

ALASKA LEGISLATURE SPECIAL COMMITTEE/SUBJECT FILE 8672
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The long-run percentage change of dependent variable with 1-percent changes in right-hand side variables, all else remaining constant are:

$\ln(\text{EPLXER})$	-2.777
$\ln(\text{EPHXER3})$	3.302
$\ln(\text{EYRP})$	2.496

Variable definitions:

NQAEP^d = the per capita quantity of imported Norwegian farmed Atlantic salmon (FOB Norway) in the EEC, in millions of lbs.

UQHXP^d = the per capita quantity of North American high-valued salmon imported in the EEC, in millions of lbs.

UQLXP^d = the per capita quantity of North American low-valued salmon imported in the EEC in millions of lbs.

EPAERT = the "real" price of Norwegian farmed Atlantic salmon in the EEC (FOB Norway), in ECUs per pound.

EPLERT3 = the "real" price of North American low-valued Pacific salmon in the EEC in quarters 1, 3, and 4 (FOB North America), in ECUs per pound, and zero elsewhere.

EPLERT = the "real" price of North American low-valued Pacific salmon in the EEC (FOB North America), in ECUs per pound.

EPHERT = the "real" price of North American high-valued Pacific salmon in the EEC (FOB North America), in ECUs per pound.

EPHERT3 = the "real" price of North American high-valued Pacific salmon in the EEC in quarters 1, 2, and 4 (FOB North America), in ECUs per pound, and zeros elsewhere.

QSCOT12 = the estimated amount of the quantity of Scottish and Irish farmed Atlantic salmon remaining in the EEC countries in millions of lbs.

EYRP = the "real" per capita private consumption expenditure in the EEC in millions of lbs.

UQLXE^d_{-1} = UQLXE^d lagged one quarter.

NQAEP^d_{-4} = NQAEP^d lagged four quarters.

D4T = an indicator variable which is assigned a value of 1 for quarter four and is multiplied by a time variable which starts at 1 for 1981 and ends at 11 for 1991, and is assigned a value of 0 elsewhere.

DISEASE = an indicator variable assigned a value of 1 for the last two quarters of 1986 and the first two quarters of 1987 and a value of 0 elsewhere.

- D89 = an indicator variable which is assigned a value of 0 between 1983 and 1988, and a value of 1 in 1989.
- D91 = an indicator variable which is assigned a value of 0 between 1983 and 1990 and a value of 1 in 1991.
- DQ_is = quarterly indicator variables for quarter i where DQ_i is 1 in quarter i and 0 elsewhere.
- C = a constant.

"Real" prices are prices that have been divided by the EEC's consumer price index (ECPI) and net of tariffs. ECPI is included to impose homogeneity on the demand equations. The Atlantic salmon equation performed fairly well with a correlation coefficient of 0.987, but a probability of prior range only slightly above 0.5. This latter feature is probably due to a low probability of high-valued salmon being a substitute for Atlantic salmon.

In the Atlantic salmon equation, the own-price elasticity indicates demand is slightly elastic. The income elasticity is over 2.0. These elasticities are both below the ones found in Herrmann (1990), possibly reflecting increased supplies and lower prices of world salmon in recent years.

High-valued Pacific salmon was found to be a substitute for Atlantic salmon at a posterior probability of 0.610. This probability of substitution is also lower than found in Herrmann (1990), and may reflect increased dominance of Norwegian, Scottish, and Irish farm-raised salmon in the EEC over U.S. exports of high-valued wild salmon (primarily chinook). Low-valued salmon was not found to be a substitute for Atlantic salmon. This is consistent with *a priori* expectations.

The coefficient on the variable DISEASE was negative, which indicates that there may have been significant quality and availability changes for Norwegian Atlantic salmon in the last two quarters of 1986 and the first two quarters of 1987 when greater quantities of smaller salmon were placed on the market. Because of the Hitra disease problem in Norway in late 1986 and 1987, many small salmon were sold quickly. The quality and availability differences resulted in a structural change in the market, since smaller salmon generally receive lower prices than larger salmon. Perceived quality changes due to Norwegian disease problems may have contributed to market shifts. Additionally, European buyers may have perceived that increased supplies provided them with greater bargaining strength.

Another exogenous variable was D4T which represents a positive time-varying shift in the demand for farm-raised Norwegian salmon imports in the fourth quarter. The fourth quarter is a time of increased demand in the EEC for salmon imports because of the holiday season. Over time, D4T indicates that there has been structurally an outward shift in the demand for Norwegian farm-raised Atlantic salmon during the holiday season.

In the EEC demand equation for high-valued Pacific salmon, the correlation coefficient was 0.942 with 62 percent of the bootstrapped iterations jointly satisfying all constraints. The own-price elasticity of North American high-valued salmon imports differed only slightly from 1.0. This is well below the -1.883 own-price elasticity found in Herrmann (1990). This provides one more indication that the effect of rapidly increasing worldwide supply of salmon has been to decreased demand for U.S. salmon.

The reported income elasticity remains high, and is almost identical to the previous study.

Atlantic salmon was found to be a significant substitute for North America low-valued salmon (probability of 97.6 percent). Additionally, low-valued Pacific salmon was found to be a substitute in quarters 1, 3 and 4 (probability of 96.3 percent). That low-valued salmon was not found to be a substitute in quarter 2 may be due to only high-quality low-valued salmon being considered a substitute for the higher quality high-valued salmon. In quarters 3 and 4 (and to a lesser extent in quarter 1), low-valued salmon can be fresh or frozen and, therefore, considered a higher quality product.

Similar to the other two equations, the equation representing the EEC demand for imports of North-American imports of low-valued salmon exhibits a high correlation coefficient but a lower probability of prior range. Similar to the 1990 study, the own-price elasticity for low-valued Pacific salmon imports into the EEC exhibit an own-price elasticity close to 1.0. Surprisingly, this elasticity is almost identical to the own-price elasticity for high-valued salmon. This might be explained by the proliferation of Atlantic salmon consumption in the EEC directly impacting the demand for high-valued Pacific salmon imports through competition but only indirectly effecting the demand for low-valued Pacific salmon. This may have shifted the demand for high-valued salmon inward sufficiently such that it is no more profitable (in terms of marginal revenue) than low-valued salmon as an export commodity to the EEC. In fact, low-valued salmon exhibits a long-run elasticity that exceeds the own-price elasticity of high-valued salmon. However, examining the income elasticity, it is clear that an increase in income will expand the demand for high-valued Pacific salmon imports far more than it will low-valued Pacific salmon imports.

The negative value of the 1991 indicator variable suggests that the entire price decline of 1991 could not be captured through the other included variables. In other words, there was a structural break in quantity imported that was not captured through price or income changes.

Japanese Demand Equations

The Japanese demand for salmon was estimated as a function of its own-price, substitute prices, private expenditure, inventories, a constant, quarterly indicator variables, and Japanese landings. In addition, the Japanese demand for Norwegian farmed Atlantic salmon has a four-quarter lagged quantity to capture a partial adjustment process. The equations were estimated using a double-log functional form. The sample period for estimation was from the first quarter of 1983 to the third quarter of 1991.

Equation 9: Japanese Demand for Norwegian Farm-Raised Atlantic Salmon

Endogenous variable = $\ln(\text{NQAJP}^d)$

<u>Variable</u>	<u>Bayesian Coefficient</u>	<u>Standard Error</u>	<u>HYPOIG</u>
$\ln(\text{JPAJRT})$	-2.537	0.516	1.000
$\ln(\text{JPHJRT})$	1.260	0.423	0.996
$\ln(\text{JYRP})$	2.002	1.245	0.532
C	-2.014	1.345	0.464
DQ2	0.016	0.199	0.680
DQ3	-0.288	0.338	0.481
DQ4	-0.640	0.363	0.403
$\ln(\text{NQAJP}^d_{-4})$	0.511	0.732	1.000

Correlation coefficient = 0.950

Probability of prior range = 0.448

Odds in Favor of P(B) = 1.367

Probability of positive first-order autocorrelation (ignorance) = 0.148

Het Correction = Quarter 1 and 3

Sample period = 1983:1 to 1991:3

Probability [Column $\sigma_i \geq$ Row σ_j]

	σ_1	σ_2	σ_3	σ_4
σ_1	...	0.007	0.993	0.007
σ_2	0.993	...	1.000	0.433
σ_3	0.007	0.000	...	0.000
σ_4	0.993	0.567	1.000	...

