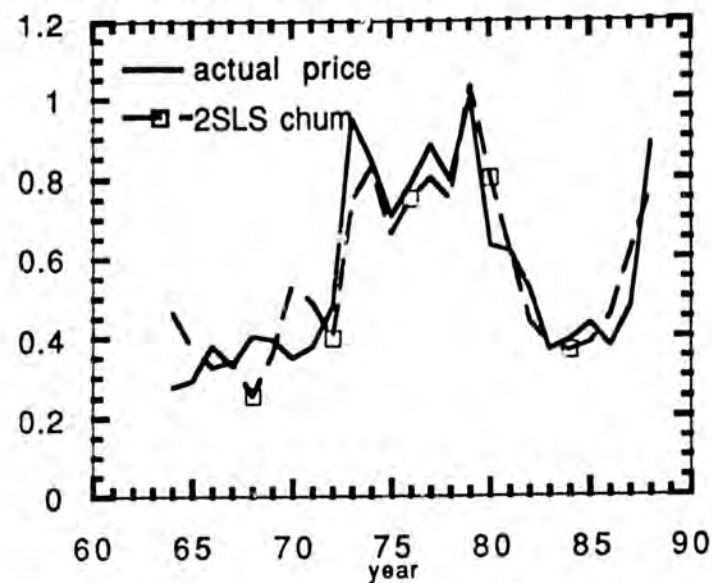
**ISER1 predicted vs. actual
pink salmon price**



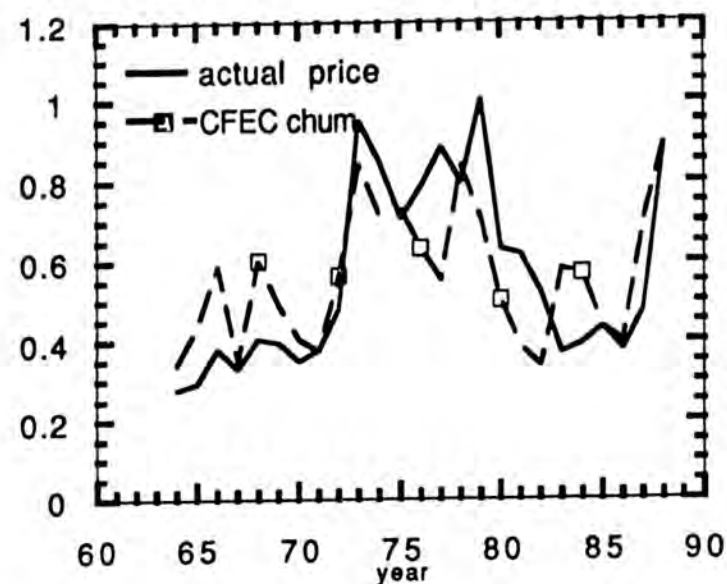
**ISER2 predicted vs. actual
pink salmon price**



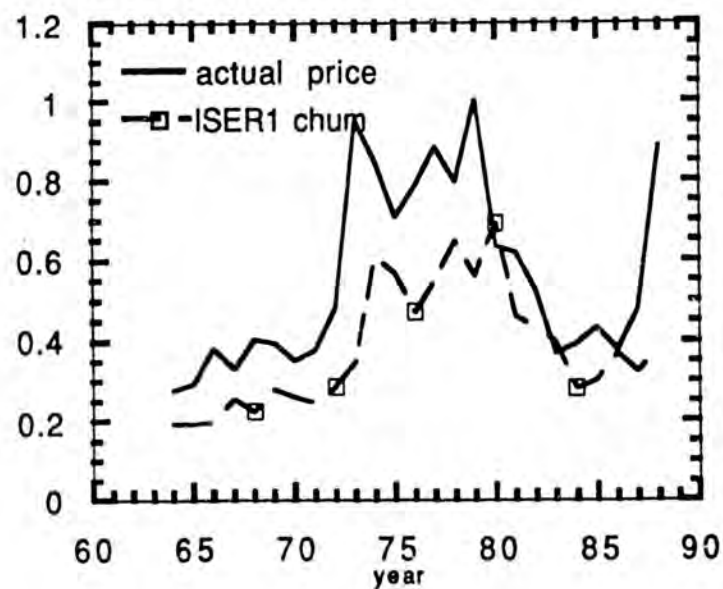
2SLS chum salmon price predictions



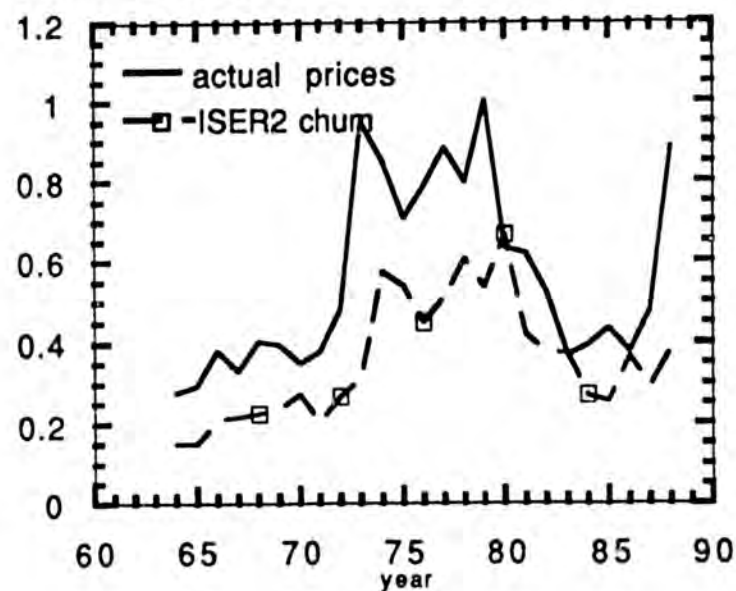
CFEC chum salmon price predictions



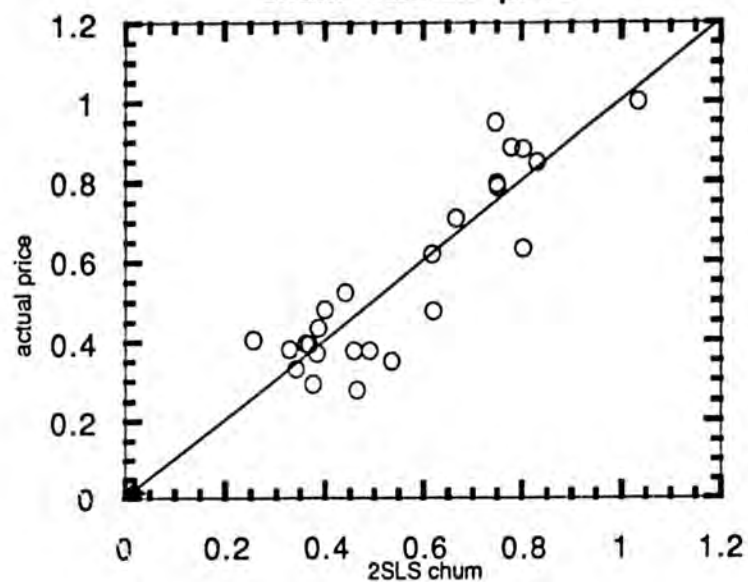
ISER1 chum salmon price predictions



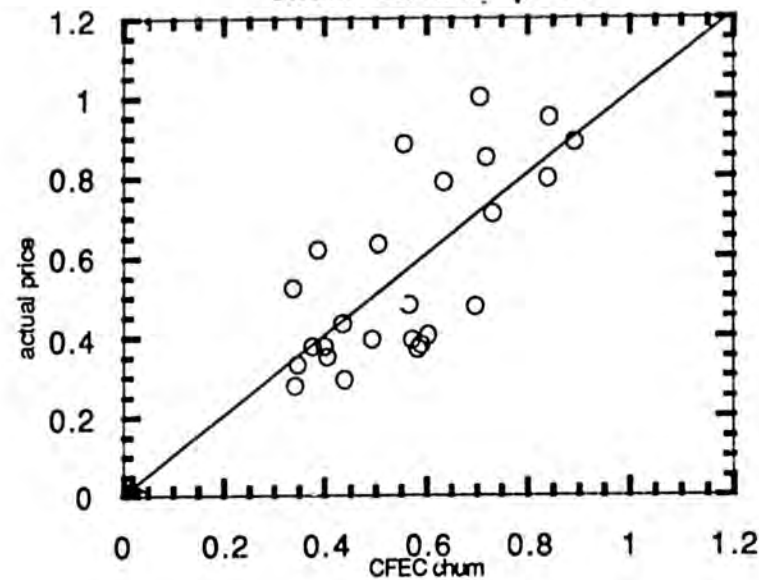
ISER2 chum salmon price predictions



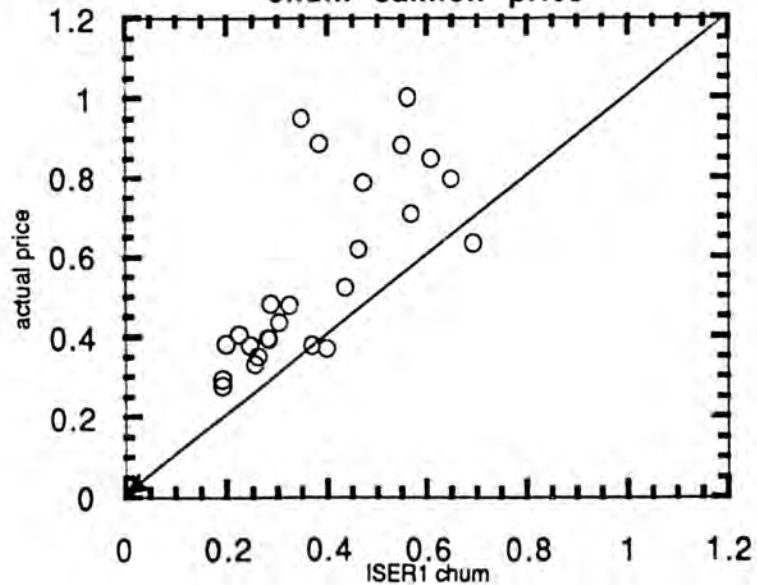
**2SLS predicted vs. actual
chum salmon price**



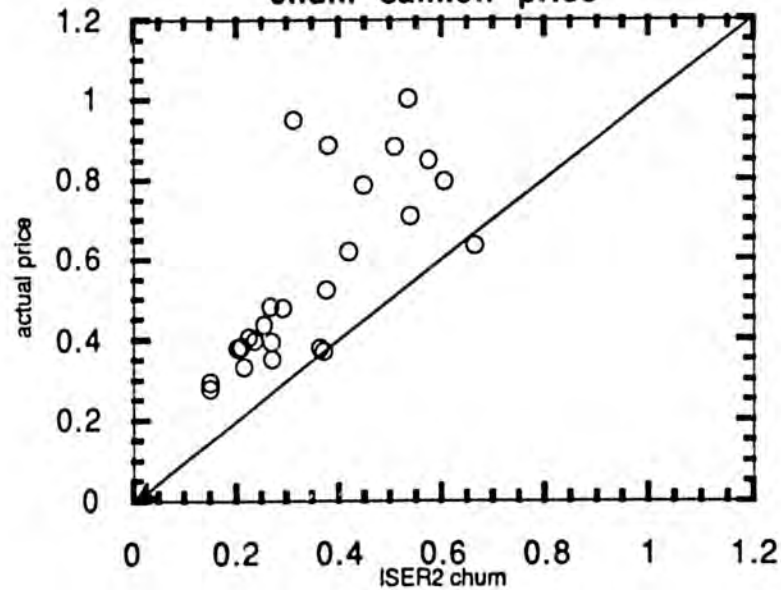
**CFEC predicted vs. actual
chum salmon price**



**ISER1 predicted vs. actual
chum salmon price**



**ISER2 predicted vs. actual
chum salmon price**



5 Calculation of price flexibility parameters

5.1 Partial equilibrium estimates of price flexibility parameters

In this section we calculate the price flexibility parameters for the 2SLS model. We do this by two different methods. The first method simply calculates the price flexibility parameter by multiplying the coefficient for quantity in the demand equation (ex-vessel, canned, and fresh/frozen) by the ratio of quantity to prices. This gives the *partial equilibrium* estimate of the price flexibility. Again, the partial equilibrium price flexibility assumes that conditions in other parts of the market do not change. This gives a good approximation for small changes in the quantity supplied.

Table 5.1 lists the average price and average quantity for each of the species at the ex-vessel, canned, and fresh/frozen levels for the entire sample (1964-1988) and for the most recent period (1978-1988) of the sample. Prices are in 1988 dollars, and quantities are in millions of pounds.

Table 5.1: Means of price and quantity data

1964-1988 data

	ex-vessel quantity	canned quantity	fresh/frozen quantity	ex-vessel price	canned price	fresh/frozen price
king	11.978	0.879	8.375	1.641	2.967	3.173
red	130.830	39.469	48.665	1.085	3.379	2.501
silver	22.183	2.655	13.763	1.187	2.661	2.496
pink	149.428	69.473	17.035	0.486	2.273	1.147
chum	62.884	17.129	24.338	0.559	1.926	1.472

1978-1988 data

	ex-vessel quantity	canned quantity	fresh/frozen quantity	ex-vessel price	canned price	fresh/frozen price
king	13.997	0.239	11.194	1.983	2.813	3.560
red	204.724	36.005	104.126	1.321	3.627	3.291
silver	33.136	1.750	22.923	1.267	2.629	2.907
pink	220.897	91.623	34.128	0.439	2.210	1.134
chum	83.674	12.600	43.041	0.592	1.853	1.592

Table 5.2 presents the results of the point estimates for the demand price flexibilities for ex-vessel, canned, and fresh/frozen salmon by species. Estimates are calculated using the mean prices and quantities for the whole sample (1964-1988) and for the most recent period (1978-1988). In the event that the quantity coefficient is statistically insignificant at the 90% confidence level, the coefficient is set equal to zero.

In all cases, the estimate is less than unity in absolute value, indicating that a percentage increase in quantity will result in less than a percentage decrease in price. This means that from a partial equilibrium focus, enhancement programs benefit both processors and the harvesting sector, although the benefits to each group are *not* the same magnitude. King, silver and chum salmon appear to be the species for which further enhancement would be most beneficial when considered only in terms of increased revenues since the prices for these species are the least responsive in each of the markets.

Table 5.2: Partial equilibrium price flexibility estimates

1964-1988

	EX-VESSEL	CANNED	FRESH/FROZEN
king	0	0	0
red	0	-0.009	-0.459
silver	0	0	-0.319
pink	-0.141	-0.341	-0.288
chum	0	-0.280	0

1978-1988

	EX-VESSEL	CANNED	FRESH/FROZEN
king	0	0	0
red	0	-0.003	-0.746
silver	0	0	-0.456
pink	-0.235	-0.463	-0.584
chum	0	-0.214	0

5.2 General equilibrium estimates of price flexibility parameters

For large changes in the quantity supplied we calculate a *general equilibrium* price flexibility estimate. By general equilibrium, we mean that the estimate takes into account changes in other parts of the system. In the case of ex-vessel quantity increases due to enhancement programs, these estimates indicate how ex-vessel prices will respond given that quantity increases at the ex-vessel level imply quantity increases at the canned and fresh/frozen quantity levels, which further imply that prices at these levels will decline, causing a decline in ex-vessel prices which is not taken into account in the partial equilibrium estimations.

While we are specifically interested in changes in the ex-vessel quantity, the method used can evaluate the general equilibrium elasticity for any of the exogenous variables to the system. We first demonstrate the method, which is a straight-forward application of Crammer's rule. Let the system of equations be defined by

$$PF = \alpha_{FD} + \beta_{FF} \cdot QF + \beta_{FZ} \cdot ZF \quad (\text{Fresh/frozen demand})$$

$$PC = \alpha_{CD} + \beta_{CF} \cdot QC + \beta_{CZ} \cdot ZC \quad (\text{Canned demand})$$

$$QF = \alpha_{FS} + \gamma_{FF} \cdot PF + \gamma_{FC} \cdot PC + \gamma_{FX} \cdot QX \quad (\text{Fresh/frozen supply})$$

$$QC = \alpha_{CS} + \gamma_{CF} \cdot PF + \gamma_{CC} \cdot PC + \gamma_{CX} \cdot QX \quad (\text{Canned supply})$$

$$PX = \alpha_{XD} + \gamma_{XF} \cdot PF + \gamma_{XC} \cdot PC + \gamma_{XX} \cdot QX \quad (\text{Ex-vessel demand})$$

where the variables PF, PC, QF, QC, and PX are the five endogenous variables corresponding to fresh/frozen price, canned price, fresh/frozen quantity, canned quantity, and ex-vessel price. The exogenous variables are the demand shifters ZF, and ZC, respectively for the exogenous variables in the fresh/frozen and canned demand equations, and QX which is ex-vessel landings. If we were interested

in how the five endogenous variables would change when one of the exogenous variables changes, we recognize that in equilibrium each of the endogenous variables is a function of all of the exogenous variables in the system. We may thus totally differentiate the system with respect to one of the exogenous variables (we shall do this for QX). This results in the following matrix equation

$$\begin{bmatrix} -1 & 0 & \beta_{FF} & 0 & 0 \\ 0 & -1 & 0 & \beta_{CF} & 0 \\ \gamma_{FF} & \gamma_{FC} & -1 & 0 & 0 \\ \gamma_{CF} & \gamma_{CC} & 0 & -1 & 0 \\ \gamma_{XF} & \gamma_{XC} & 0 & 0 & -1 \end{bmatrix} \cdot \begin{bmatrix} dPF/dQX \\ dPC/dQX \\ dQF/dQX \\ dQC/dQX \\ dPX/dQX \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ -\gamma_{FX} \\ -\gamma_{CX} \\ -\gamma_{XX} \end{bmatrix}$$

Define by $Hx = b$ the above system. Then $x = H^{-1}b$ will give the general equilibrium slope coefficients. The price flexibilities and supply elasticities are obtained by multiplying the general equilibrium slope coefficients by the respective quantity/price ratios (price/quantity ratios in the case of the supply elasticities).

An alternative method is to use Crammer's rule on the above system by substituting the b vector in the column corresponding to the endogenous variable of interest, say column i , creating a new matrix which we denote as H_i . Crammer's rule states that $x_i = |H_i|/|H|$, where $|A|$ denotes the determinant of the matrix A . The vector b would be $(-\gamma_{FZ}, 0, 0, 0, 0)'$ for an exogenous variable in the fresh/frozen demand equation, and $(0, -\gamma_{CZ}, 0, 0, 0)'$ for an exogenous variable in the canned demand equation.

It is by the process just described that we calculate the general equilibrium price flexibility parameters and the supply elasticity parameters for each of the exogenous variables in the system. We use the coefficients estimated for the 2SLS models given in Section 3 for the ex-vessel demand equation

and in Appendix B for the other equations. We consider a coefficient whose t -value is insignificant at the 90% confidence level to be equal to zero.

Table 5.3 reports the point estimates of the partial and general equilibrium price flexibilities and supply elasticities with respect to each of the exogenous variables. The rows correspond to the endogenous variables, and the columns correspond to the exogenous variables. The coefficient in the i th row and the j th column is the percentage change in the i th endogenous variable for a one percent change in the j th exogenous variable. The flexibilities (elasticities) in Table 5.3 are calculated using the average price and quantity for the entire sample 1964–1988. Table 5.4 reports these same estimates using the means from the period 1978–1988. Note that the own-price flexibilities are not calculated for the canned and fresh/frozen demand functions. The reason is simply that both price and quantity are endogenous, so it is meaningless to ask how one changes with respect to the other since each is determined simultaneously with the other as a function of the common set of exogenous variables.

We confine our discussion to the ex-vessel landings variable. For king salmon, the general equilibrium price flexibility parameter is positive in sign, due to the positive sign on quantity in the ex-vessel demand equation (this is the opposite of what is expected). For red salmon, the general equilibrium ex-vessel demand flexibility is zero (as is the partial equilibrium flexibility at the 90% confidence level). However, the red salmon fresh/frozen price is found to be much more responsive in the general equilibrium model relative to the partial equilibrium model (an increase in magnitude to -0.63 from 0). Silver salmon also becomes more responsive at the ex-vessel level and at the fresh/frozen level (canned remains perfectly inflexible). Pink salmon shows the largest change, with all of the prices having change of -0.52 percent in price due to a one percent increase in ex-vessel landings. Chum salmon prices are not responsive at the 90% confidence level in either the partial or general equilibrium models. These results generally hold when using the mean price and quantity data for the period 1978–1988 as reported in Table 5.4. The signs hold exactly since the same slope coefficients are used as in Table 5.3. The prices appear to be more flexible when evaluated using the 1978–1988 means than when using the means for the whole data set.

Table 5.3a: General equilibrium price flexibilities and supply elasticities

price and quantity means from 1964-1988

KING SALMON

Partial Equilibrium Flexibilities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
PF	0.00	0.00	0.00	0.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PC	0.00	0.00	0.00	0.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.07
PX	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

General Equilibrium Flexibilities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
PF	0.00	0.00	0.00	0.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PC	0.00	0.00	0.00	0.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.07
PX	0.24	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Partial Equilibrium Elasticities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
QF	0.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
QC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

General Equilibrium Elasticities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
QF	0.69	0.00	0.00	3.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.44
QC	0.00	0.00	0.00	-0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02

PF = fresh/frozen price, PC = canned price, PX = ex-vessel price, QF = fresh/frozen quantity, QC = canned quantity, QX = ex-vessel landings, CI = canned inventory holdings on July 1, FI = fresh/frozen inventory holdings on June 30, PT = tuna price, YJP = real per capita income average for US and Japan, PJP = sum of US and Japan populations, ERJP = exchange rate in yen/dollar, IRJP = real Japanese short term interest rates, YUK = real per capita income averages of US and UK, PUK = sum of US and UK populations, ERUK = exchange rate in pounds/dollar, UK short term real interest rates.

Table 5.3b: General equilibrium price flexibilities and supply elasticities

price and quantity means from 1964-1988

RED SALMON

Partial Equilibrium Flexibilities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
PF	0.00	0.00	0.00	0.78	-2.08	6.04	-2.52	0.00	0.00	0.00	0.00	0.00
PC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-2.62	4.00	0.00	0.00
PX	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

General Equilibrium Flexibilities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
PF	-0.63	0.00	0.00	0.78	-2.08	6.04	-2.52	0.00	0.00	0.00	0.00	0.00
PC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-3.67	5.61	0.00	0.00
PX	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-2.06	3.15	0.00	0.00

Partial Equilibrium Elasticities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
QF	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
QC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

General Equilibrium Elasticities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
QF	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
QC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	29.68	-0.10	0.00	0.00

PF = fresh/frozen price, PC = canned price, PX = ex-vessel price, QF = fresh/frozen quantity, QC = canned quantity, QX = ex-vessel landings, CI = canned inventory holdings on July 1, FI = fresh/frozen inventory holdings on June 30, PT = tuna price, YJP = real per capita income average for US and Japan, PJP = sum of US and Japan populations, ERJP = exchange rate in yen/dollar, IRJP = real Japanese short term interest rates, YUK = real per capita income averages of US and UK, PUK = sum of US and UK populations, ERUK = exchange rate in pounds/dollar, UK short term real interest rates.

Table 5.3c: General equilibrium price flexibilities and supply elasticities

price and quantity means from 1964-1988

SILVER SALMON

Partial Equilibrium Flexibilities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
PF	0.00	0.00	0.00	0.72	-2.27	5.96	-1.44	-0.08	0.00	0.00	0.00	0.00
PC	0.00	0.00	0.00	0.48	0.00	0.00	0.00	0.00	1.40	-1.65	0.00	-0.08
PX	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

General Equilibrium Flexibilities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
PF	-0.40	0.00	0.00	0.72	-2.27	5.96	-1.44	-0.08	0.00	0.00	0.00	0.00
PC	0.00	0.00	0.00	0.48	0.00	0.00	0.00	0.00	1.40	-1.65	0.00	-0.08
PX	-0.27	0.00	0.00	0.75	-1.53	4.00	-0.97	-0.06	0.77	-0.91	0.00	-0.04

Partial Equilibrium Elasticities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
QF	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
QC	0.00	0.00	0.00	-0.51	0.04	-0.00	0.00	0.03	0.00	0.00	0.00	0.00

General Equilibrium Elasticities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
QF	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
QC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

PF = fresh/frozen price, PC = canned price, PX = ex-vessel price, QF = fresh/frozen quantity, QC = canned quantity, QX = ex-vessel landings, CI = canned inventory holdings on July 1, FI = fresh/frozen inventory holdings on June 30, PT = tuna price, YJP = real per capita income average for US and Japan, PJP = sum of US and Japan populations, ERJP = exchange rate in yen/dollar, IRJP = real Japanese short term interest rates, YUK = real per capita income averages of US and UK, PUK = sum of US and UK populations, ERUK = exchange rate in pounds/dollar, UK short term real interest rates.

Table 5.3d: General equilibrium price flexibilities and supply elasticities

price and quantity means from 1964-1988

PINK SALMON

Partial Equilibrium Flexibilities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
PF	0.00	0.00	0.00	0.00	0.00	3.77	0.00	-0.11	0.00	0.00	0.00	0.00
PC	0.00	-0.23	0.00	0.00	0.00	0.00	0.00	0.00	-3.03	5.10	-0.00	-0.03
PX	-0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

General Equilibrium Flexibilities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
PF	-0.50	0.00	0.00	0.00	0.00	3.77	0.00	-0.11	0.00	0.00	0.00	0.00
PC	-0.29	-0.27	0.00	0.00	0.00	0.00	0.00	0.00	-3.54	5.96	-0.00	-0.03
PX	-0.52	0.00	0.00	0.00	0.00	2.89	0.00	-0.08	0.00	0.00	0.00	0.00

Partial Equilibrium Elasticities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
QF	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
QC	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

General Equilibrium Elasticities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
QF	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
QC	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	45.16	-0.16	18.46	18.85

PF = fresh/frozen price, PC = canned price, PX = ex-vessel price, QF = fresh/frozen quantity, QC = canned quantity, QX = ex-vessel landings, CI = canned inventory holdings on July 1, FI = fresh/frozen inventory holdings on June 30, PT = tuna price, YJP = real per capita income average for US and Japan, PJP = sum of US and Japan populations, ERJP = exchange rate in yen/dollar, IRJP = real Japanese short term interest rates, YUK = real per capita income averages of US and UK, PUK = sum of US and UK populations, ERUK = exchange rate in pounds/dollar, UK short term real interest rates.