The short-run percentage change of the dependent variable with 1-percent changes in right-hand side variables, all else remaining constant are:

JPAJRT	-2.537
JPHXJR	1.260
JYRP	2.002

The long-run percentage change of the dependent variable with 1-percent changes in right-hand side variables, all else remaining constant are:

JPAJRT	-5.188
JPHXJR	2.577
JYRP	4.094

Equation 10: Japanese Demand for North American High-Valued Pacific Salmon

Endogenous variable = $\ln(UQHXP^d)$

<u>Variable</u>	<u>Bayesian Coefficient</u>	<u>Standard Error</u>	<u>HYP0IG</u>
$\ln(JPHJRT)$	-1.252	0.363	0.999
$\ln(JINVZP_{-1})$	-0.626	0.257	0.980
$\ln(JYRP)$	3.574	0.652	1.000
$\ln(PTUNAR)$	1.188	0.395	0.994
C	-7.930	0.900	1.000
DQ3	2.036	0.251	1.000

Correlation coefficient = 0.968

Probability of prior range = 0.975

Odds in Favor of P(B) = 1.317

Probability of positive first-order autocorrelation (ignorance) = 0.751

Het Correction = Quarter 3 and 4

Sample period = 1983:1 to 1991:3

Probability [Column $\sigma_i \geq$ Row σ_j]

	σ_1	σ_2	σ_3	σ_4
σ_1	...	0.316	0.000	0.002
σ_2	0.684	...	0.000	0.006
σ_3	1.000	1.000	...	0.963
σ_4	0.998	0.994	0.037	...

The short-run percentage change of the dependent variable with 1-percent changes in right-hand side variables, all else remaining constant are:

JPHXJR	-1.252
JINVZEP ₋₁	-0.626
JYRP	3.574
FPFR	1.188

Equation 11: Japanese Demand for North American Low-Valued Pacific Salmon

Endogenous variable = $\ln(UQLXJP^d)$

Variable	Bayesian Coefficient	Standard Error	HYP0IG
$\ln(JPLJRT)$	-0.827	0.277	0.995
$\ln(JINVTP_{-1})$	-0.639	0.332	0.948
$\ln(PSQUIDR)$	0.369	0.191	0.879
$\ln(JYRP)$	1.516	1.057	0.490
C	-4.026	1.467	0.745
DQ1	-0.417	0.316	0.910
DQ2	-1.574	0.332	1.000
DQ3	-0.469	0.346	0.913
D22	0.724	0.292	0.993

Correlation coefficient = 0.919

Probability of prior range = 0.425

Odds in Favor of P(B) = 22.831

Probability of positive first-order autocorrelation (ignorance) = 0.930

Het Correction = Quarter 1

Sample period = 1983:1 to 1991:3

Probability [Column $\sigma_i \geq$ Row σ_j]

	σ_1	σ_2	σ_3	σ_4
σ_1	...	0.998	0.054	0.024
σ_2	0.002	...	0.000	0.006
σ_3	0.946	1.000	...	0.335
σ_4	0.976	1.000	0.665	...

The short-run percentage change of the dependent variable with 1-percent changes in right-hand side variables, all else remaining constant are:

JPLXJR	-0.827
JINVTEP ₋₁	-0.639
PSQUIDR	0.369
JYRP	1.516

Variable definitions:

JINVZP₋₁ = the Japanese per capita beginning inventories of frozen salmon, in millions of lbs.

JINVTP₋₁ = the Japanese per capita beginning inventories of frozen salmon and salted salmon, in millions of lbs.

JPAJRT = the "real" price of Norwegian farmed Atlantic salmon in Japan (FOB Norway), measured in Japanese yen per pound.

JPHJRT = the "real" price of North American high-valued Pacific salmon in Japan (FOB North America), measured in Japanese yen per pound.

JPLJRT = the "real" price of North American low-valued Pacific salmon in Japan (FOB North America), measured in yen per pound.

NQAJP^d = the per capita quantity of imported Norwegian farmed Atlantic salmon (FOB Norway) in Japan, in millions of lbs.

NQAJP^d₋₄ = NQAJP lagged four periods.

UQHXJP^d = the per capita quantity of North American high-valued salmon imported in Japan, in millions of lbs.

UQLXJP^d = the per capita quantity of North American low-valued salmon imported in Japan, in millions of lbs.

PTUNAR = the weighted average "real" price of a "high-valued" substitute fish consisting of fresh tuna, measured in yens per pound.

- PSQUIDR = the weighted average "real" price of a "lower-valued" substitute fish consisting of fresh squid, measured in yens per pound
- JYRP = the "real" per capita food consumption expenditure in Japan in billions of lbs.
- D22 = an indicator variable which is assigned a value of 1 in the second quarter of 1986 and zero elsewhere.
- DQ_is = quarterly indicator variables for quarter i where DQ_i is 1 in quarter i and 0 elsewhere.
- C = a constant.

All imported salmon prices are multiplied by the tariff rate and then divided by the Japanese CPI. All domestic prices as well as private expenditure are divided by the Japanese CPI. All quantities and incomes are divided by Japanese population.

In the Japanese demand for Norwegian farm-raised Atlantic salmon, the correlation was high at 0.912, although the probability that the prior restrictions were jointly satisfied was a somewhat low 0.448. This was mainly due to the positive prior sign constraint on the income variable being satisfied in only 53.2 percent of the bootstrapped iterations.

The coefficients for Norwegian farmed salmon in Japan show high own-price and income elasticities of -2.537 and 2.002, respectively. High-valued salmon was found to be a substitute with a 99.6 percent probability. Low-valued salmon was not found to be a substitute for the high-priced Atlantic salmon. The long-run elasticities are twice that of the short-run elasticities. This seems to indicate that it may be very profitable for the Norwegians to continue penetration of the Japanese market, especially if the Japanese economy remains healthy.

The Japanese demand equation for high-valued salmon had a high correlation coefficient of 0.968. In addition, 97.5 percent of the bootstrapped iterations jointly satisfied the Bayesian constraints. The demand for high-valued salmon only includes an indicator variable for the third quarter, when nearly all the imports occur.

The own-price elasticity in the Japanese demand for North American high-valued salmon imports was slightly elastic at -1.252. The income elasticity was very high at 3.574. The own-price elasticity was, again, far lower than the -3.019 elasticity found in the 1990 study. This indicates that even in Japan, exports of high-valued salmon may be close to reaching the saturation point if demand is not expanded, all else remaining constant. The high income elasticity suggests that salmon exports to Japan are highly sensitive to the state of the Japanese economy.

The demand equation for high-valued Pacific salmon did not have either Atlantic salmon or low-valued Pacific salmon appearing as a significant substitute. For the high-valued Pacific salmon, this indicates an asymmetric relationship regarding substitution. This is not surprising since, during the time period modelled, Atlantic salmon shipments to Japan were only a fraction of the high-valued Pacific salmon exports. Therefore, a price change in the Atlantic salmon would not significantly impact high-valued salmon, but a price change in high-valued salmon could

significantly affect the import demand for Atlantic salmon. The fact that low- and high-valued Pacific salmon were not substitutes may be explained by the Japanese market for salmon being fully developed, with these species competing with many other fish species. The Japanese, more than any other consumers in the world, are aware of the quality differences between all salmon species. It may be the case that, when a decision is made to consume or import fish, a decision in favor of either high or low-valued Pacific salmon is made in comparison to other similarly priced fish, and not with regard to each other. This is particularly true with sockeye salmon, which Japanese consumers consider to be the best salmon in the world and vastly superior to chum and pink salmon.

Frozen inventories of Japanese salmon were significant, as expected. A one-percent increase in the Japanese inventories of frozen salmon will decrease imports of North American high-valued salmon by 0.62 percent. Beginning Japanese frozen inventories in the high-valued salmon equation included all salmon species except pink salmon. Inventories are not broken out by species in Japanese data, other than having inventories including and excluding pink salmon.

An additional substitute good, named "PTUNAR", was used in the Japanese demand for high-valued salmon. Wholesale tuna prices are generally similar to high-valued wholesale salmon prices. The tuna price can be seen as a proxy to similarly priced fish in Japan.

Similar to the Japanese demand equation for Norwegian farmed Atlantic salmon, the demand equation for low-valued North American salmon exhibited a high correlation coefficient (0.919) but a moderate probability of prior range of 0.425. This again reflected a low HYPOIG for income of 0.490.