Table 5.3e: General equilibrium price flexibilities and supply elasticities

price and quantity means from 1964-1988

CHUM SALMON

Partial Equilibrium Flexibilities

[illegible]

General Equilibrium Flexibilities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
PF	0.00	0.00	0.00	1.24	0.00	2.32	0.00	0.00	0.00	0.00	0.00	0.00
PC	0.00	-0.10	0.00	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.05
PX	0.00	-0.06	0.00	1.59	0.00	2.03	0.00	0.00	0.00	0.00	0.00	-0.03

Partial Equilibrium Elasticities

[illegible]

General Equilibrium Elasticities

[illegible]

Table 5.4a: General equilibrium price flexibilities and supply elasticities

price and quantity means from 1978-1988

KING SALMON

Partial Equilibrium Flexibilities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
PF	0.00	0.00	0.00	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PC	0.00	0.00	0.00	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.17
PX	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

General Equilibrium Flexibilities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
PF	0.00	0.00	0.00	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PC	0.00	0.00	0.00	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.17
PX	0.23	0.00	0.00	0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Partial Equilibrium Elasticities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
QF	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
QC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

General Equilibrium Elasticities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
QF	0.79	0.00	0.00	4.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.25
QC	0.00	0.00	0.00	-0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

PF = fresh/frozen price, PC = canned price, PX = ex-vessel price, QF = fresh/frozen quantity, QC = canned quantity, QX = ex-vessel landings, CI = canned inventory holdings on July 1, FI = fresh/frozen inventory holdings on June 30, PT = tuna price, YJP = real per capita income average for US and Japan, PJP = sum of US and Japan populations, ERJP = exchange rate in yen/dollar, IRJP = real Japanese short term interest rates, YUK = real per capita income averages of US and UK, PUK = sum of US and UK populations, ERUK = exchange rate in pounds/dollar, UK short term real interest rates.

Table 5.4b: General equilibrium price flexibilities and supply elasticities

price and quantity means from 1978-1988

RED SALMON

Partial Equilibrium Flexibilities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
PF	0.00	0.00	0.00	0.52	-1.83	4.93	-1.35	0.00	0.00	0.00	0.00	0.00
PC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-2.91	3.97	0.00	0.00
PX	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

General Equilibrium Flexibilities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
PF	-0.75	0.00	0.00	0.52	-1.83	4.93	-1.35	0.00	0.00	0.00	0.00	0.00
PC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-4.07	5.57	0.00	0.00
PX	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-2.02	2.76	0.00	0.00

Partial Equilibrium Elasticities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
QF	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
QC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

General Equilibrium Elasticities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
QF	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
QC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.74	-0.08	0.00	0.00

PF = fresh/frozen price, PC = canned price, PX = ex-vessel price, QF = fresh/frozen quantity, QC = canned quantity, QX = ex-vessel landings, CI = canned inventory holdings on July 1, FI = fresh/frozen inventory holdings on June 30, PT = tuna price, YJP = real per capita income average for US and Japan, PJP = sum of US and Japan populations, ERJP = exchange rate in yen/dollar, IRJP = real Japanese short term interest rates, YUK = real per capita income averages of US and UK, PUK = sum of US and UK populations, ERUK = exchange rate in pounds/dollar, UK short term real interest rates.

Table 5.4c: General equilibrium price flexibilities and supply elasticities

price and quantity means from 1978-1988

SILVER SALMON

Partial Equilibrium Flexibilities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
PF	0.00	0.00	0.00	0.55	-2.26	5.50	-0.87	-0.13	0.00	0.00	0.00	0.00
PC	0.00	0.00	0.00	0.43	0.00	0.00	0.00	0.00	1.69	-1.78	0.00	-0.19
PX	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

General Equilibrium Flexibilities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
PF	-0.51	0.00	0.00	0.55	-2.26	5.50	-0.87	-0.13	0.00	0.00	0.00	0.00
PC	0.00	0.00	0.00	0.43	0.00	0.00	0.00	0.00	1.69	-1.78	0.00	-0.19
PX	-0.37	0.00	0.00	0.62	-1.66	4.03	-0.64	-0.09	0.86	-0.91	0.00	-0.10

Partial Equilibrium Elasticities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
QF	0.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
QC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

General Equilibrium Elasticities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
QF	0.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
QC	0.00	0.00	0.00	-0.38	0.02	-0.00	0.00	0.01	0.00	0.00	0.00	0.00

PF = fresh/frozen price, PC = canned price, PX = ex-vessel price, QF = fresh/frozen quantity, QC = canned quantity, QX = ex-vessel landings, CI = canned inventory holdings on July 1, FI = fresh/frozen inventory holdings on June 30, PT = tuna price, YJP = real per capita income average for US and Japan, PJP = sum of US and Japan populations, ERJP = exchange rate in yen/dollar, IRJP = real Japanese short term interest rates, YUK = real per capita income averages of US and UK, PUK = sum of US and UK populations, ERUK = exchange rate in pounds/dollar, UK short term real interest rates.

Table 5.4d: General equilibrium price flexibilities and supply elasticities

price and quantity means from 1978-1988

PINK SALMON

Partial Equilibrium Flexibilities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
PF	0.00	0.00	0.00	0.00	0.00	4.10	0.00	-0.19	0.00	0.00	0.00	0.00
PC	0.00	-0.32	0.00	0.00	0.00	0.00	0.00	0.00	-3.71	5.59	-0.00	-0.07
PX	-0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

General Equilibrium Flexibilities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
PF	-0.75	0.00	0.00	0.00	0.00	4.10	0.00	-0.19	0.00	0.00	0.00	0.00
PC	-0.44	-0.37	0.00	0.00	0.00	0.00	0.00	0.00	-4.34	6.53	-0.00	-0.08
PX	-0.86	0.00	0.00	0.00	0.00	3.44	0.00	-0.16	0.00	0.00	0.00	0.00

Partial Equilibrium Elasticities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
QF	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
QC	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

General Equilibrium Elasticities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
QF	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
QC	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.03	-0.20	16.56	10.59

PF = fresh/frozen price, PC = canned price, PX = ex-vessel price, QF = fresh/frozen quantity, QC = canned quantity, QX = ex-vessel landings, CI = canned inventory holdings on July 1, FI = fresh/frozen inventory holdings on June 30, PT = tuna price, YJP = real per capita income average for US and Japan, PJP = sum of US and Japan populations, ERJP = exchange rate in yen/dollar, IRJP = real Japanese short term interest rates, YUK = real per capita income averages of US and UK, PUK = sum of US and UK populations, ERUK = exchange rate in pounds/dollar, UK short term real interest rates.

Table 5.4e: General equilibrium price flexibilities and supply elasticities

price and quantity means from 1978-1988

CHUM SALMON

Partial Equilibrium Flexibilities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
PF	0.00	0.00	0.00	1.01	0.00	2.31	0.00	0.00	0.00	0.00	0.00	0.00
PC	0.00	-0.09	0.00	0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.12
PX	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

General Equilibrium Flexibilities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
PF	0.00	0.00	0.00	1.01	0.00	2.31	0.00	0.00	0.00	0.00	0.00	0.00
PC	0.00	-0.09	0.00	0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.12
PX	0.00	-0.05	0.00	1.33	0.00	2.06	0.00	0.00	0.00	0.00	0.00	-0.07

Partial Equilibrium Elasticities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
QF	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
QC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

General Equilibrium Elasticities

	QX	CI	FI	PT	YJP	PJP	ERJP	IRJP	YUK	PUK	ERUK	IRUK
QC	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
QF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

PF = fresh/frozen price, PC = canned price, PX = ex-vessel price, QF = fresh/frozen quantity, QC = canned quantity, QX = ex-vessel landings, CI = canned inventory holdings on July 1, FI = fresh/frozen inventory holdings on June 30, PT = tuna price, YJP = real per capita income average for US and Japan, PJP = sum of US and Japan populations, ERJP = exchange rate in yen/dollar, IRJP = real Japanese short term interest rates, YUK = real per capita income averages of US and UK, PUK = sum of US and UK populations, ERUK = exchange rate in pounds/dollar, UK short term real interest rates.

6 Out of sample predictions (1989-1998)

This section contains estimates of the ex-vessel prices for 1989-1998. These predictions are generated by using linear trend forecasts for the exogenous variables and are computed for three levels of ex-vessel landings quantity, one using the 1978-1988 average, and another using the ten percent higher quantities, and another using twenty percent higher quantities than the 1978-1988 average.

Several caveats are in order. First, by definition, exogenous variables are variables which the model is not designed to predict. Thus our estimates of the future values of these variables are little better than guesses. The way we estimated these values was to run a regression of the exogenous variable against time and a constant. The coefficient for time is the linear trend. A positive and significant value was interpreted as meaning that the trend was for the variable to continue to increase. In the event that the t-ratio indicated no time trend, we used the 1978-1988 average value for that variable.

Second, in the event that the 1988 value differed significantly from the predicted trend, the starting point for the trend analysis may be biased. This is particularly a problem when the time pattern for the exogenous variable does not follow a linear progression (which is, unfortunately, true of many of the variables). This means that estimates for the first several years are bound to be off by possibly large margins.

Third, the values given are simply the point estimates of the price. That is, they represent the average or expected value given the exogenous variables equal the value predicted by the trend analysis. Even in the event that the trend analysis exactly predicted the exogenous variable's value, there would still exist variability due to the imprecision of the prediction model. Compound this with the variance in the predictions of the exogenous variables, and it is impossible to state what the prediction error is. We suspect that it is at least an order of magnitude larger than the prediction error within the sample.

Table 6.1 presents the predictions for ex-vessel prices given the quantity equals the average for 1978-1988 for each species. Table 6.2 presents the predictions for ex-vessel prices given a ten percent

increase over the average for 1978-1988, and Table 6.3 presents the predictions for ex-vessel prices given a twenty percent increase over the average for 1978-1988. Appendix C contains the models used to predict the linear trend analysis.

The results generally indicate that prices in real 1988 dollars should be increasing over the forecast period. King and chum salmon seem to be the least responsive to changes in the quantities. Pink salmon are predicted to grow in value the most in percentage terms by 20 percent or so over the period. However, pink salmon is also the most responsive to increases in quantity in terms of reductions in price.

Note that for none of the species does a twenty percent increase in quantity imply a price decrease of near twenty percent (the highest is pink salmon with a price decrease of 12.5% on a twenty percent quantity increase). This indicates that with current enhancement capabilities, an increase of up to twenty percent appears to be warranted at least on revenues grounds. Of course, a complete analysis of this would require information regarding costs of expanding enhancement capabilities.

Table 6.1 Ex-vessel price predictions using 1978-1988 average landings

YEAR	KING	RED	SILVER	PINK	CHUM
89	1.96	1.37	1.40	0.48	0.60
90	1.96	1.40	1.42	0.49	0.61
91	1.96	1.44	1.45	0.50	0.62
92	1.96	1.47	1.48	0.51	0.63
93	1.96	1.51	1.51	0.52	0.63
94	1.96	1.55	1.53	0.54	0.64
95	1.97	1.58	1.56	0.55	0.65
96	1.97	1.62	1.59	0.56	0.66
97	1.97	1.65	1.62	0.57	0.67
98	1.97	1.69	1.64	0.58	0.68

Table 6.2 Ex-vessel price predictions using 1978-1988 average landings plus 10%

YEAR	KING	RED	SILVER	PINK	CHUM
89	1.93	1.34	1.36	0.45	0.59
90	1.93	1.37	1.39	0.46	0.60
91	1.94	1.41	1.42	0.47	0.61
92	1.94	1.44	1.44	0.48	0.62
93	1.94	1.48	1.47	0.49	0.63
94	1.94	1.51	1.50	0.50	0.64
95	1.94	1.55	1.53	0.52	0.65
96	1.94	1.58	1.55	0.53	0.66
97	1.94	1.62	1.58	0.54	0.67
98	1.94	1.66	1.61	0.55	0.68

Table 6.3 Ex-vessel price predictions using 1978-1988 average landings plus 20%

YEAR	KING	RED	SILVER	PINK	CHUM
89	1.93	1.34	1.36	0.45	0.59
90	1.93	1.37	1.39	0.46	0.60
91	1.94	1.41	1.42	0.47	0.61
92	1.94	1.44	1.44	0.48	0.62
93	1.94	1.48	1.47	0.49	0.63
94	1.94	1.51	1.50	0.50	0.64
95	1.94	1.55	1.53	0.52	0.65
96	1.94	1.58	1.55	0.53	0.66
97	1.94	1.62	1.58	0.54	0.67
98	1.94	1.66	1.61	0.55	0.68

7. Summary of results and recommendations for further research

This paper has studied three different demand models for Alaskan salmon with the purpose of using the information to guide policy with respect to salmon enhancement programs. The results are that the 2SLS model appears to perform better at predicting ex-vessel prices than either the CFEC (Muse, 1984) or ISER (Ronan, 1989) models. The 2SLS model suggests that prices are relatively inflexible with respect to quantity changes. This implies that from a revenues standpoint, further enhancement appears to be warranted. However, we do not believe that the data is robust enough to make a prediction as to what quantity would maximize revenues. In this regard, it appears that continued expansion of the enhancement program will continue to increase revenues, but that as quantities continue to increase, that the demand flexibility coefficients need to be re-estimated.¹²

The revenue effects are not the same across all species nor for different sectors of the fishing economy. King, silver, and chum salmon appear to have the greatest potential from a revenue increasing point of view due to their low price flexibility estimates. However, specific recommendations regarding species selection would require a more indepth analysis of the cost side of both the fishing industry (harvesting and processing) and of the enhancement process itself.

¹²One test that may be worthwhile pursuing would be to test functional forms. Recall that Zhang estimated his model using a double logged form, implying a constant elasticity of demand. We estimated the demand function linearly on the assumption that the elasticity may decrease as quantity increased. One way to test this is to use the Box-Cox transformation.