There is indication that the own-price is inelastic for low-valued Pacific salmon (-0.827). This result was expected since low-valued salmon is priced at the lower end of the fish market in Japan and is plentiful because of large Japanese chum salmon harvest. Most of this salmon goes to the low quality segment of the salted salmon market. Therefore, the market is likely to be inelastic. The income elasticity was 1.516 which indicates some demand sensitivity to the Japanese economy, although not as much as high-valued salmon or Atlantic salmon.

The substitute price of a more similar valued substitute fish (squid) was used to proxy low-valued salmon substitute goods. In the low-valued Pacific salmon demand equations, other salmon species were not found to be significant substitutes for low-valued salmon. A one percent increase in the total inventory of Japanese salmon displaces 0.639 percent of North American low-valued salmon imports. This is nearly identical to the effect of inventory on high-valued salmon imports. D22 was used to account for an apparent outlier in the data.

Japanese Inventory Equations

The Japanese inventory equations for Pacific salmon were estimated as a function of Japanese import own-price of salmon, the lagged import price, a constant and quarterly indicator variables, other indicator variables, beginning inventory levels, and import quantities. In addition, for the Japanese frozen inventory equation, the Japanese

discount rate was used to proxy the cost of storing salmon. Data was used from the first quarter of 1983 to the third quarter of 1991.

Equation 12: The Japanese Inventory of Frozen Salmon

Endogenous variable = $\ln(\text{JINVZ}^d)$

<u>Variable</u>	<u>Bayesian Coefficient</u>	<u>Standard Error</u>	<u>HYP0IG</u>
$\ln(\text{JPHXJ})$	-0.713	0.358	0.954
$\ln(\text{UQHXL})$	0.209	0.093	0.973
$\ln(\text{JINVZ}_{-1})$	0.648	0.173	1.000
$\ln(\text{JPHXJT}_{-1})$	0.704	0.297	0.989
C	1.280	2.537	0.613
DQ1	-0.179	0.123	0.091
DQ2	-0.428	0.133	0.997
DQ3	0.313	0.317	0.859
$\ln(\text{JINT})$	-0.122	0.075	0.834

Correlation coefficient = 0.943

Probability of prior range = 0.790

Probability of positive first-order autocorrelation (ignorance) = 0.833

Het Correction = Quarter 1 and 4

Sample period = 1983:1 to 1991:3

Probability [Column $\sigma_i \geq$ Row σ_j]

	σ_1	σ_2	σ_3	σ_4
σ_1	...	0.957	0.996	0.027
σ_2	0.043	...	0.814	0.000
σ_3	0.004	0.186	...	0.000
σ_4	0.973	1.000	1.000	...

The short-run percentage change of the dependent variable with 1-percent changes in right-hand side variables, all else remaining constant are:

JPHXJ	-0.713
UQHXL	0.209
JPHXJ ₋₁	0.704
JINT	-0.122

The long-run percentage change of the dependent variable with 1-percent changes in right-hand side variables, all else remaining constant are:

JPHXJ	-2.026
UQHXJ	0.594
JPHXJ ₋₁	2.000
JINT	-0.347

Equation 13: The Japanese Inventory of Frozen and Salted Salmon

Endogenous variable = $\ln(\text{JINVT}^d)$

<u>Variable</u>	<u>Bayesian Coefficient</u>	<u>Standard Error</u>	<u>HYP0IG</u>
$\ln(\text{JPLXJT})$	-0.210	0.134	0.920
$\ln(\text{JTSUPL})$	0.676	0.185	1.000
$\ln(\text{JPHXJT}_{-1})$	0.381	0.194	0.949
C	0.131	1.987	0.474
DQ2	-0.060	0.098	0.678
DQ3	0.519	0.076	1.000
DQ4	-0.132	0.156	0.830
D2728	-0.187	0.076	0.993

Correlation coefficient = 0.931

Probability of prior range = 0.790

Probability of positive first-order autocorrelation (ignorance) = 0.958

Het Correction = Quarter 4

Sample period = 1983:1 to 1991:3

Probability [Column $\sigma_i > =$ Row σ_j]

	σ_1	σ_2	σ_3	σ_4
σ_1	...	0.825	0.982	0.023
σ_2	0.175	...	0.861	0.002
σ_3	0.018	0.139	...	0.000
σ_4	0.977	0.998	1.000	...

The short-run percentage change of the dependent variable with 1-percent changes in right-hand side variables, all else remaining constant are:

JPLXJ	-0.210
JTSUP	0.676
JPHXJ ₋₁	0.381

UQHXJ = the quantity of North American high-valued salmon imported in Japan in millions of lbs.

JINVZ = Japanese ending inventories of frozen salmon in millions of lbs.

JINVZEP₋₁ = Japanese beginning inventories of frozen salmon in millions of lbs.

JINVT = the Japanese ending inventories of frozen salmon and salted salmon in millions of lbs.

JTSUPL = the summation of U.S. exports of low-valued Pacific salmon to Japan, the beginning inventories of the total frozen and salted salmon in Japan, and the landings of salmon in Japan in millions of lbs.

JPHXJT = the price of North American high-valued Pacific salmon in Japan (FOB North America), measured in yens per pound.

JPHXJT₋₁ = JPHXJT lagged one quarter.

JPLXJT = the price of North American low-valued Pacific salmon in Japan (FOB North America), measured in yens per pound.

JINT = the Japanese discount rate.

D2728 = an indicator variable which is assigned a value of 1 in the last two quarters of 1987 and zero elsewhere.

DQ_is = quarterly indicator variables for quarter i where DQ_i is 1 in quarter i and 0 elsewhere.

C = the constant.

The inventory equations incorporate the notion of partial adjustment and price expectations. A complete theory of how the above specifications were formed can be found in Herrmann (1990). The theory involved a partial adjustment process and both a speculative motive and a transactions motive where a buffer is formed to alleviate the risk of running short on salmon supplies.

In summary, we would expect, as the current import price increases, that less inventory would be held and more released onto the market. As the lagged export price increases (which proxies the future expectation of the price level) we would expect more salmon to be held in inventory as a speculative maneuver. The ending inventory levels are also some function of the beginning levels in the theory of partial adjustment. The ending

inventory levels are also a function of stocks on hand which is from the buffer theory of inventory motivation. Finally, the interest rate partially captures the cost of storing salmon reflecting its negative coefficient.

Both ending Japanese inventory equations performed well, with correlation coefficients greater than 0.90, and the Bayesian prior restrictions jointly holding 79 percent of the time. Neither equation exhibited autocorrelation problems. Both equations were also estimated using the double-log functional form.

In the Japanese ending inventory levels for frozen salmon, the Japanese discount rate was significant at the 83.4 percent level, although the effect was relatively minor. The elasticity indicates that a one-percent increase in the Japanese discount rate will decrease the Japanese inventory holdings of frozen salmon by 0.122 percent. The elasticity with respect to the import price suggests that when the import price of high-valued salmon increases by one-percent, the ending Japanese inventories will decrease by 0.713 percent.

The ending frozen inventories of Japanese salmon is included in the right-hand-side equation as higher levels of inventory reduces the demand for imported high-valued salmon, and vice versa. This variable is not exact because it includes frozen chum salmon (chum salmon could not be separated out). For the imported low-valued salmon equation it was necessary to include inventory levels of salted salmon (a large portion of which is inventory levels of domestic chum landings) and frozen salmon. Because of the way the raw data is aggregated, the ending inventory variable of total salmon that was used in the Japanese demand equation for low-valued salmon will also include inventory levels of high-valued salmon.

The total available supply of Japanese salmon includes imports of North American low-valued salmon, beginning inventories, and Japanese landings of salmon. When the sum of these items increases by one-percent the total Japanese ending inventories of frozen and salted salmon increased by 0.676 percent. When the current import price of low-valued salmon increases by 1 percent, the inventory levels decrease by 0.21 percent.

The lagged high-valued import salmon price was used in place of the lagged low-valued import price because of estimation considerations. The equation performance was enhanced by this specification. There may be a satisfactory theoretical explanation if, in some sense, the low-valued salmon prices follow the high-valued price in Japan (which are dominated by sockeye salmon). In this case the previous year sockeye prices may be an indication of the future direction of all imported salmon prices. Also, the total inventory of all salmon includes high-valued salmon.

The seasonal indicator variables (for both equations) reflect that the North American fishing season, and subsequent export season, is strongest in the third quarter. Finally, the indicator variable (D2728) marks the last two quarters of 1988. This variable is negative indicating a downward structural shift in demand during these two quarters following the incredible Japanese purchasing frenzy of salmon during 1988.

North American Allocation Equations of High-Valued Salmon

The North American allocation of high-valued salmon was estimated in two parts. First, the total exports of North American high-valued salmon to the EEC and Japan was estimated as a function of its weighted average export price, the total available supply (landings plus beginning inventories), and seasonal indicator variables. Then the EEC export price was estimated as a function of the Japanese export prices, seasonal indicator variables, an indicator variable for 1989, and a one-quarter lagged dependent variable. The functional form used was linear and the estimation time period was from the first quarter of 1983 to the fourth quarter of 1990.

Equation 14 The North American Exports of High-Valued Salmon

Endogenous variable = UQHX^S

<u>Variable</u>	<u>Bayesian Coefficient</u>	<u>Standard Error</u>	<u>HYPOIG</u>
UPHX	3.067	1.651	0.931
UHSUP	0.345	0.057	1.000
C	-6.468	5.102	0.847
DQ2	-18.308	3.862	1.000
DQ3	44.102	18.331	0.994
DQ4	4.906	3.188	0.953

Correlation coefficient = 0.994

Probability of prior range = 0.931

Probability of positive first-order autocorrelation (ignorance) = 0.496

Het Correction = Quarter 3

Sample period = 1983:1 to 1990:4

Probability [Column $\sigma_i \geq$ Row σ_j]

	σ_1	σ_2	σ_3	σ_4
σ_1	...	0.828	1.000	0.974
σ_2	0.172	...	1.000	0.874
σ_3	0.000	0.000	...	0.000
σ_4	0.026	0.126	1.000	...

The short-run percentage change of the dependent variable with 1-percent changes in right-hand side variables, all else remaining constant are:

UPHX	0.14
UHSUP	0.83

Equation 15: High-Valued Salmon Price Mapping Equation

Endogenous variable = UPHXE^s

<u>Variable</u>	<u>Bayesian Coefficient</u>	<u>Standard Error</u>	<u>HYP0IG</u>
UPHXJ	0.528	0.113	1.000
C	0.112	0.242	0.727
DQ2	0.152	0.134	0.867
DQ3	0.189	0.108	0.945
DQ4	0.369	0.118	0.997
D89	-0.615	0.146	1.000
UPHXE ^s ₋₁	0.359	0.134	0.998

Correlation coefficient = 0.511

Probability of prior range = 0.998

Probability of positive first-order autocorrelation (ignorance) = 0.590

Het Correction = Quarters 1 and 2

Sample period = 1983:1 to 1990:4

Probability [Column $\sigma_i \geq$ Row σ_j]

	σ_1	σ_2	σ_3	σ_4
σ_1	...	1.000	0.924	0.992
σ_2	0.000	...	0.019	0.130
σ_3	0.075	0.981	...	0.805
σ_4	0.998	0.870	0.195	...

The short-run percentage change of the dependent variable with 1-percent changes in right-hand side variables, all else remaining constant are:

$$\text{UPHXJ} \quad 0.54$$

The long-run percentage change of dependent variable with 1-percent changes in right-hand side variables, all else remaining constant are:

$$\text{UPHXJ} \quad 0.84$$

Variable definitions:

- UHSUP = the North American total available supply of high-valued salmon (beginning inventories plus landings) in millions of lbs.
- UQHX = the total North American quantity of high-valued salmon exports to Japan and the EEC in millions of lbs.
- UPHX = the North American weighted average export price of high-valued salmon (FOB North America) exported to the EEC and Japan, measured in U.S. dollars per pound.
- UPHXJ = the price of North American high-valued Pacific salmon exported to Japan (FOB North America), measured in U.S. dollars per pound.
- UPHXE = the price of North American high-valued Pacific salmon exported to the EEC (FOB North America), measured in U.S. dollars per pound.
- DQ_is = quarterly indicator variables for quarter i where DQ_i is 1 in quarter i and 0 elsewhere.
- C = a constant.

The allocation equations were based on supply theory. It was assumed that the export price to the EEC and Japan differs only because of momentum and seasonal adjustments. Both equations performed very well, with correlation coefficients and the probability of the prior range exceeding 0.90, and the autocorrelation coefficients close to 0.50.

The North American wholesale market is not explicitly modelled because of data limitations. Data on wholesale prices for use in the context of this model were unavailable, and domestically derived wholesale quantities from utilization tables were often nonsensical (negative-valued).

In the equation for total North American high-valued salmon exports the exports rise. This is consistent with the theory of supply. Producers are willing to export more salmon as the price received for the salmon increases. Similarly, as total available supply increases exports will increase. The indicator variables reflect the highly seasonal nature of exports, which are mainly in the third quarter.

The price mapping equation links the EEC high-valued salmon price with that of Japan. A break occurred in 1989 when the Japanese price increased via the EEC prices, *ceteris paribus*. The lagged EEC price indicates that there is some systematic pattern in the drifting spread between the two prices.

North American Allocation Equations of Low-Valued Salmon

The North American allocation of low-valued salmon was also estimated in two parts. The estimation was slightly different than that for the high-valued salmon allocation equations. First, the total exports of North American low-valued salmon to the EEC were estimated as a function of the price received from the EEC, the total available supply (landings plus beginning inventories), and seasonal indicator variables. Then the Japanese export price was estimated as a function of the EEC export price, seasonal indicator variables, an indicator variable for 1989, and a one-quarter lagged dependent variable. The functional form used was linear, and the estimation time period was from the first quarter of 1983 to the fourth quarter of 1990. In effect, this specification works the same as the specification for the allocation of high-valued salmon but this form was more easily estimated.

Equation 16: The North American Allocation of Low-Valued Salmon to the EEC

Endogenous variable = UQLXE^S

<u>Variable</u>	<u>Bayesian Coefficient</u>	<u>Standard Error</u>	<u>HYP0IG</u>
UPLXE	4.290	2.275	0.932
ULSUP	0.123	0.043	0.996
C	-6.248	4.282	0.887
DQ2	-0.823	1.906	0.683
DQ3	-10.925	16.357	0.743
DQ4	-2.719	2.440	0.851

Correlation coefficient = 0.880

Probability of prior range = 0.929

Probability of positive first-order autocorrelation (ignorance) = 0.381

Het Correction = Quarter 3

Sample period = 1983:1 to 1990:4

Probability [Column $\sigma_i \geq$ Row σ_j]

	σ_1	σ_2	σ_3	σ_4
σ_1	...	0.161	1.000	0.520
σ_2	0.839	...	1.000	0.864
σ_3	0.000	0.000	...	0.000
σ_4	0.480	0.136	1.000	...

The short-run percentage change of the dependent variable with 1-percent changes in right-hand side variables, all else remaining constant are:

UPLXE	0.47
ULSUP	1.36

Equation 17 Low-Valued Salmon Price Mapping Equation

Endogenous variable = UPLXJ

<u>Variable</u>	<u>Bayesian Coefficient</u>	<u>Standard Error</u>	<u>HYP0IG</u>
UPLXE	0.421	0.099	1.000
C	-0.285	0.097	0.999
DQ2	0.001	0.051	0.515
DQ3	0.192	0.048	1.000
DQ4	0.029	0.049	0.723
D89	-0.129	0.053	0.994
UPLXJ ₋₁	0.761	0.088	1.000

Correlation coefficient = 0.955

Probability of prior range = 0.988

Probability of positive first-order autocorrelation (ignorance) = 0.131

Het Correction = Quarters 1 and 3

Sample period = 1983:1 to 1990:4

Probability [Column $\sigma_i \geq$ Row σ_j]

	σ_1	σ_2	σ_3	σ_4
σ_1	...	1.000	0.642	1.000
σ_2	0.000	...	0.000	0.497
σ_3	0.358	1.000	...	1.000
σ_4	0.000	0.503	0.000	...

The short-run percentage change of dependent variable with 1-percent changes in right-hand side variables, all else remaining constant are:

UPLXE 0.41

Variable definitions:

ULSUP = the North American total available supply of low-valued salmon
(beginning inventories plus landings)

UPLXE = the North American export price of low-valued salmon exported to
the EEC in U.S. dollars.

UPLXJ = the North American export price of low-valued salmon exported to
Japan.