References

- Alaska Department of Fish and Game, (various years) *Catch and production statistics*.
- International Monetary Fund (1989), *International Financial Statistics*
- Maddala, G.S. (1977) *Econometrics*, McGraw-Hill.
- Muse, B. (1984) *Ex-vessel Price Models for Alaska Salmon*, CFEC discussion draft 84-6.
- Ronan, N. (1989) *Simple Demand Models for Alaska Sockeye Salmon Prices*, ISER mimeo.
- United States Department of Commerce (NOAA), *Fishery Statistics of the United States*.
- Zhang, H. (1990) *An Econometric Analysis of Alaska Salmon Markets*, M.S. Thesis, University of Alaska, Fairbanks.

APPENDIX A: DATA USED IN THE ANALYSIS.

Table A.1: ADF&G Ex-vessel total values (nominal dollars)

YEAR	PXKING	PXRED	PXSILV	PXPINK	PXCHUM
1964.00	3662.00	12247.00	3582.00	17174.00	4695.00
1965.00	3049.00	30802.00	4362.00	7684.00	2377.00
1966.00	2949.00	19737.00	3705.00	22093.00	5718.00
1967.00	3100.00	11865.00	3343.00	3241.00	3083.00
1968.00	3865.00	12723.00	5362.00	20490.00	7015.00
1969.00	3506.00	18046.00	2229.00	15712.00	2934.00
1970.00	5035.00	37249.00	3512.00	15563.00	6616.00
1971.00	4688.00	22849.00	2820.00	13518.00	7536.00
1972.00	3731.00	13180.00	5583.00	10882.00	11919.00
1973.00	7880.00	15327.00	7470.00	11666.00	17716.00
1974.00	6945.00	22119.00	8678.00	13861.00	13975.00
1975.00	5345.00	19262.00	4405.00	16053.00	10850.00
1976.00	8446.00	45991.00	10064.00	34871.00	18582.00
1977.00	14449.00	68273.00	14624.00	45574.00	27802.00
1978.00	20179.00	113992.00	21119.00	62502.00	26105.00
1979.00	22597.00	189592.00	28053.00	74908.00	29008.00
1980.00	17035.00	114123.00	17796.00	84517.00	34386.00
1981.00	23748.00	196301.00	23853.00	105851.00	47578.00
1982.00	27080.00	156533.00	40146.00	47476.00	38752.00
1983.00	18233.00	212817.00	16186.00	47974.00	25015.00
1984.00	21779.00	171470.00	42742.00	70360.00	36281.00

Table A.2: ADF&G Canned total values (nominal dollars)

YEAR	PC KING	PCRED	PCSILV	PCPINK	PCCHUM
1964.00	1268.00	29289.00	4770.00	39429.00	12674.00
1965.00	1793.00	72153.00	3156.00	24015.00	6621.00
1966.00	1328.00	46182.00	3596.00	55547.00	13923.00
1967.00	1829.00	28915.00	2228.00	10057.00	9093.00
1968.00	1666.00	28530.00	4105.00	58181.00	16965.00
1969.00	1385.00	29581.00	1026.00	37735.00	5763.00
1970.00	1087.00	67446.00	1939.00	42108.00	12032.00
1971.00	1293.00	50737.00	3063.00	36104.00	16831.00
1972.00	1045.00	29469.00	2278.00	25682.00	16872.00
1973.00	889.00	31652.00	2924.00	31588.00	19843.00
1974.00	1430.00	38189.00	4461.00	34891.00	19923.00
1975.00	696.00	43383.00	3294.00	36176.00	11875.00
1976.00	2854.00	78732.00	2514.00	74117.00	19979.00
1977.00	826.00	74974.00	1654.00	84777.00	26603.00
1978.00	1344.00	88866.00	2136.00	110341.00	17751.00
1979.00	1065.00	108958.00	3142.00	126508.00	13462.00
1980.00	1002.00	16094.00	4327.00	173885.00	31234.00
1981.00	337.00	130339.00	3302.00	192670.00	36009.00
1982.00	179.00	37962.00	2516.00	112539.00	12364.00
1983.00	706.00	148025.00	4035.00	136234.00	15866.00
1984.00	201.00	119089.00	4523.00	180763.00	17907.00

Table A.3: ADF&G Canned plus Fresh/frozen total value (nominal dollars)

YEAR	TRKING	TRRED	TRSILV	TRPINK	TRCHUM
1964.00	6524.00	30738.00	8737.00	43065.00	14513.00
1965.00	5290.00	72841.00	5697.00	24265.00	7075.00
1966.00	5226.00	47381.00	6290.00	57089.00	15459.00
1967.00	5900.00	29710.00	5814.00	10384.00	10603.00
1968.00	5728.00	30505.00	10085.00	58795.00	18732.00
1969.00	5953.00	31138.00	3833.00	38149.00	7242.00
1970.00	7883.00	70101.00	5800.00	43326.00	16653.00
1971.00	6952.00	52709.00	4806.00	36736.00	20127.00
1972.00	6462.00	30957.00	8810.00	26476.00	23672.00
1973.00	11525.00	39213.00	11202.00	32547.00	32881.00
1974.00	8225.00	39804.00	11066.00	36675.00	28086.00
1975.00	7466.00	48178.00	8957.00	38294.00	24867.00
1976.00	13392.00	88725.00	12296.00	76207.00	35078.00
1977.00	23764.00	111346.00	20717.00	90075.00	44793.00
1978.00	28827.00	184470.00	34107.00	120863.00	42051.00
1979.00	31148.00	257873.00	58857.00	153218.00	46845.00
1980.00	26444.00	245518.00	30153.00	189485.00	63519.00
1981.00	32096.00	325965.00	37117.00	216094.00	77744.00
1982.00	38846.00	260233.00	59850.00	149694.00	73405.00
1983.00	30685.00	395359.00	37817.00	151718.00	58607.00
1984.00	28950.00	326386.00	63849.00	207634.00	73760.00

Table A.4: ADF&G Ex-vessel total quantity (1000 lbs)

YEAR	QXKING	QXRED	QXSILV	QXPINK	QXCHUM
1964.00	11567.00	54132.00	20954.00	162281.00	62690.00
1965.00	11009.00	142034.00	17666.00	74873.00	29263.00
1966.00	9350.00	92767.00	16113.00	162866.00	52230.00
1967.00	11632.00	53522.00	13022.00	28822.00	31518.00
1968.00	11246.00	48696.00	20968.00	148456.00	55916.00
1969.00	10746.00	71735.00	8034.00	105967.00	22668.00
1970.00	11547.00	150812.00	11898.00	117718.00	54491.00
1971.00	11972.00	87288.00	11459.00	86260.00	54726.00
1972.00	9973.00	41984.00	13035.00	59969.00	64823.00
1973.00	8917.00	35248.00	9837.00	36610.00	45881.00
1974.00	9290.00	32246.00	12820.00	40072.00	37174.00
1975.00	6942.00	42762.00	7128.00	49969.00	30805.00
1976.00	8915.00	75689.00	11158.00	102419.00	47675.00
1977.00	12102.00	89770.00	15403.00	129554.00	60548.00
1978.00	16304.00	116767.00	19978.00	183993.00	52614.00
1979.00	15054.00	171824.00	23918.00	186838.00	45043.00
1980.00	12536.00	186644.00	22462.00	217866.00	71812.00
1981.00	15746.00	225956.00	26051.00	244677.00	99572.00
1982.00	16897.00	189555.00	46559.00	219426.00	90247.00
1983.00	15683.00	305661.00	26890.00	193977.00	79186.00
1984.00	12519.00	222250.00	44583.00	276265.00	104453.00

Table A.5: ADF&G Canned total quantity (1000 lbs)

YEAR	QCKING	QCRED	QCSILV	QCPINK	QCCHUM
1964.00	1818.00	34357.00	7929.00	92555.00	33742.00
1965.00	2401.00	92708.00	5056.00	42393.00	14321.00
1966.00	1678.00	59394.00	5620.00	96767.00	28100.00
1967.00	2172.00	32761.00	3201.00	15798.00	16363.00
1968.00	2099.00	30088.00	5761.00	87274.00	30237.00
1969.00	1579.00	36788.00	1321.00	56909.00	10092.00
1970.00	1309.00	81871.00	2567.00	63772.00	21599.00
1971.00	1537.00	53200.00	3943.00	51578.00	28887.00
1972.00	968.00	26049.00	2372.00	28935.00	23556.00
1973.00	439.00	16568.00	1532.00	22742.00	17046.00
1974.00	788.00	20809.00	2837.00	24711.00	15339.00
1975.00	384.00	26559.00	2356.00	26524.00	10609.00
1976.00	1747.00	42974.00	1575.00	54589.00	17640.00
1977.00	413.00	36559.00	1052.00	64430.00	22089.00
1978.00	721.00	42942.00	1313.00	87569.00	15397.00
1979.00	499.00	20162.00	2036.00	36960.00	6709.00
1980.00	391.00	66603.00	2204.00	108355.00	20758.00
1981.00	184.00	54656.00	1784.00	122175.00	28065.00
1982.00	73.00	14303.00	1303.00	83821.00	9178.00
1983.00	381.00	66262.00	2156.00	98028.00	12969.00
1984.00	104.00	53285.00	2713.00	130563.00	16409.00

Table A.6: ADF&G Canned plus Fresh/frozen total quantity (1000 lbs)

YEAR	TCKING	TQRED	TQSILV	TQPINK	TQCHUM
1964.00	8636.00	36509.00	14557.00	107033.00	38552.00
1965.00	7375.00	94585.00	11147.00	43583.00	16307.00
1966.00	6969.00	62331.00	11424.00	103625.00	34671.00
1967.00	8048.00	34650.00	9933.00	16986.00	21139.00
1968.00	7592.00	34580.00	15407.00	90025.00	35614.00
1969.00	7128.00	40494.00	6793.00	58622.00	14427.00
1970.00	8622.00	88361.00	8794.00	67349.00	34190.00
1971.00	8449.00	57081.00	7231.00	53407.00	36908.00
1972.00	7197.00	28453.00	10375.00	31151.00	36780.00
1973.00	7666.00	23142.00	8179.00	24008.00	33821.00
1974.00	6174.00	22466.00	9254.00	27387.00	27058.00
1975.00	5505.00	31246.00	7710.00	28913.00	27397.00
1976.00	7080.00	50930.00	7372.00	57049.00	30378.00
1977.00	9123.00	57106.00	10870.00	70300.00	37377.00
1978.00	13683.00	86176.00	16272.00	100008.00	35766.00
1979.00	11429.00	58991.00	16635.00	61155.00	28086.00
1980.00	9449.00	121918.00	14891.00	128297.00	46461.00
1981.00	11854.00	154220.00	18716.00	146098.00	61950.00
1982.00	14247.00	139696.00	34421.00	136927.00	60867.00
1983.00	14416.00	221087.00	22648.00	118635.00	52288.00
1984.00	9509.00	165596.00	32198.00	169406.00	67287.00

Table A.7: Ex-Vessel prices (nominal dollars)

YEAR	PXKING	PXRED	PXSILV	PXPINK	PXCHUM
1964.00	0.32	0.23	0.17	0.11	0.07
1965.00	0.28	0.22	0.25	0.10	0.08
1966.00	0.32	0.21	0.23	0.14	0.11
1967.00	0.27	0.22	0.26	0.11	0.10
1968.00	0.34	0.26	0.26	0.14	0.13
1969.00	0.33	0.25	0.28	0.15	0.13
1970.00	0.44	0.25	0.30	0.13	0.12
1971.00	0.39	0.26	0.25	0.16	0.14
1972.00	0.37	0.31	0.43	0.18	0.18
1973.00	0.88	0.43	0.76	0.32	0.39
1974.00	0.75	0.69	0.68	0.35	0.38
1975.00	0.71	0.45	0.57	0.32	0.35
1976.00	1.02	0.60	0.93	0.34	0.41
1977.00	1.27	0.51	1.02	0.36	0.49
1978.00	1.25	0.97	1.11	0.33	0.47
1979.00	1.51	1.10	1.31	0.40	0.65
1980.00	1.42	0.59	0.80	0.35	0.45
1981.00	1.51	0.87	0.92	0.43	0.48
1982.00	1.60	0.83	0.86	0.22	0.43
1983.00	1.16	0.70	0.60	0.25	0.32
1984.00	1.74	0.77	0.96	0.25	0.35
1985.00	1.54	0.99	0.90	0.24	0.40
1986.00	1.52	1.43	0.90	0.24	0.35
1987.00	2.02	1.55	1.14	0.42	0.46
1988.00	2.73	2.35	1.75	0.79	0.89

Source: ADF&G (1964-1974), CFEC (1975-1988)

Table A.8: Canned prices (nominal dollars)

YEAR	PCKING	PCRED	PCSILV	PCPINK	PCCHUM
1964.00	0.70	0.85	0.60	0.43	0.38
1965.00	0.75	0.78	0.62	0.57	0.46
1966.00	0.79	0.78	0.64	0.57	0.50
1967.00	0.84	0.88	0.70	0.64	0.56
1968.00	0.79	0.95	0.71	0.67	0.56
1969.00	0.88	0.80	0.78	0.66	0.57
1970.00	0.83	0.82	0.76	0.66	0.56
1971.00	0.84	0.95	0.78	0.70	0.58
1972.00	1.08	1.13	0.96	0.89	0.72
1973.00	2.03	1.91	1.91	1.39	1.16
1974.00	1.81	1.84	1.57	1.41	1.30
1975.00	1.81	1.63	1.40	1.36	1.12
1976.00	1.63	1.83	1.60	1.36	1.13
1977.00	2.00	2.05	1.57	1.32	1.20
1978.00	1.86	2.07	1.63	1.26	1.15
1979.00	2.13	5.40	1.54	3.42	2.01
1980.00	2.56	0.24	1.96	1.60	1.50
1981.00	1.83	2.38	1.85	1.58	1.28
1982.00	2.45	2.65	1.93	1.34	1.35
1983.00	1.85	2.23	1.87	1.39	1.22
1984.00	1.91	2.25	1.68	1.40	1.09
1985.00	1.82	2.62	2.06	1.19	1.34
1986.00	2.94	3.64	2.95	1.34	1.21
1987.00	2.28	3.62	2.45	1.97	1.67
1988.00	3.68	5.71	4.22	2.95	2.74