UPLXJ₋₁ = UPLXJ lagged one quarter

UQLXE^S = the quantity of North American low-valued salmon exported in the
EEC

D89 = an indicator variable which is assigned a value of 0 between 1983 and
1988 and a value of 1 in 1989

DQ_is = quarterly indicator variables for quarter i where DQ_i is 1 in quarter i
and 0 elsewhere

C = the constant

The allocation equations were also based on the theory of supply, and utilized one export price. The export price to the EEC and Japan are correlated to some degree, and it was assumed that price differences are a result of momentum and seasonal adjustments. Both equation performed very well with correlation coefficients and the probability of the prior range exceeding 0.88. No evidence of an autocorrelation problem was present.

Again, the North American wholesale market is not explicitly modelled because of data limitations. Data on wholesale prices for use in the context of this model were

unavailable, and domestically derived wholesale quantities from utilization tables were often nonsensical.

In the equation for total North American low-valued salmon exports to the EEC, the exports rise as the EEC price rises. Similarly, as total available supply increases exports will increase.

The price mapping equation relates the Japanese low-valued salmon price with that of Japan. As with North American high-valued salmon allocations, a break occurred in 1989 when the EEC price increased relative to the Japanese price, *ceteris paribus*. This is opposite to the effect found in the high-valued equations. The lagged Japanese price also indicates that there is some systematic drifting pattern between the two prices.

North American Inventory Equations

The North American inventory equations for Pacific salmon were estimated as a function of North American weighted average export price of Pacific salmon, the total available supply of Pacific salmon, beginning inventories of Pacific salmon, a constant, quarterly indicator variables, a one-quarter lag of the North American weighted average export price of Pacific salmon, and an indicator variable assigned the value of 1 in 1987. The equations were estimated using a double-log functional form. The estimation time period was from the first quarter of 1983 to the fourth quarter of 1990. The specification of the equations are identical to the ones found in Herrmann (1990) and explained more fully in the Japanese inventory section.

Equation 18: North American High-Valued Salmon Inventory

Endogenous variable = $\ln(UHINV)$

<u>Variable</u>	<u>Bayesian Coefficient</u>	<u>Standard Error</u>	<u>HYP0IG</u>
$\ln(UPHX)$	-0.463	0.244	0.909
$\ln(UHSUP)$	0.731	0.154	1.000
$\ln(UHINV_{-1})$	0.337	0.115	1.000
C	-1.292	0.594	0.991
DQ2	-0.945	0.221	1.000
DQ3	0.118	0.476	0.598
DQ4	0.392	0.138	0.994
$UPHX_{-1}$	0.611	0.226	0.972
D87	-0.260	0.112	0.991

Correlation coefficient = 0.973

Probability of prior range = 0.773

Odds in Favor of P(B) = 1.372

Probability of positive first-order autocorrelation (ignorance) = 0.590

Het Correction = Quarter 3

Sample period = 1983:1 to 1990:4

Probability [Column $\sigma_i \geq$ Row σ_j]

	σ_1	σ_2	σ_3	σ_4
σ_1	...	0.369	0.810	0.083
σ_2	0.632	...	0.876	0.163
σ_3	0.190	0.124	...	0.011
σ_4	0.918	0.837	0.989	...

The short-run percentage change of the dependent variable with 1-percent changes in right-hand side variables, all else remaining constant are:

UPHX	-0.463
UHSUP	0.731

The long-run percentage change of the dependent variable with 1-percent changes in right-hand side variables, all else remaining constant are:

UPHX	-1.315
UHSUP	2.077

Equation: American Low-Valued Salmon Inv

Endogenous: $\ln(\text{ULINV})$

fts Variable	Bayesian Coefficient	Standard Error	H1 POIG
$\ln(\text{UPLX})$	-0.673	0.296	0.962
$\ln(\text{ULSUP})$	0.573	0.111	1.000
$\ln(\text{ULINV}_{-1})$	0.364	0.121	0.999
C	-0.419	0.470	0.800
DQ2	-0.571	0.119	1.000
DQ3	0.015	0.406	0.505
DQ4	0.472	0.119	0.999
UPLX_{-1}	0.541	0.245	0.943
D87	-0.186	0.079	0.991

Correlation coefficient = 0.979

Probability of prior range = 0.834

Odds in Favor of $P(B) = 1.372$

Probability of positive first-order autocorrelation (ignorance) = 0.282

Het Correction = Quarters 1 and 4

Sample period = 1983:1 to 1990:4

Probability [Column $\sigma_i \geq$ Row σ_j]

	σ_1	σ_2	σ_3	σ_4
σ_1	...	1.000	1.000	0.250
σ_2	0.000	...	0.452	0.000
σ_3	0.000	0.548	...	0.0000
σ_4	0.750	1.000	1.000	...

The short-run percentage change of the dependent variable with 1-percent changes in right-hand side variables, all else remaining constant are:

UPLX	-1.058
ULSUP	0.901

The long-run percentage change of the dependent variable with 1-percent changes in right-hand side variables, all else remaining constant are:

UPLX	-1.315
ULSUP	2.077

Variable definitions:

UHINV = the ending inventory of North American high-valued salmon in millions of lbs.

ULINV = the ending inventory of North American low-valued salmon in millions of lbs.

UHINV₋₁ = UHINV lagged one quarter.

ULINV₋₁ = ULINV lagged one quarter.

UPHX = the North American weighted average export price of high-valued salmon (FOB North America) exported to the EEC and Japan, measured in U.S. dollars

UPHX₋₁ = UPHX lagged one quarter.

- UPLX = the North American weighted average export price of low-valued salmon (FOB North America) exported to the EEC and Japan, measured in U.S. dollars.
- D87 = an indicator variable which is assigned a value of 1 in 1987 and zero elsewhere.
- UHSUP = the North American total available supply of high-valued salmon (beginning inventories plus landings) in millions of lbs.
- ULSUP = the North American total available supply of low-valued salmon (beginning inventories plus landings) in millions of lbs.
- DQ_is = quarterly indicator variables for quarter i where DQ_i is 1 in quarter i and 0 elsewhere.
- C = a constant.

The models performed well with high correlation coefficients and moderate to high probabilities of prior ranges. Both equations indicate that the holdings of North American inventories decrease when the current weighted average export price increases (used as a proxy for U.S. wholesale prices), and increases when the expectations of future wholesale price, (as proxied by the lagged weighted average export price) and beginning available supplies increase. Momentum (or friction), as stated in the partial adjustment theory, is incorporated in the equations through the beginning inventory variable. High-valued salmon was less responsive to prices and more responsive to the proportion held back from total supply than low-valued salmon. This indicates that processors have a more conservative attitude toward buffer stocks when dealing with the higher-priced product.

The indicator variables reflect the large buildup of inventory in the fourth quarter after the heavy third quarter fishing season. Besides quarterly indicator variables, the only other exogenous variable is D87. This variable was used to capture a structural change in 1987 that is not well represented by the partial adjustment framework. In 1987, North American ending inventories were approximately 50 percent of 1986 ending levels. Levels in 1987 were, in part, drawn down by a low Alaska catch which was under 100 million salmon for the first time in 8 years. Japanese buyers bid up prices and inventories were depleted. By the end of 1988, continued high prices started to depress purchases so that, at the end of 1988, inventory levels were up to slightly higher than 1986 levels.

Can Salmon Equations

The can salmon equations are presented below as a group. They include the "world" demand for low-valued canned salmon (the EEC, Australia, and New Zealand), the North American allocation of low-valued canned salmon, the North American inventory level of low-valued canned salmon, and an equation proxying the high-valued canned salmon prices. All equations are estimated in the linear form. The demand and price mapping equations used data from the first quarter of 1983 to the third quarter of 1991. The other two equations incorporate data through the fourth quarter of 1990.

The demand for low-valued canned salmon is modelled as a function of its own-price, a substitute price, income, quarterly indicator variables, and an indicator variable marking 1986, and the lagged dependent variable. The allocation of low-valued salmon was estimated as a function of the export price, the total available supply, quarterly indicator variables, an indicator variable marking 1986, and the lagged dependent variable.

The inventory equation was based on the same theory as the frozen inventory equations, with an added indicator variable for 1986. Finally, the high-valued export canned salmon price was proxied as a function of the high-valued export fresh/frozen price, quarterly indicator variables, an indicator variable marking 1989, and the lagged dependent variable.

Equation 20: The Import Demand for Canned North American Low-Valued Pacific Salmon

Endogenous variable = UQLXAC^d

Variable	Bayesian Coefficient	Standard Error	HYP0IG
APLACR	-0.882	0.398	0.946
APHACR	0.555	0.322	0.789
EYRP	0.479	0.304	0.704
C	0.003	0.018	0.766
DQ2	-0.014	0.003	1.000
DQ3	-0.016	0.003	1.000
DQ4	0.013	0.004	0.994
D86	0.017	0.004	1.000
UQLXAC ^d ₋₁	0.196	0.115	0.903

Correlation coefficient = 0.922

Probability of prior range = 0.518

Probability of positive first-order autocorrelation (ignorance) = 0.166

Het Correction = Quarters 2 and 3

Sample period = 1983:1 to 1991:3

Probability [Column $\sigma_i \geq$ Row σ_j]

	σ_1	σ_2	σ_3	σ_4
σ_1	...	0.004	0.002	0.502
σ_2	0.996	...	0.366	0.996
σ_3	0.998	0.635	...	0.999
σ_4	0.498	0.004	0.001	...

The short-run percentage change of the dependent variable with 1-percent changes in right-hand side variables, all else remaining constant are:

APLACRT	-0.423
APHACRT	0.398
EYRP	0.832

The long-run percentage change of the dependent variable with 1-percent changes in right-hand side variables, all else remaining constant are:

APLACRT	-0.527
APHACRT	0.496
EYRP	1.034

Equation 21: North American Allocation of Low-Valued Canned Salmon

Endogenous variable = UQLXAC^S

<u>Variable</u>	<u>Bayesian Coefficient</u>	<u>Standard Error</u>	<u>HYP0IG</u>
UPLXC	1.013	0.559	0.866
ULSUPC	0.012	0.007	0.869
C	-0.774	2.065	0.528
DQ3	-5.833	2.300	0.957
DQ4	6.465	1.542	1.000
D86	6.346	1.511	1.000
UQLXAC ^S ₋₁	0.411	0.125	1.000

Correlation coefficient = 0.887

Probability of prior range = 0.659

Probability of positive first-order autocorrelation (ignorance) = 0.000

Het Correction = None

Sample period = 1983:1 to 1990:4

Probability [Column $\sigma_i \geq$ Row σ_j]

	σ_1	σ_2	σ_3	σ_4
σ_1	...	0.032	0.000	0.187
σ_2	0.967	...	0.085	0.814
σ_3	1.000	0.915	...	0.991
σ_4	0.813	0.186	0.009	...

The short-run percentage change of the dependent variable with 1-percent changes in right-hand side variables, all else remaining constant are:

UPLXC	0.15
ULSUPC	0.40

The long-run percentage change of the dependent variable with 1-percent changes in right-hand side variables, all else remaining constant are:

UPLC	0.25
ULSUPC	0.68

Equation 22: North American Ending Inventory of Low-Valued Canned Salmon

Endogenous variable = ULINVC

<u>Variable</u>	<u>Bayesian Coefficient</u>	<u>Standard Error</u>	<u>HYP0IG</u>
UPLXC	-12.050	5.489	0.980
ULSUPC	0.194	0.079	0.986
C	-26.707	10.851	0.995
DQ2	9.609	3.950	0.996
DQ3	35.438	30.127	0.878
DQ4	14.432	5.188	0.997
D86	-12.756	4.590	0.990
UPLXC ₋₁	11.817	4.088	0.996
ULINVC ₋₁	0.495	0.152	1.000

Correlation coefficient = 0.966

Probability of prior range = 0.965

Probability of positive first-order autocorrelation (ignorance) = 0.958

Het Correction = Quarters 3 and 4

Sample period = 1983:1 to 1990:4

Probability [Column $\sigma_i > \text{Row } \sigma_j$]

	σ_1	σ_2	σ_3	σ_4
σ_1	...	0.081	1.000	1.000
σ_2	0.919	...	1.000	1.000
σ_3	0.000	0.000	...	0.000
σ_4	0.000	0.000	1.000	...

The short-run percentage change of the dependent variable with 1-percent changes in right-hand side variables, all else remaining constant are:

UPLXC	0.39
ULSUPC	0.73

The long-run percentage change of the dependent variable with 1-percent changes in right-hand side variables, all else remaining constant are:

UPLXC	0.77
ULSUPC	1.45

Equation 23 Correlation of High-Valued Fresh/Frozen and Canned Low-Valued Salmon

Endogenous variable = APHXAC

<u>Variable</u>	<u>Bayesian Coefficient</u>	<u>Standard Error</u>	<u>HYP0IG</u>
EPHXE	0.5619	0.127	1.000
C	1.071	0.347	0.999
DQ2	-0.1023	0.163	0.712
DQ3	-0.3327	0.131	0.995
DQ4	-0.3366	0.147	0.988
D89	0.3940	0.204	0.968
APHXAC ₋₁	0.2444	0.134	0.922

Correlation coefficient = 0.753

Probability of prior range = 0.922

Probability of positive first-order autocorrelation (ignorance) = 0.777

Het Correction = Quarter 2

Sample period = 1983:1 to 1991:3

Probability [Column $\sigma_i \geq$ Row σ_j]

	σ_1	σ_2	σ_3	σ_4
σ_1	...	1.000	0.790	0.601
σ_2	0.000	...	0.156	0.002
σ_3	0.210	0.984	...	0.293
σ_4	0.399	0.998	0.707	...

The short-run percentage change of the dependent variable with 1-percent changes in right-hand side variables, all else remaining constant are:

EPHXE 0.73

The long-run percentage change of the dependent variable with 1-percent changes in right-hand side variables, all else remaining constant are:

EPHXE 0.97

Variable definitions:

$UQLXAC^S$ = the quantity of North American low-valued canned salmon exported to the EEC, Australia, and N.Z. in millions of lbs.

$ULSUPC$ = the North American total available supply of low-valued salmon (beginning fresh/frozen and canned inventories plus landings) in millions of lbs.

$UQLXAC^d$ = the quantity of imported North American low-valued canned salmon into the EEC, Australia, and N.Z. in millions of lbs.

$UQLXAC^d_{-1}$ = $UQLXAC^d$ lagged one quarter.

$UQLXAC^S$ = the quantity of North American exports of low-valued canned salmon to the EEC, Australia, and N.Z. in millions of lbs..

$UQLXAC^S_{-1}$ = $UQLXAC^S$ lagged one quarter.

$ULINVC$ = the ending inventory of North American low-valued canned salmon in millions of lbs.

$ULINVC_{-1}$ = the beginning inventory of North American low-valued canned salmon in millions of lbs.

$APLACR$ = the "real" price of North American low-valued can Pacific salmon in the EEC, Australia, and New Zealand in ECUs per pound.

APHACR = the "real" price of North American high-valued can Pacific salmon in the EEC, Australia, and New Zealand in ECUs per pound.

APHXAC = the nominal price of North American high-valued can Pacific salmon in the EEC, Australia, and New Zealand per pound.

APHXAC₋₁ = APHXAC lagged one quarter.

EPHXE = North American high-valued Pacific salmon export price to the EEC in ECUs per pound.

EYRP = the "real" per capita private consumption expenditure in the EEC in millions of ECUs

UPLXC = the North American weighted average export price of low-valued canned salmon (FOB North America) exported to the EEC, Australia, and New Zealand, in U.S. dollars per pound.

UPLXC₋₁ = UPLXC lagged one quarter.

D89 = an indicator variable which is assigned a value of 1 in 1989, and 0 elsewhere.

D86 = an indicator variable which is assigned a value of 1 in 1986, and zero elsewhere.

DQ_is = quarterly indicator variables for quarter i, where DQ_i is 1 in quarter i and 0 elsewhere.

C = a constant.

For the low-valued Pacific can demand equation, "real" prices represent prices that have been divided by the EEC's consumer price index (ECPI). ECPI is included to impose homogeneity on the demand equations. Because the exports are a combined EEC, Australia, and New Zealand figure, the EEC income and CPI level will only proxy a combined level for the three countries.

The demand equation performed fairly well with a correlation coefficient of 0.922. The own-price elasticity for low-valued can salmon is very inelastic, and the income elasticity is also below 1.0. This low price elasticity is not a good sign for producers of canned salmon. The value of less than 1.0, indicates that exporters of canned salmon to the EEC, Australia, and New Zealand would increase revenues by decreasing canned exports, *ceteris paribus*. The low income elasticity indicates that the level of demand for canned salmon is not very sensitive to changes in income levels.