Source: ADF&G (1964-1983), CFEC (1984-1988)

Table A.9: Fresh/Frozen prices (nominal dollars)

YEAR	TRKING	TRRED	TRSILV	TRPINK	TRCHUM
1964.00	0.77	0.67	0.60	0.55	0.38
1965.00	0.70	0.37	0.42	0.21	0.23
1966.00	0.74	0.41	0.46	0.22	0.23
1967.00	0.69	0.42	0.53	0.28	0.32
1968.00	0.74	0.44	0.62	0.22	0.33
1969.00	0.82	0.42	0.51	0.24	0.34
1970.00	0.93	0.41	0.62	0.34	0.37
1971.00	0.82	0.51	0.53	0.35	0.41
1972.00	0.87	0.62	0.82	0.36	0.51
1973.00	1.47	1.15	1.25	0.76	0.78
1974.00	1.26	0.97	1.03	0.67	0.70
1975.00	1.32	1.02	1.06	0.89	0.77
1976.00	1.98	1.26	1.69	0.85	1.19
1977.00	2.63	1.77	1.94	0.90	1.19
1978.00	2.12	2.21	2.14	0.85	1.19
1979.00	2.75	3.84	3.82	1.10	1.56
1980.00	2.81	4.15	2.04	0.78	1.26
1981.00	2.72	1.96	2.00	0.98	1.23
1982.00	2.73	1.77	1.73	0.70	1.18
1983.00	2.14	1.60	1.65	0.75	1.09
1984.00	3.06	1.82	2.01	0.73	1.10
1985.00	2.73	2.03	1.84	0.68	1.09
1986.00	2.84	2.54	1.99	0.73	1.07
1987.00	3.78	2.85	2.96	1.15	1.48
1988.00	4.60	4.13	3.47	1.69	1.90

Source: ADF&G (1964-1983), CFEC (1984-1988)

Table A.10: Ex-vessel quantity (1000 lbs)

YEAR	QXKING	QXRED	QXSILV	QXPINK	QXCHUM
1964.00	11567.00	54132.00	20954.00	162281.00	62690.00
1965.00	11009.00	142034.00	17666.00	74873.00	29263.00
1966.00	9350.00	92767.00	16113.00	162866.00	52230.00
1967.00	11632.00	53522.00	13022.00	28822.00	31518.00
1968.00	11246.00	48696.00	20968.00	148456.00	55916.00
1969.00	10746.00	71735.00	8034.00	105967.00	22668.00
1970.00	11547.00	150812.00	11898.00	117718.00	54491.00
1971.00	11972.00	87288.00	11459.00	86260.00	54726.00
1972.00	9973.00	41984.00	13035.00	59969.00	64823.00
1973.00	8917.00	35248.00	9837.00	36610.00	45881.00
1974.00	9290.00	32246.00	12820.00	40072.00	37174.00
1975.00	7184.38	42866.85	7687.62	49971.04	32063.77
1976.00	8947.89	75689.93	11178.81	102411.48	47662.68
1977.00	12102.64	89772.51	15402.41	129554.18	60569.56
1978.00	16305.36	116767.42	19978.86	183993.98	52614.79
1979.00	15059.76	171826.93	23922.43	186842.40	45044.95
1980.00	12501.30	186700.17	22424.63	217944.19	71802.49
1981.00	15738.25	225955.79	25847.19	244968.47	99540.88
1982.00	16903.89	188550.21	46541.16	219147.48	91188.56
1983.00	15683.57	305641.04	26793.39	194080.83	79117.34
1984.00	12524.04	222698.89	44514.79	276681.29	104068.04
1985.00	13476.81	221508.10	47262.31	304258.42	83363.31
1986.00	11712.22	194556.61	46602.98	259254.91	97096.83
1987.00	13282.48	224831.36	25312.49	164811.93	80346.79
1988.00	10784.33	192929.30	35291.40	177882.96	116207.06

Source: ADF&G (1964-1974), CFEC (1975-1988)

Table A.11: Canned quantity (1000 lbs)

YEAR	QCKING	QCRED	QCSILV	QCPINK	QCCHUM
1964.00	1818.00	34357.00	7929.00	92555.00	33742.00
1965.00	2401.00	92708.00	5056.00	42393.00	14321.00
1966.00	1678.00	59394.00	5620.00	96767.00	28100.00
1967.00	2172.00	32761.00	3201.00	15798.00	16353.00
1968.00	2099.00	30088.00	5761.00	87274.00	30237.00
1969.00	1579.00	36788.00	1321.00	56909.00	10092.00
1970.00	1309.00	81871.00	2567.00	63772.00	21599.00
1971.00	1537.00	53200.00	3943.00	51578.00	28887.00
1972.00	968.00	26049.00	2372.00	28935.00	23556.00
1973.00	439.00	16568.00	1532.00	22742.00	17046.00
1974.00	788.00	20809.00	2837.00	24711.00	15339.00
1975.00	384.00	26559.00	2356.00	26524.00	10609.00
1976.00	1747.00	42974.00	1575.00	54589.00	17640.00
1977.00	413.00	36559.00	1052.00	64430.00	22089.00
1978.00	721.00	42942.00	1313.00	87569.00	15397.00
1979.00	499.00	20162.00	2036.00	36960.00	6709.00
1980.00	391.00	66603.00	2204.00	108355.00	20758.00
1981.00	184.00	54656.00	1784.00	122175.00	28065.00
1982.00	73.00	14703.00	1303.00	83821.00	9178.00
1983.00	381.00	63262.00	2156.00	98028.00	12969.00
1984.00	97.84	49437.45	2673.09	122628.80	15958.02
1985.00	122.77	21406.26	826.41	120791.41	7738.03
1986.00	40.47	17913.38	2409.72	106695.56	6263.55
1987.00	57.16	32184.77	1117.51	65073.38	8543.29
1988.00	64.16	10179.39	174.07	55752.32	7017.34

Source: ADF&G (1964-1983), CFEC (1984-1988)

Table A.12: Fresh/frozen quantity (1000 lbs)

YEAR	TCKING	TQRED	TQSILV	TQPINK	TQCHUM
1964.00	6818.00	2152.00	6628.00	14478.00	4810.00
1965.00	4974.00	1877.00	6091.00	1190.00	1986.00
1966.00	5291.00	2937.00	5804.00	6858.00	6571.00
1967.00	5876.00	1889.00	6732.00	1188.00	4776.00
1968.00	5493.00	4492.00	9646.00	2751.00	5377.00
1969.00	5549.00	3706.00	5472.00	1713.00	4335.00
1970.00	7313.00	6490.00	6227.00	3577.00	12591.00
1971.00	6912.00	3881.00	3288.00	1829.00	8021.00
1972.00	6229.00	2404.00	8003.00	2216.00	13224.00
1973.00	7227.00	6574.00	6647.00	1266.00	16775.00
1974.00	5386.00	1657.00	6417.00	2676.00	11719.00
1975.00	5121.00	4687.00	5354.00	2389.00	16788.00
1976.00	5333.00	7956.00	5797.00	2460.00	12738.00
1977.00	8710.00	20547.00	9818.00	5870.00	15288.00
1978.00	12962.00	43234.00	14959.00	12439.00	20369.00
1979.00	10930.00	38829.00	14599.00	24195.00	21377.00
1980.00	9058.00	55315.00	12687.00	19942.00	25703.00
1981.00	11670.00	99564.00	16932.00	23923.00	33885.00
1982.00	14174.00	125393.00	33118.00	53106.00	51689.00
1983.00	14035.00	154825.00	20492.00	20607.00	39319.00
1984.00	9409.07	114387.57	29491.75	43146.09	50906.25
1985.00	10085.23	149028.77	35328.37	57954.84	54830.28
1986.00	8645.77	120428.75	34187.61	39227.73	54341.55
1987.00	10419.45	126915.63	17508.28	35373.37	45242.74
1988.00	11746.46	117462.40	22849.37	45499.44	75786.55

Source: ADF&G (1964-1983), CFEC (1984-1988)

Table A.13: Nominal National Income in own currency (billions)

YEAR	USNYDOL	JPNYEN	UKNYLBS
1964.00	649.80	25408.00	33.82
1965.00	705.10	28233.00	36.35
1966.00	772.00	32797.00	38.70
1967.00	816.40	38755.00	40.92
1968.00	892.70	45652.00	44.35
1969.00	964.00	53535.00	47.53
1970.00	1015.50	63550.00	52.19
1971.00	1102.70	69452.00	58.50
1972.00	1212.80	80027.00	64.73
1973.00	1359.30	98532.00	75.25
1974.00	1477.80	116193.00	85.68
1975.00	1598.40	128557.00	107.24
1976.00	1782.80	145808.00	128.27
1977.00	1990.50	161816.00	146.19
1978.00	2249.70	178771.00	169.24
1979.00	2508.20	193966.00	198.34
1980.00	2732.00	209142.00	231.01
1981.00	3052.60	221234.00	256.04
1982.00	3166.00	232544.00	279.05
1983.00	3405.70	241085.00	306.07
1984.00	3774.50	256460.00	327.46
1985.00	4014.90	272484.00	356.76
1986.00	4240.30	283598.00	383.93
1987.00	4526.70	295444.00	419.57
1988.00	4864.30	311447.15	459.05

Source: International Financial Statistics (IMF Yearbook, 1989).

Table A.14: Real National Incomes in own currency (1988 billions)

YEAR	USRYDOL	JPRYEN	UKRYLBS
1964.00	2400.10	81932.76	268.41
1965.00	2544.39	86654.90	275.38
1966.00	2688.52	95759.72	280.43
1967.00	2764.17	106445.67	286.15
1968.00	2880.27	119280.48	297.65
1969.00	2945.70	133054.06	302.74
1970.00	2939.32	146842.29	308.82
1971.00	3024.15	151870.36	317.93
1972.00	3175.28	165746.98	323.65
1973.00	3343.39	180582.93	353.29
1974.00	3324.41	176454.05	349.71
1975.00	3277.47	181188.91	344.82
1976.00	3443.19	191714.00	358.30
1977.00	3603.26	201085.98	358.31
1978.00	3790.97	212069.44	373.60
1979.00	3886.29	223334.86	382.90
1980.00	3877.11	231899.56	372.60
1981.00	3953.60	237803.21	370.54
1982.00	3854.72	245302.63	375.07
1983.00	3991.51	262183.15	391.39
1984.00	4255.53	265312.43	400.32
1985.00	4404.35	277661.20	412.44
1986.00	4529.32	284155.71	428.97
1987.00	4680.29	296608.31	447.30
1988.00	4864.30	311447.15	459.05

Table A.15: Price Indexes for own currency (1988=1.00)

YEAR	USPRICE	JPPRICE	UKPRICE
1964.00	0.27	0.31	0.13
1965.00	0.28	0.33	0.13
1966.00	0.29	0.34	0.14
1967.00	0.30	0.36	0.14
1968.00	0.31	0.38	0.15
1969.00	0.33	0.40	0.16
1970.00	0.35	0.43	0.17
1971.00	0.36	0.46	0.18
1972.00	0.38	0.48	0.20
1973.00	0.41	0.55	0.21
1974.00	0.44	0.66	0.25
1975.00	0.49	0.71	0.31
1976.00	0.52	0.76	0.36
1977.00	0.55	0.80	0.41
1978.00	0.59	0.84	0.45
1979.00	0.65	0.87	0.52
1980.00	0.70	0.90	0.62
1981.00	0.77	0.93	0.69
1982.00	0.82	0.95	0.74
1983.00	0.85	0.92	0.78
1984.00	0.89	0.97	0.82
1985.00	0.91	0.98	0.87
1986.00	0.94	1.00	0.90
1987.00	0.97	1.00	0.94
1988.00	1.00	1.00	1.00

Source: International Financial Statistics (IMF Yearbook, 1989).