High-valued canned Pacific salmon was found to be a substitute for low valued can salmon at a posterior probability of 0.789. The low value of the lagged quantity coefficient indicates that adjustment is quite rapid, and that long-run own-price elasticity is still inelastic (although the income elasticity rises to unitary). There was also a positive shift in exports in 1986 which was not captured by the other variables in the equation. The positive 1986 shift is significant in all low-valued canned salmon equations.

The low-valued canned salmon allocation equation was based on the theory of supply. The equation had a correlation coefficient of 0.887 and a probability of prior range of 0.651. However, some caution must be taken as this is the only equation in the model which had persistent autocorrelation. Repeated efforts were unsuccessful in remedying this problem.

In the equation for total North American low-valued canned exports to the EEC, Australia and New Zealand, the exports increase as the weighted average export price to these countries (measured in ECUs) increases. Similarly, as total supply increases, exports to these countries also increase. Again, the indicator variable marking 1986 indicates a large 1986 increase in canned salmon exports.

For the low-valued canned salmon inventory equation the models performed well, with the correlation coefficients and the probability of prior range both exceeding 0.965. The equation indicates that the holdings of North American canned inventories decrease when the current weighted average export price increases (used as a proxy for U.S. canned wholesale prices), and increases when the expectations of future wholesale price (as proxied by the lagged wholesale price proxy) and beginning available supplies increase. Momentum (or friction) is incorporated through the beginning inventory variable.

The price mapping equation is used in lieu of explicitly modelling the high-valued canned salmon markets. This approach was taken, in part, due to time constraints and also because these markets are relatively unimportant. However, because high- and low-valued canned salmon were found to be substitutes, the high-valued canned salmon price needed to be internally generated. This was done by correlating it with the high-valued fresh/frozen export price.

Model Performance

Model performance is evaluated by examining the predicted versus observed values for each of the endogenous variables, and the generated fit statistics. A variety of statistics are available which measure the differences between the observed and predicted values. The most straightforward is the mean percent error (M%E) which is the average of the percentage differences between the actual and predicted values. The root mean squared percentage error (RMSE) measures the square root of the sum of squared deviations of the error, measured in percent terms. A substantial difference between M%E and RMSE indicates that there may be large outliers present in the data set. The correlation coefficient (r) measures how well that actual and predicted values are clustered around the estimated trend line. More discussion on this statistic is presented under the Bloc 2 discussion.

Four additional statistics, developed by Theil (1963) to further evaluate simulation fits are presented. The U-inequality coefficient, measures the turning point accuracy of the forecast. A coefficient of zero is associated with a perfect forecast, whereas, a coefficient of 1.0 implies that the model forecast is no better than a status quo forecast.

Measures of the systematic and unsystematic portions of forecast error can be derived by decomposing the U-inequality coefficient (Pindyck and Rubinfeld 1981). Three partial inequality coefficients are reported. UM measures forecast bias, reflecting the differences in central tendencies between predicted and observed changes in the variable. UR reflects the slope proportion of an optimal linear correction to the predicted change. Finally, UD indicates the portion of forecast error attributable to random disturbances. The three partial measures add to one, by definition, and the combined total of UM + UR reflects systematic forecast error. It is generally desirable that this combined figure be close to zero, i.e., most of the forecast error is attributable to random disturbances.

The historical simulation was performed over the time period of 1983 to the third quarter of 1991. Simulation statistics are presented for the quarterly predictions from Bloc 1 in Tables 1 and 2. Table 1 provides the mean absolute percentage error and root mean percentage error for each endogenous variable. The Theil U statistics are presented in Table 2. Graphical presentation of predicted versus actual values of the key variables are provided following the presentation of the fit statistics.

Table 1. Mean-Absolute-Percent-Error and Root-Mean-Percent-Error for Bloc 1
Endogenous Variables , 1983:1 to 1991:3.

Variable	Mean Abs % Error	RMS Percent Error
NQAU	17.77	36.35
NPAU	8.15	10.96
NP AE	8.82	10.69
NQAJ	25.49	34.30
NPAJ	9.74	11.92
UPHX	18.86	26.30
UPHXJ	21.74	29.67
NQAE	3.04	3.90
UPHXE	16.69	22.15
UHSUP	10.65	17.57
UHINV	24.51	29.63
UQH XJ	30.81	45.02
UQH X	20.90	29.72
UQH XE	36.81	51.22
JINVZ	22.76	30.89
UPLXE	16.60	21.44
UQLXE	44.88	62.72
UQLXJ	27.80	37.07
UPLXJ	11.27	13.88
JINVT	18.39	24.07
UPLX	14.29	17.68
ULSUP	8.93	12.92
ULINV	19.40	23.67
APHXA	19.77	24.20
UQLXAC	24.03	31.83
UPLXC	20.90	25.87
ULINVC	33.78	47.82
ULSUPC	11.84	15.22
NAPHEX	14.01	18.13
NAPLEX	18.59	24.28

Table 2. Theil U-Statistics for Bloc 1 Endogenous Variables, 1983:1 to 1991:3.

Variable	Corr (R)	Bias (UM)	Reg (UR)	DIST (UD)	Theil U
NQAU	0.975	0.013	0.002	0.965	0.1077
NPAU	0.752	0.015	0.250	0.953	0.1004
NPAE	0.784	0.000	0.197	0.982	0.1026
NQAJ	0.876	0.002	0.058	0.998	0.3484
NPAJ	0.653	0.000	0.267	0.985	0.1130
UPHX	0.637	0.006	0.292	0.973	0.2234
UPHXJ	0.612	0.011	0.318	0.963	0.2486
NQAE	0.999	0.009	0.132	0.847	0.0242
UPHXE	0.626	0.002	0.160	0.997	0.1968
UHSUP	0.999	0.003	0.000	0.997	0.0384
UHINV	0.898	0.000	0.071	0.998	0.2623
UQHXY	0.993	0.001	0.003	0.999	0.0954
UQHX	0.996	0.005	0.001	0.995	0.0734
UQHXE	0.827	0.002	0.282	0.925	0.3910
JINVZ	0.843	0.005	0.079	0.995	0.2106
UPLXE	0.714	0.042	0.211	0.947	0.1915
UQLXE	0.853	0.009	0.040	0.985	0.4123
UQLXJ	0.861	0.003	0.051	0.995	0.2419
UPLXJ	0.836	0.100	0.096	0.898	0.1295
JINVT	0.839	0.005	0.228	0.947	0.2014
UPLX	0.795	0.056	0.231	0.906	0.1550
ULSUP	0.999	0.012	0.011	0.971	0.0340
ULINV	0.919	0.032	0.224	0.881	0.2416
APHXA	0.127	0.025	0.082	0.678	0.2265
UQLXAC	0.908	0.004	0.002	0.964	0.1976
UPLXC	0.628	0.008	0.142	0.988	0.2449
ULINVC	0.898	0.004	0.034	0.828	0.2382
ULSUPC	0.984	0.000	0.014	0.999	0.0911
NAPHEX	0.918	0.007	0.076	0.988	0.1598
NAPLEX	0.871	0.014	0.043	0.943	0.2078

Glossary -- Endogenous Variables (bloc 1 simulation)

NQAU = the quantity of Norwegian farmed Atlantic salmon exported to the U.S., in millions of lbs.

NPAU = the Norwegian price of Norwegian farmed Atlantic salmon exported to the United States, in Norwegian kroner per pound.

NPAE = the Norwegian price of Norwegian farmed Atlantic salmon exported to the EEC, in Norwegian kroner per pound.

NQAJ = the quantity of Norwegian farmed Atlantic salmon exported to Japan, in millions of lbs..

NPAJ = the Norwegian price of Norwegian farmed Atlantic salmon exported to Japan, in Norwegian kroner per pound.

UPHX = the North American weighted average export price of high-valued salmon to Japan and the EEC, in U.S. dollars per pound.

UPHXJ = the North American export price of high-valued salmon to Japan, in U.S. dollars per pound.