Table A.16: Populations of major consuming nations (millions)

YEAR	USPOP	JPPOP	UKPOP
1964.00	191.89	97.83	53.85
1965.00	194.30	98.88	54.18
1966.00	196.56	99.79	54.50
1967.00	198.71	100.83	54.80
1968.00	200.71	101.96	55.05
1969.00	202.68	103.17	55.27
1970.00	205.05	104.34	55.42
1971.00	207.66	105.70	55.61
1972.00	209.90	107.19	55.78
1973.00	211.91	108.71	55.91
1974.00	213.85	110.16	55.92
1975.00	215.97	111.57	55.90
1976.00	218.04	112.77	55.89
1977.00	220.24	113.86	55.85
1978.00	222.59	114.90	55.84
1979.00	256.06	115.87	55.88
1980.00	227.76	116.78	55.95
1981.00	230.14	117.65	56.35
1982.00	232.52	118.45	56.34
1983.00	234.80	119.26	56.38
1984.00	237.00	120.02	56.49
1985.00	239.28	120.75	56.62
1986.00	241.62	121.49	56.76
1987.00	242.93	122.09	56.93
1988.00	246.33	122.93	57.08

Source: International Financial Statistics (IMF Yearbook, 1989)

Table A.17: Ex-Vessel prices (1988 dollars)

YEAR	PXKING	PXRED	PXSILV	PXPINK	PXCHUM
1964.00	1.17	0.84	0.63	0.39	0.28
1965.00	1.00	0.78	0.89	0.37	0.29
1966.00	1.10	0.74	0.80	0.47	0.38
1967.00	0.90	0.75	0.87	0.38	0.33
1968.00	1.11	0.84	0.83	0.45	0.40
1969.00	1.00	0.77	0.85	0.45	0.40
1970.00	1.26	0.71	0.85	0.38	0.35
1971.00	1.07	0.72	0.67	0.43	0.38
1972.00	0.98	0.82	1.12	0.48	0.48
1973.00	2.17	1.07	1.87	0.78	0.95
1974.00	1.69	1.55	1.53	0.78	0.85
1975.00	1.47	0.92	1.17	0.66	0.71
1976.00	1.98	1.16	1.80	0.67	0.79
1977.00	2.31	0.91	1.85	0.64	0.88
1978.00	2.10	1.63	1.87	0.56	0.80
1979.00	2.34	1.70	2.03	0.62	1.00
1980.00	2.02	0.83	1.13	0.50	0.63
1981.00	1.95	1.13	1.19	0.56	0.62
1982.00	1.94	1.01	1.05	0.26	0.52
1983.00	1.36	0.82	0.71	0.29	0.37
1984.00	1.96	0.87	1.08	0.29	0.39
1985.00	1.69	1.08	0.79	0.26	0.43
1986.00	1.62	1.53	0.96	0.26	0.38
1987.00	2.09	1.60	1.18	0.43	0.48
1988.00	2.73	2.35	1.75	0.79	0.89

Source: constructed from Table A.7 using the price index in Table A.15.

Table A.18: Canned prices (1988 dollars)

YEAR	PCKING	PCRED	PCSILV	PCPINK	PCCHUM
1964.00	2.58	3.15	2.22	1.57	1.39
1965.00	2.69	2.81	2.25	2.04	1.67
1966.00	2.76	2.71	2.23	2.00	1.73
1967.00	2.85	2.99	2.36	2.16	1.88
1968.00	2.56	3.06	2.30	2.15	1.81
1969.00	2.68	2.46	2.37	2.03	1.74
1970.00	2.40	2.38	2.19	1.91	1.61
1971.00	2.31	2.62	2.13	1.92	1.60
1972.00	2.83	2.96	2.51	2.32	1.88
1973.00	4.98	4.70	4.69	3.42	2.86
1974.00	4.10	4.14	3.55	3.19	2.93
1975.00	3.72	3.35	2.87	2.80	2.30
1976.00	3.16	3.54	3.08	2.62	2.19
1977.00	3.62	3.71	2.85	2.38	2.18
1978.00	3.14	3.49	2.74	2.12	1.94
1979.00	3.31	8.37	2.39	5.30	3.11
1980.00	3.64	0.34	2.79	2.28	2.14
1981.00	2.37	3.09	2.40	2.04	1.66
1982.00	2.99	3.23	2.35	1.63	1.64
1983.00	2.17	2.62	2.19	1.63	1.43
1984.00	2.15	2.54	1.89	1.58	1.23
1985.00	2.00	2.87	2.26	1.31	1.47
1986.00	3.14	3.89	3.15	1.43	1.29
1987.00	2.36	3.74	2.53	2.04	1.73
1988.00	3.68	5.71	4.22	2.95	2.74

Source: constructed from Table A.8 using the price index in Table A.15.

Table A.19: Fresh/Frozen prices (1988 dollars)

YEAR	PFKING	PFRED	PFSILV	PFPINK	PFCHUM
1964.00	2.85	2.49	2.21	0.93	1.41
1965.00	2.54	1.32	1.51	0.76	0.82
1966.00	2.57	1.42	1.62	0.78	0.81
1967.00	2.35	1.42	1.80	0.93	1.07
1968.00	2.39	1.42	2.00	0.72	1.06
1969.00	2.52	1.28	1.57	0.74	1.04
1970.00	2.69	1.18	1.79	0.99	1.06
1971.00	2.25	1.39	1.45	0.95	1.13
1972.00	2.28	1.62	2.14	0.94	1.35
1973.00	3.62	2.83	3.06	1.86	1.91
1974.00	2.85	2.20	2.32	1.50	1.57
1975.00	2.71	2.10	2.17	1.82	1.59
1976.00	3.82	2.43	3.26	1.64	2.29
1977.00	4.77	3.20	3.51	1.63	2.15
1978.00	3.57	3.73	3.60	1.43	2.01
1979.00	4.26	5.94	5.91	1.71	2.42
1980.00	3.99	5.89	2.89	1.11	1.78
1981.00	3.52	2.54	2.59	1.27	1.60
1982.00	3.32	2.16	2.11	0.85	1.44
1983.00	2.50	1.87	1.93	0.88	1.27
1984.00	3.45	2.05	2.27	0.83	1.24
1985.00	2.99	2.23	2.02	0.75	1.19
1986.00	3.04	2.71	2.13	0.78	1.14
1987.00	3.91	2.94	3.06	1.19	1.53
1988.00	4.60	4.13	3.47	1.69	1.90

Source: constructed from Table A.10 using the price index in Table A.15.

Table 20: US landings, salmon species (1000 lbm)

YEAR	USLKING	USLRED	USLSILV	USLPINK	USLCHUM
1964.00	28732.00	57350.00	38071.00	162325.00	65842.00
1965.00	29316.00	148119.00	38515.00	79655.00	31266.00
1966.00	27223.00	102021.00	38755.00	163016.00	56506.00
1967.00	26181.00	66013.00	38290.00	51721.00	34459.00
1968.00	25838.00	54047.00	37786.00	148472.00	61466.00
1969.00	28028.00	81444.00	21326.00	112214.00	24816.00
1970.00	31685.00	159568.00	43708.00	117762.00	57396.00
1971.00	31770.00	104314.00	36500.00	87334.00	52153.00
1972.00	28254.00	48218.00	30285.00	55414.00	54514.00
1973.00	31008.00	45911.00	31892.00	47024.00	57174.00
1974.00	26829.00	53916.00	37839.00	37347.00	40889.00
1975.00	31252.00	52324.00	28070.00	56198.00	33797.00
1976.00	34511.00	83159.00	39690.00	99237.00	52645.00
1977.00	32676.00	89932.00	29792.00	125644.00	57398.00
1978.00	29776.00	98707.00	30648.00	194873.00	50485.00
1979.00	33008.00	190727.00	39767.00	226830.00	45784.00
1980.00	28553.00	207551.00	39270.00	253541.00	84916.00
1981.00	31070.00	226173.00	35210.00	257106.00	98880.00
1982.00	34602.00	200172.00	59151.00	221472.00	92023.00
1983.00	24424.00	310146.00	30663.00	194140.00	79920.00
1984.00	21711.00	229666.00	51077.00	275615.00	113340.00
1985.00	27187.00	236077.00	52044.00	319139.00	92499.00
1986.00	30845.00	212212.00	60359.00	268646.00	86459.00
1987.00	39938.00	227411.00	39041.00	169308.00	86320.00
1988.00	45672.00	190036.00	47486.00	176487.00	146467.00

Source: Fishery Statistics of the United States

Table A.21: Real (1988 US dollars) and nominal tuna prices

YEAR	NPTUNA	RPTUNA
1964.00	0.62	2.30
1965.00	0.65	2.35
1966.00	0.69	2.39
1967.00	0.67	2.28
1968.00	0.68	2.19
1969.00	0.75	2.28
1970.00	0.87	2.52
1971.00	0.94	2.58
1972.00	1.02	2.67
1973.00	1.11	2.73
1974.00	1.25	2.82
1975.00	1.23	2.53
1976.00	1.42	2.75
1977.00	1.66	3.00
1978.00	1.81	3.04
1979.00	1.78	2.76
1980.00	1.90	2.70
1981.00	1.88	2.44
1982.00	1.70	2.07
1983.00	1.45	1.70
1984.00	1.42	1.60
1985.00	1.51	1.65
1986.00	1.38	1.48
1987.00	1.56	1.61
1988.00	1.41	1.41

Source: Fishery Statistics of the US.

Table A.22: July 1 Canned Inventory holdings (1000 lbs)

YEAR	CIKING	CIRED	CISILV	CIPINK	CICHUM
1964.00	887.60	4931.71	2014.56	32794.24	10479.68
1965.00	646.02	2629.18	2399.85	17480.68	12065.86
1966.00	978.85	30058.58	974.33	2785.79	874.39
1967.00	1248.13	28975.18	2603.92	22680.40	4634.57
1968.00	1710.10	21309.01	1460.02	4997.47	2732.78
1969.00	960.80	6808.07	2047.43	20592.40	11627.28
1970.00	663.36	2222.33	666.95	6021.50	2106.01
1971.00	429.00	14847.44	1635.76	6578.18	4500.22
1972.00	1045.98	11304.10	2554.79	7099.63	6141.55
1973.00	486.23	2278.45	453.28	1588.60	3246.00
1974.00	642.26	2731.92	1915.20	933.73	5443.02
1975.00	931.67	7973.72	4601.54	6742.99	13399.38
1976.00	275.92	2960.32	976.72	8849.72	3206.28
1977.00	361.43	5571.60	757.37	13429.73	4699.54
1978.00	250.62	8168.63	660.58	19833.59	8809.51
1979.00	246.85	11166.41	578.09	14525.74	4376.29
1980.00	235.40	9728.56	652.74	12500.69	1615.51
1981.00	89.30	6461.93	424.81	14602.10	5795.50
1982.00	278.92	18836.81	689.92	43182.91	16295.80
1983.00	171.80	6923.02	611.75	23575.74	3937.42
1984.00	379.60	13272.88	373.60	18943.12	2329.22
1985.00	148.87	14390.62	418.58	34254.47	5215.26
1986.00	80.98	2841.85	137.32	25932.90	2092.58
1987.00	9.14	4250.54	211.61	15470.96	2306.59
1988.00	27.04	5067.76	169.45	3186.94	303.23

Source: National Canners Association, Division of Statistics and Economics

Table A.23: July 1 Fresh/Frozen inventory holdings (1000 lbs)

YEAR	FIKING	FIRED	FISILV	FIPINK	FICHUM
1964.00	7402.00	4393.00	4227.00	4393.00	3921.00
1965.00	5907.00	3522.00	3672.00	3522.00	2892.00
1966.00	4970.00	2651.00	2837.00	2651.00	2080.00
1967.00	3834.00	1920.00	1799.00	1920.00	1607.00
1968.00	3957.00	2240.00	1883.00	2240.00	1341.00
1969.00	5522.00	2765.00	3059.00	2765.00	2457.00
1970.00	5328.00	2353.00	3143.00	2353.00	2206.00
1971.00	10072.00	3272.00	4717.00	3272.00	1890.00
1972.00	7050.00	2370.00	2499.00	2370.00	1745.00
1973.00	10524.00	6179.00	9097.00	6179.00	9463.00
1974.00	6642.00	3268.00	3469.00	3268.00	2782.00
1975.00	5147.00	3773.00	3867.00	3773.00	2080.00
1976.00	3736.00	2917.00	2775.00	2917.00	1717.00
1977.00	6043.00	3724.00	1928.00	3724.00	2910.00
1978.00	7893.00	4991.00	3694.00	4991.00	4264.00
1979.00	4735.00	6469.00	2349.00	6469.00	3269.00
1980.00	4590.00	4041.00	5037.00	4041.00	4125.00
1981.00	3994.00	3477.00	2290.00	3477.00	3745.00
1982.00	4068.00	4215.00	1840.00	4215.00	1573.00
1983.00	5222.00	3076.00	2442.00	3076.00	5768.00
1984.00	3891.00	6642.00	3202.00	6642.00	6104.00
1985.00	2181.00	5166.00	3083.00	5166.00	6840.00
1986.00	1974.00	5741.00	1678.00	5741.00	6084.00
1987.00	1994.00	3593.00	1889.00	3593.00	3518.00
1988.00	2334.00	2737.00	1700.00	2737.00	3505.00

Source: Fishery Statistics of the United States.

Note: King, Silver, & Chum include own holdings plus Steaks/Fillets & Cured. Red and Pink data is Unclassified plus Steaks/Fillets and Cured.

Table A.24: Per Capita Income own currency (nominal and 1988 values)

YEAR	USNINC	JPNINC	UKNINC	USRINC	JPRINC	UKRINC
1964	3.39	259.72	0.63	12.51	837.50	4.98
1965	3.63	285.53	0.67	13.10	876.36	5.08
1966	3.93	328.66	0.71	13.68	959.61	5.15
1967	4.11	384.36	0.75	13.91	1055.69	5.22
1968	4.45	447.74	0.81	14.35	1169.88	5.41
1969	4.76	518.90	0.86	14.53	1289.66	5.48
1970	4.95	609.07	0.94	14.33	1407.34	5.57
1971	5.31	657.07	1.05	14.56	1436.81	5.72
1972	5.78	746.59	1.16	15.13	1546.11	5.80
1973	6.41	906.37	1.35	15.78	1661.14	6.32
1974	6.89	1054.77	1.53	15.55	1601.80	6.25
1975	7.40	1152.25	1.92	15.18	1623.99	6.17
1976	8.18	1292.97	2.30	15.79	1700.04	6.41
1977	9.04	1421.18	2.62	16.36	1766.08	6.42
1978	10.11	1555.88	3.03	17.03	1845.69	6.69
1979	9.80	1674.00	3.55	15.18	1927.46	6.85
1980	12.00	1790.91	4.13	17.02	1985.78	6.66
1981	13.26	1880.44	4.54	17.18	2021.28	6.58
1982	13.62	1963.22	4.95	16.58	2070.94	6.66
1983	14.50	2021.51	5.43	17.00	2198.42	6.94
1984	15.93	2136.81	5.80	17.96	2210.57	7.09
1985	16.78	2256.60	6.30	18.41	2299.47	7.28
1986	17.55	2334.33	6.76	18.75	2338.92	7.56
1987	18.63	2419.89	7.37	19.27	2429.42	7.86
1988	19.75	2533.59	8.04	19.75	2533.59	8.04

Table A.25: Exchange rates, real and nominal (currency/dollars)

YEAR	JPNER	UKNER	JPRER	UKRER
1964.00	361.99	0.36	414.63	0.17
1965.00	361.51	0.36	425.03	0.17
1966.00	362.35	0.36	432.19	0.17
1967.00	362.13	0.36	446.40	0.18
1968.00	360.55	0.42	445.23	0.20
1969.00	358.36	0.42	440.60	0.20
1970.00	358.16	0.42	448.65	0.20
1971.00	347.78	0.41	436.18	0.21
1972.00	303.12	0.40	383.18	0.21
1973.00	271.30	0.41	364.10	0.21
1974.00	291.84	0.43	433.77	0.24
1975.00	296.78	0.45	431.77	0.29
1976.00	296.45	0.55	435.45	0.38
1977.00	268.62	0.57	391.30	0.42
1978.00	210.38	0.52	298.85	0.40
1979.00	219.02	0.47	294.73	0.38
1980.00	226.63	0.44	290.06	0.39
1981.00	220.63	0.49	265.84	0.44
1982.00	249.06	0.57	287.47	0.52
1983.00	237.55	0.66	256.01	0.60
1984.00	237.45	0.75	258.78	0.69
1985.00	238.47	0.77	256.72	0.73
1986.00	168.35	0.68	179.47	0.65
1987.00	144.60	0.61	148.92	0.59
1988.00	128.17	0.56	128.17	0.56

Source: Nominal Exchange rates: Federal Reserve Board Bulletin (various years), Deflators: International Financial Statistics, IMF yearbook 1989

Table A.26: Real Per Capita Income (in own currency and in dollars)

YEAR	USRINC \$	JPRINC yen	JPRINC \$	UKRINC lb	UKRINC \$
1964.00	12.51	837.50	2.02	4.98	29.90
1965.00	13.10	876.36	2.06	5.08	29.83
1966.00	13.68	959.61	2.22	5.15	29.90
1967.00	13.91	1055.69	2.36	5.22	29.66
1968.00	14.35	1169.88	2.63	5.41	26.92
1969.00	14.53	1289.66	2.93	5.48	27.29
1970.00	14.33	1407.34	3.14	5.57	27.29
1971.00	14.56	1436.81	3.29	5.72	27.69
1972.00	15.13	1546.29	4.04	5.80	27.74
1973.00	15.78	1661.14	4.56	6.32	29.58
1974.00	15.55	1601.80	3.69	6.25	26.47
1975.00	15.18	1623.99	3.76	6.17	21.49
1976.00	15.79	1700.04	3.90	6.41	16.73
1977.00	16.36	1766.08	4.51	6.42	15.16
1978.00	17.03	1845.69	6.18	6.69	16.81
1979.00	15.18	1927.46	6.54	6.85	18.12
1980.00	17.02	1985.78	6.85	6.66	17.24
1981.00	17.18	2021.28	7.60	6.58	14.87
1982.00	16.58	2070.94	7.20	6.66	12.85
1983.00	17.00	2198.42	8.59	6.94	11.48
1984.00	17.96	2210.57	8.54	7.09	10.27
1985.00	18.41	2299.47	8.96	7.28	9.96
1986.00	18.75	2335.92	13.03	7.56	11.60
1987.00	19.27	2429.42	16.31	7.86	13.28
1988.00	19.75	2533.59	19.77	8.04	14.33

Table A.27: Short term interest rates (nominal and real)

YEAR	USNSTI	JPNSTI	UKNSTI	USRSTI	JPRSTI	UKRSTI
1964	4.50	7.90	6.16	2.79	-2.56	2.86
1965	4.54	7.80	7.18	2.18	2.74	2.42
1966	5.63	7.48	7.25	2.01	2.36	2.70
1967	5.63	7.31	5.50	2.77	1.01	1.88
1968	6.31	7.46	6.13	1.37	2.34	1.93
1969	7.95	7.41	6.63	2.36	2.28	1.26
1970	7.91	7.66	7.25	2.34	0.10	-0.39
1971	5.72	7.59	7.50	0.18	1.92	-1.38
1972	5.25	7.05	7.50	0.50	1.47	-1.20
1973	8.02	7.19	8.00	1.58	-5.82	1.50
1974	10.80	9.11	9.00	1.83	-11.57	-6.02
1975	7.86	9.10	9.00	-2.22	1.35	-17.94
1976	6.84	8.26	9.00	0.67	1.07	-6.11
1977	6.82	7.56	9.75	0.13	1.75	-4.22
1978	9.06	6.31	8.83	1.63	1.55	-2.20
1979	12.67	6.29	13.88	3.91	3.26	-0.47
1980	15.27	8.32	16.17	6.09	4.48	-3.52
1981	18.87	7.79	13.25	9.30	4.63	1.80
1982	14.86	7.23	11.79	8.48	5.33	4.12
1983	10.79	7.05	9.79	6.91	10.05	4.68
1984	12.04	6.66	9.65	8.09	1.54	5.05
1985	9.93	6.52	12.29	7.16	5.00	6.54
1986	8.35	5.91	10.83	5.65	4.21	7.36
1987	8.21	5.09	9.63	4.90	5.29	4.83
1988	9.32	4.93	10.29	5.93	4.54	3.68

Calculated by: $r(t) = i(t) - [P(t) - P(t-1)]/P(t)$,
 $r(t)$ = real interest rate
 $i(t)$ = nominal interest rate (prime rate)
 $P(t)$ = price index (GNP deflator) for year t

Table A.28: Inflation rates: $[P(t) - P(t-1)]/P(t)$.

YEAR	USINFL	JPINFL	UKINFL
1964.00	1.71	10.46	3.30
1965.00	2.36	5.06	4.76
1966.00	3.62	5.12	4.55
1967.00	2.86	6.30	3.62
1968.00	4.94	5.12	4.20
1969.00	5.59	5.13	5.37
1970.00	5.57	7.56	7.64
1971.00	5.54	5.67	8.88
1972.00	4.75	5.58	8.70
1973.00	6.44	13.01	6.50
1974.00	8.97	20.68	15.02
1975.00	10.08	7.75	26.94
1976.00	6.17	7.19	15.11
1977.00	6.69	5.81	13.97
1978.00	7.43	4.76	11.03
1979.00	8.76	3.03	14.35
1980.00	9.18	3.84	19.69
1981.00	9.57	3.16	11.45
1982.00	6.58	1.90	7.67
1983.00	3.88	-3.00	5.11
1984.00	3.95	5.12	4.60
1985.00	2.77	1.52	5.75
1986.00	2.70	1.70	3.47
1987.00	3.31	-0.20	4.80
1988.00	3.39	0.39	6.61

Source: International Financial Statistics, IMF 1989 Yearbook

APPENDIX B: 2SLS ESTIMATES OF THE WHOLESALE DEMAND AND SUPPLY FUNCTIONS

2SLS Linear Canned Supply Equation Estimation (1964-1988)

KING

rho & asymptotic t-ratio

0.592

2.765

second order rho & asymptotic t-ratios

0.302 0.523

1.224 1.838

corrected for ar(1) since rho significant at 5% one-tail level

Valid cases:	24	Dependent variable:	QCKING
Total SS:	5.941	Degrees of freedom:	20
R-squared:	0.252	Rbar-squared:	0.139
Residual SS:	4.446	Std error of ect:	0.472
F(3,20):	2.240	Probability of F:	0.115
Durbin-Watson:	2.264		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	1.274546	0.474936	2.683613	0.014	---	---
PCKING	-0.464472	0.269934	-1.720685	0.101	-0.537795	-0.438058
PFFING	-0.047416	0.239072	-0.198333	0.845	-0.053493	-0.374917
QCKING	-0.071136	0.065668	-1.083265	0.292	-0.262394	0.015670

t=1978-1988

MSE	MAE	U1	UM	UR	UD
39.617	0.488	4.250	0.574	0.374	0.053

t=1964-1988

MSE	MAE	U1	UM	UR	UD
17.226	0.729	3.355	0.375	0.539	0.086

2SLS Linear Canned Supply Equation Estimation (1964-1988)

RED

rho & asymptotic t-ratio

0.371
1.606

second order rho & asymptotic t-ratios

0.315 -0.226
1.543 -1.143

not corrected for ar(1) since rho not significant at 5% one-tail level

Valid cases:	25	Dependent variable:	QCRED
Total SS:	11128.528	Degrees of freedom:	21
R-squared:	0.362	Rbar-squared:	0.271
Residual SS:	7103.423	Std error of est:	18.392
F(3,21):	3.967	Probability of F:	0.022
Durbin-Watson:	1.317		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	64.957533	12.742958	5.097524	0.000	---	---
PCRED	-9.719394	3.844628	-2.528046	0.020	-0.562205	-0.566877
PFRED	0.084085	4.054667	0.020738	0.984	0.004815	-0.264851
QXRED	0.054968	0.052049	1.056074	0.303	0.199463	0.221929

t=1978-1988

MSE	MAE	U1	UM	UR	UD
0.216	12.223	0.307	0.172	0.325	0.503

t=1964-1988

MSE	MAE	U1	UM	UR	UD
0.241	12.896	0.465	0.005	0.012	0.983

2SLS Linear Canned Supply Equation Estimation (1964-1988)

SILVER

rho & asymptotic t-ratio

0.155
0.885

second order rho & asymptotic t-ratios

-0.072 0.363
-0.317 2.229

not corrected for ar(1) since rho not significant at 5% one-tail level

Valid cases:	25	Dependent variable:	QXSILV
Total SS:	73.469	Degrees of freedom:	21
R-squared:	0.223	Rbar-squared:	0.112
Residual SS:	57.069	Std error of est:	1.649
F(3,21):	2.012	Probability of F:	0.143
Durbin-Watson:	1.321		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	6.639220	1.853024	3.582911	0.002	---	---
PCSILV	-0.714990	0.631901	-1.131490	0.271	-0.231960	-0.290212
PFSILV	-0.566355	0.387355	-1.462110	0.159	-0.296930	-0.379866
QXSILV	-0.030065	0.027173	-1.106406	0.281	-0.216439	-0.199165

t=1978-1988

MSE	MAE	U1	UM	UR	UD
0.276	0.706	0.697	0.111	0.030	0.860

t=1964-1988

MSE	MAE	U1	UM	UR	UD
0.238	0.958	0.777	0.050	0.088	0.861

2SLS Linear Canned Supply Equation Estimation (1964-1988)

PINK

rho & asymptotic t-ratio

-0.211

-0.932

second order rho & asymptotic t-ratios

-0.210 0.000

-0.859 0.002

not corrected for ar(1) since rho not significant at 5% one-tail level

Valid cases:	25	Dependent variable:	QCPINK
Total SS:	27389.244	Degrees of freedom:	21
R-squared:	0.890	Rbar-squared:	0.875
Residual SS:	3005.395	Std error of est:	11.963
F(3,21):	56.794	Probability of F:	0.000
Durbin-Watson:	2.211		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	47.810592	11.613305	4.116881	0.000	---	---
PCPINK	-12.935849	4.632446	-2.792445	0.011	-0.302621	-0.589393
PFPINK	0.312580	9.806914	0.031873	0.975	0.003420	-0.488805
QXPINK	0.339404	0.033506	10.129662	0.000	0.791807	0.901204

t=1978-1988

MSE	MAE	U1	UM	UR	UD
0.050	13.481	0.329	0.000	0.600	0.400

t=1964-1988

MSE	MAE	U1	UM	UR	UD
0.060	8.950	0.221	0.050	0.652	0.297

2SLS Linear Canned Supply Equation Estimation (1964-1988)

CHUM

rho & asymptotic t-ratio

-0.043

-0.197

second order rho & asymptotic t-ratios

0.036 0.107

0.157 0.503

not corrected for ar(1) since rho not significant at 5% one-tail level

Valid cases:	25	Dependent variable:	QCCHUM
Total SS:	1604.733	Degrees of freedom:	21
R-squared:	0.084	Rbar-squared:	-0.047
Residual SS:	1469.553	Std error of est:	8.365
F(3,21):	0.644	Probability of F:	0.595
Durbin-Watson:	1.911		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	30.778190	10.456185	2.943539	0.008	---	---
PCCHUM	-4.217176	6.448541	-0.653974	0.520	-0.239355	-0.194956
PFCHUM	-0.829075	6.852334	-0.120992	0.905	-0.041590	-0.227744
QXCHUM	-0.068435	0.082042	-0.834147	0.414	-0.212819	-0.132048

t=1978-1988

MSE	MAE	U1	UM	UR	UD
0.598	7.398	0.976	0.179	0.090	0.731

t=1964-1988

MSE	MAE	U1	UM	UR	UD
0.302	6.265	0.819	0.018	0.065	0.917

2SLS Linear Canned Demand Equation Estimation (1964-1988)

KING

rho & asymptotic t-ratio

-0.427

-1.712

second order rho & asymptotic t-ratios

-0.467 -0.153

-1.755 -0.537

corrected for ar(1) since rho significant at 5% one-tail level

Valid cases:	24	Dependent variable:	PCKING
Total SS:	17.739	Degrees of freedom:	16
R-squared:	0.756	Rbar-squared:	0.650
Residual SS:	4.324	Std error of est:	0.520
F(7,16):	7.090	Probability of F:	0.001
Durbin-Watson:	2.100		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	4.354449	6.936100	0.627795	0.539	---	---
QCKING	-0.278213	0.406032	-0.685200	0.503	-0.323680	-0.145816
CIKING	0.000467	0.000410	1.139965	0.271	0.309162	0.000397
PTUNA	0.890825	0.291494	3.056064	0.008	0.691522	0.563382
RPCIUK	0.095123	0.141102	0.674148	0.510	0.358745	-0.068856
POPLUK	-0.006605	0.014376	-0.459455	0.652	-0.265507	-0.024100
ERUK	-0.003145	0.003155	-0.996667	0.334	-0.505144	0.156871
PRIMEUK	-0.103785	0.035728	-2.904831	0.010	-0.602264	-0.692138

t=1978-1988

MSE	MAE	U1	UM	UR	UD
0.596	1.866	2.337	0.891	0.039	0.070

t=1964-1988

MSE	MAE	U1	UM	UR	UD
0.504	1.865	2.576	0.889	0.048	0.064

CIKING = July 1 inventory holdings of king salmon (1000 lbs), PTUNA = tuna price (1988 dollars), RPCIUK = Real per capita income population weighted average of US and UK (\$1000 1988), POPLUK = sum of populations in US and UK (millions), ERUK = exchange rate in pounds/dollar, PRIMEUK = real prime rate in UK (%/year).

2SLS Linear Canned Demand Equation Estimation (1964-1988)

RED

rho & asymptotic t-ratio

-0.142

-0.504

second order rho & asymptotic t-ratios

-0.053 0.256

-0.179 0.878

not corrected for ar(1) since rho not significant at 5% one-tail level

Valid cases:	25	Dependent variable:	PCRED
Total SS:	47.789	Degrees of freedom:	17
R-squared:	0.499	Rbar-squared:	0.293
Residual SS:	23.944	Std error of est:	1.187
F(7,17):	2.419	Probability of F:	0.065
Durbin-Watson:	1.987		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	0.965433	9.006733	0.107190	0.916	---	---
QCRED	-0.029464	0.015725	-1.873710	0.078	-0.432030	-0.509374
CIRED	-0.000026	0.000038	-0.683980	0.503	-0.145042	-0.167084
PTUNA	0.038028	0.772232	0.049244	0.961	0.013098	0.026242
RPCIUK	-0.699014	0.343010	-2.037883	0.057	-1.222670	0.215950
POPLUK	0.049033	0.024915	1.967985	0.066	0.902506	0.388439
ERUK	-0.007663	0.007891	-0.971100	0.345	-0.552207	-0.256196
PRIMEUK	-0.063378	0.095531	-0.663435	0.516	-0.182272	-0.144439

t=1978-1988

MSE	MAE	U1	UM	UR	UD
0.108	0.998	0.122	0.187	0.059	0.754

t=1964-1988

MSE	MAE	U1	UM	UR	UD
0.074	0.719	0.162	0.002	0.085	0.913

CIRED = July 1 inventory holdings of red salmon (1000 lbs), PTUNA = tuna price (1988 dollars), RPCIUK = Real per capita income population weighted average of US and UK (\$1000 1988), POPLUK = sum of populations in US and UK (millions), ERUK = exchange rate in pounds/dollar, PRIMEUK = real prime rate in UK (%/year).

2SLS Linear Canned Demand Equation Estimation (1964-1988)

SILVER

rho & asymptotic t-ratio

-0.748

-2.220

second order rho & asymptotic t-ratios

-0.789 -0.365

-2.329 -1.173

corrected for ar(1) since rho significant at 5% one-tail level

Valid cases:	25	Dependent variable:	PCSILVER
Total SS:	19.826	Degrees of freedom:	16
R-squared:	0.806	Rbar-squared:	0.721
Residual SS:	3.847	Std error of est:	0.490
F(7,16):	9.494	Probability of F:	0.000
Durbin-Watson:	2.323		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	5.996168	9.348481	0.641406	0.530	---	---
QCSILV	-0.014284	0.176210	-0.081063	0.936	-0.033309	-0.344731
CISILV	0.000113	0.000121	0.930225	0.366	0.180226	0.043755
PTUNA	0.551265	0.312571	1.763649	0.097	0.489288	0.243536
RPCIUK	0.294675	0.171157	1.721666	0.104	1.272417	0.233554
POPLUK	-0.015892	0.009142	-1.738391	0.101	-0.739447	0.154854
ERUK	-0.002266	0.003007	-0.753697	0.462	-0.415650	-0.097641
PRIMEUK	-0.110531	0.026282	-4.205659	0.001	-0.727212	-0.610800

t=1978-1988

MSE	MAE	U1	UM	UR	UD
3.649	4.482	6.639	0.965	0.023	0.012

t=1964-1988

MSE	MAE	U1	UM	UR	UD
3.326	4.478	6.774	0.957	0.030	0.013

CISILVER = July 1 inventory holdings of silver salmon (1000 lbs), PTUNA = tuna price (1988 dollars), RPCIUK = Real per capita income population weighted average of US and UK (\$1000 1988), POPLUK = sum of populations in US and UK (millions), ERUK = exchange rate in pounds/dollar, PRIMEUK = real prime rate in UK (%/year).

2SLS Linear Canned Demand Equation Estimation (1964-1988)

PINK

rho & asymptotic t-ratio

0.209

0.831

second order rho & asymptotic t-ratios

0.273 -0.395

1.064 -1.329

not corrected for $ar(\hat{\rho})$ since rho not significant at 5% one-tail level

Valid cases:	25	Dependent variable:	PCPINK
Total SS:	16.238	Degrees of freedom:	17
R-squared:	0.860	Rbar-squared:	0.803
Residual SS:	2.268	Std error of est:	0.365
F(7,17):	14.963	Probability of F:	0.000
Durbin-Watson:	1.544		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	-0.863518	2.743467	-0.314754	0.757	---	---
QCPINK	-0.011164	0.002822	-3.955719	0.001	-0.452094	-0.572252
CIPINK	-0.000034	0.000009	-3.880036	0.001	-0.460825	-0.478888
PTUNA	0.166089	0.242850	0.683917	0.503	0.098137	0.446498
RPCIUK	-0.544405	0.116792	-4.661314	0.000	-1.633579	-0.060965
POPLUK	0.042046	0.007706	5.455992	0.000	1.327653	0.176043
ERUK	-0.006471	0.002527	-2.560948	0.020	-0.799914	0.064451
PRIMEUK	-0.034677	0.024271	-1.428714	0.171	-0.171084	-0.323724

t=1978-1988

MSE	MAE	U1	UM	UR	UD
0.034	0.257	0.622	0.062	0.220	0.718

t=1964-1988

MSE	MAE	U1	UM	UR	UD
0.026	0.253	0.423	0.004	0.038	0.958

CIPINK = July 1 inventory holdings of pink salmon (1000 lbs), PTUNA = tuna price (1988 dollars), RPCIUK = Real per capita income population weighted average of US and UK (\$1000 1988), POPLUK = sum of populations in US and UK (millions), ERUK = exchange rate in pounds/dollar, PRIMEUK = real prime rate in UK (%/year).

2SLS Linear Canned Demand Equation Estimation (1964-1988)

CHUM

rho & asymptotic t-ratio

-0.042

-0.123

second order rho & asymptotic t-ratios

-0.081 -0.431

-0.231 -1.065

not corrected for ar(1) since rho not significant at 5% one-tail level

Valid cases:	25	Dependent variable:	PCCHUM
Total SS:	6.448	Degrees of freedom:	17
R-squared:	0.606	Rbar-squared:	0.443
Residual SS:	2.542	Std error of est:	0.387
F(7,17):	3.730	Probability of F:	0.013
Durbin-Watson:	1.605		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	0.253382	3.280982	0.077227	0.939	---	---
QCCHUM	-0.031490	0.016778	-1.876884	0.078	-0.461337	-0.174532
CICHUM	-0.000034	0.000024	-1.456808	0.163	-0.279681	-0.123337
PTUNA	0.658589	0.261219	2.521212	0.022	0.617561	0.460558
RPCIUK	-0.034322	0.116296	-0.295125	0.771	-0.163442	0.023723
POPLUK	0.005018	0.008700	0.576748	0.572	0.251453	0.144370
ERUK	-0.000612	0.002608	-0.234581	0.817	-0.120040	0.062039
PRIMEUK	-0.049993	0.025099	-1.991793	0.063	-0.391431	-0.462923

t=1978-1988

MSE	MAE	U1	UM	UR	UD
0.077	0.320	0.997	0.035	0.228	0.737

t=1964-1988

MSE	MAE	U1	UM	UR	UD
0.037	0.236	0.774	0.001	0.092	0.907

CICHUM = July 1 inventory holdings of chum salmon (1000 lbs), PTUNA = tuna price (1988 dollars), RPCIUK = Real per capita income population weighted average of US and UK (\$1000 1988), POPLUK = sum of populations in US and UK (millions), ERUK = exchange rate in pounds/dollar, PRIMEUK = real prime rate in UK (%/year).

2SLS Linear Fresh/Frozen Supply Equation Estimation (1964-1988)

KING

rho & asymptotic t-ratio

0.293

1.162

second order rho & asymptotic t-ratios

0.234 0.276

0.934 1.010

not corrected for ar(1) since rho not significant at 5% one-tail level

Valid cases:	25	Dependent variable:	QFKING
Total SS:	208.289	Degrees of freedom:	21
R-squared:	0.813	Rbar-squared:	0.786
Residual SS:	38.991	Std error of est:	1.363
F(3,21):	30.394	Probability of F:	0.000
Durbin-Watson:	1.350		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	-7.702465	2.723829	-2.827808	0.010	---	---
PFFING	0.989129	0.524112	1.887246	0.073	0.236898	0.477188
PCKING	0.376148	0.669351	0.561959	0.580	0.077943	-0.226107
QXKING	0.987074	0.153729	6.420871	0.000	0.836359	0.857745

t=1978-1988

MSE	MAE	U1	UM	UR	UD
6.018	1.187	0.670	0.272	0.137	0.592

t=1964-1988

MSE	MAE	U1	UM	UR	UD
0.026	1.045	0.689	0.006	0.320	0.673

Note: PF...= fresh/frozen price (1988 dollars), PC...= canned price (1988 dollars), QX...= ex-vessel landings (millions)

2SLS Linear Fresh/Frozen Supply Equation Estimation (1964-1988)

RED

rho & asymptotic t-ratio

0.425

1.652

second order rho & asymptotic t-ratios

0.375 -0.066

1.573 -0.310

corrected for ar(1) since rho significant at 10% one-tail level

Valid cases:	24	Dependent variable:	QFRED
Total SS:	28727.831	Degrees of freedom:	20
R-squared:	0.605	Rbar-squared:	0.546
Residual SS:	11351.530	Std error of est:	23.824
F(3,20):	10.205	Probability of F:	0.000
Durbin-Watson:	1.312		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	-9.082755	11.943921	-0.760450	0.456	---	---
PFRED	-4.917535	7.002706	-0.702233	0.491	-0.130074	0.046852
PCRED	3.700253	4.947503	0.747903	0.463	0.137869	0.010260
QXRED	0.509491	0.092297	5.520129	0.000	0.792092	0.769530

t=1978-1988

MSE	MAE	U1	UM	UR	UD
0.037	15.761	0.537	0.458	0.042	0.501

t=1964-1988

MSE	MAE	U1	UM	UR	UD
12.452	13.970	4.295	0.110	0.773	0.638

Note: PF...= fresh/frozen price (1988 dollars), PC...= canned price (1988 dollars), QX...= ex-vessel landings (millions)

2SLS Linear Fresh/Frozen Supply Equation Estimation (1964-1988)

SILVER

rho & asymptotic t-ratio

0.244

1.111

second order rho & asymptotic t-ratios

0.009 0.244

0.037 1.319

not corrected for ar(1) since rho not significant at 5% one-tail level

Valid cases:	25	Dependent variable:	QFSILV
Total SS:	2421.704	Degrees of freedom:	21
R-squared:	0.944	Rbar-squared:	0.936
Residual SS:	135.565	Std error of est:	2.541
F(3,21):	118.046	Probability of F:	0.000
Durbin-Watson:	1.377		

Variable	Estimate	Standard Error	t-value	Prob > t	Standardized Estimate	Cor with Dep Var
CONSTANT	-5.251024	2.884783	-1.820249	0.083	---	---
PFSILV	0.211862	0.595878	0.355546	0.726	0.019350	0.082550
PCSILV	0.472754	0.983823	0.480527	0.636	0.026407	-0.113650
QXSILV	0.776571	0.041888	13.539093	0.000	0.973759	0.970902

t=1978-1988

MSE	MAE	U1	UM	UR	UD
0.006	1.581	0.171	0.003	0.103	0.894

t=1964-1988

MSE	MAE	U1	UM	UR	UD
0.067	1.736	0.551	0.003	0.092	0.906

Note: PF...= fresh/frozen price (1988 dollars), PC...= canned price (1988 dollars), QX...= ex-vessel landings (millions)