NQAE = the quantity of Norwegian farmed Atlantic salmon exported to the EEC, in millions of lbs..
 UPHXE = the North American export price of high-valued salmon to the EEC, in U.S. dollars in millions of lbs..
 UHSUP = the North American total available supply of high-valued salmon, in millions of lbs..
 UHINV = the ending inventory of North American high-valued salmon, in millions of lbs..
 UQHXY = the quantity of Japanese imports of North American high-valued salmon, in millions of lbs..
 UQHX = the total quantity of North American exports of high-valued salmon to the EEC and Japan, in millions of lbs..
 UQHXE = the quantity of EEC imports of North American high-valued salmon in, millions of lbs..
 JINVZ = the ending total inventory of Japanese frozen salmon (less Pink inventories), in millions of lbs..
 UPLXE = the North American export price of low-valued salmon to the EEC in, U.S. dollars per pound.
 UQLXE = the quantity of North American exports of low-valued salmon to the EEC, in millions of lbs..
 UQLXJ = the quantity of Japanese imports of North American low-valued salmon in, millions of lbs..
 UPLXJ = the North American export price of low-valued salmon to Japan, in U.S. dollars per pound.
 JINVT = the ending total inventory of Japanese frozen and salted salmon, in millions of lbs..
 UPLX = the North American weighted average export price of low-valued salmon to Japan and the EEC, in U.S. dollars per pound.
 ULSUP = the North American total available supply of low-valued salmon, in millions of lbs..
 ULINV = the ending inventory of North American low-valued salmon, in millions of lbs..
 APHXA = the export price of high-valued canned salmon exported to Australia and N.Z., in ECUs per pound.
 UQLXAC = the quantity of EEC, New Zealand, and Australia imports of North American low-valued canned salmon, in millions of lbs..
 UPLXC = the weighted average export price of high-valued canned salmon exported to Australia, and N.Z. in U.S. Dollars, in millions of lbs..
 ULINVC = the ending inventory of North American low-valued canned salmon, in millions of lbs..
 ULSUPC = the North American total available supply of low-valued salmon canned salmon, in millions of lbs..
 NAPHEX = the North American exvessel price of high-valued Pacific salmon, in U.S. dollars per pound.
 NAPLEX = the North American exvessel price of low-valued Pacific salmon, in U.S. dollars per pound.

Examination of the goodness of fit statistics indicate that, in spite of the model's large size and complexity, it performed quite well in simulation. The key variables, the exvessel prices NAPLEX and NAPHEX, were accurately estimated, as shown by the various goodness of fit statistics. The mean absolute percentage errors and the root-mean-squared percentage errors were very low for both exvessel prices. The Thiel UD statistic for both exvessel prices approach 1.0, indicating that model error is

nonsystematic. Finally the Theil U statistic are below 1.0 for both variables suggesting that the model accurately tracks changes in the exvessel prices over time.

The model's predictive capability is further demonstrated by comparing predicted versus actual historical values of the variables. A tabular listing of predicted and actual values is provided in Table 3 (an H following the variables name denoted predicted value). Figure 3-10 provide a graphical presentation of actual and predicted values. Due to length consideration, the tabular and graphical presentations are limited to those endogenous variables included in the exvessel price equations.

Table 3. Predicted and Actual Quarterly Historical Prices for North American High-Valued Exvessel Price (NAPHEXH and NAPHEX), North American Low-Valued Exvessel Price (NAPLEXH and NAPLEX), North American Weighted Average High-Valued Export Price (UPHXH and UPHX), North American Weighted Average Low-Valued Export Price (UPLXH and UPLX) for 1983:1 to 1991:3.

TIME	NAPHEXH	NAPHEX	NAPLEXH	NAPLEX	UPHXH	UPHX	UPLXH	UPLX
1983:1	2.23	2.42	0.47	0.41	1.55	1.85	1.39	1.46
1983:2	0.80	0.80	0.31	0.31	1.05	1.60	1.22	1.32
1983:3	0.94	0.78	0.33	0.28	1.28	1.62	0.67	0.99
1983:4	1.05	1.09	0.63	0.68	2.04	1.81	1.26	1.39
1984:1	2.86	2.88	0.48	0.42	2.37	1.67	1.29	1.37
1984:2	1.16	1.00	0.34	0.29	2.06	1.86	1.15	1.25
1984:3	1.19	1.07	0.33	0.30	1.65	1.77	0.75	0.95
1984:4	1.07	1.17	0.67	0.58	2.14	2.42	1.34	1.46
1985:1	2.82	2.47	0.51	0.39	2.35	1.90	1.38	1.43
1985:2	1.08	1.08	0.36	0.32	1.69	2.03	1.26	1.24
1985:3	1.05	1.21	0.23	0.32	1.43	2.00	0.55	0.99
1985:4	1.03	1.20	0.46	0.56	1.84	2.05	0.93	1.22
1986:1	2.73	2.67	0.35	0.22	2.17	2.02	1.07	1.28
1986:2	2.01	1.43	0.25	0.34	3.79	1.95	1.09	1.19
1986:3	1.72	1.38	0.28	0.30	3.37	2.45	1.45	1.06
1986:4	1.17	1.10	0.53	0.53	2.58	2.47	1.63	1.33
1987:1	2.42	2.88	0.41	0.46	1.96	2.38	1.42	1.28
1987:2	1.53	1.77	0.33	0.42	2.48	3.08	1.46	1.36
1987:3	1.71	1.60	0.65	0.47	2.52	2.72	1.73	1.31
1987:4	1.67	1.90	1.02	1.19	3.31	3.32	2.00	1.96
1988:1	4.19	3.20	0.76	0.60	3.37	3.22	1.99	2.17
1988:2	2.04	2.29	0.42	0.76	3.61	3.48	1.59	1.96
1988:3	2.18	2.48	0.63	0.85	3.59	3.63	2.01	1.80
1988:4	1.41	1.76	0.86	1.01	3.10	4.09	1.85	2.24
1989:1	2.91	2.90	0.61	0.61	2.49	3.03	1.59	1.83
1989:2	1.27	1.53	0.38	0.37	2.29	3.00	1.44	1.56
1989:3	1.37	1.51	0.35	0.43	2.74	2.68	1.01	1.17
1989:4	1.36	1.05	0.76	0.75	3.08	2.68	1.45	1.44
1990:1	2.82	2.83	0.55	0.57	2.42	2.38	1.39	1.40
1990:2	1.53	1.52	0.37	0.45	3.13	2.55	1.49	1.27
1990:3	1.18	1.33	0.48	0.37	2.70	2.51	1.61	1.28
1990:4	1.67	1.39	0.84	0.71	2.66	2.55	1.76	1.55
1991:1	2.33	2.75	0.41	0.37	1.91	2.28	1.34	1.57
1991:2	1.51	1.00	0.26	0.24	2.97	2.20	1.31	1.45
1991:3	1.20	0.93	0.21	0.19	2.96	1.86	0.76	0.96

Table 4. Predicted and Actual Quarterly Historical Prices for North American Import Price of Norwegian Farmed Atlantic salmon (NPAUH and NPAU), Total Available Supply of North American High-Valued Salmon (UHTSUPH and UHTSUP), North American Weighted Average Low-Valued Canned Salmon Export Price (UPLXCH and UPLXC), Total Available Supply of North American Low-Valued Salmon (ULSUPH and ULSUP) for 1983:1 to 1991:3.

TIME	NPAUH	NPAU	ULSUPH	ULSUP	UPLXCH	UPLXC	ULSUPH	ULSUP
1983:1	22.1	22.5	50.8	50.8	2.41	1.65	35.1	35.1
1983:2	18.7	21.2	112.1	118.0	1.46	1.71	31.5	33.9
1983:3	20.3	21.5	351.7	348.4	1.90	1.57	371.9	371.6
1983:4	22.9	22.1	52.2	40.3	1.99	1.80	69.4	48.0
1984:1	24.5	21.6	22.9	18.6	2.57	2.05	37.2	34.9
1984:2	23.8	22.5	85.3	83.3	1.77	1.61	32.6	28.9
1984:3	25.4	23.9	294.5	292.6	2.04	2.00	413.2	410.9
1984:4	25.9	25.5	50.6	49.5	2.16	1.79	75.2	63.4
1985:1	28.6	26.3	25.2	30.6	2.69	1.75	39.4	34.7
1985:2	26.5	28.0	88.6	95.0	1.83	1.56	28.0	28.9
1985:3	24.4	25.3	349.5	349.1	1.68	1.91	508.5	510.4
1985:4	23.6	25.4	58.2	72.1	1.60	1.46	130.0	113.4
1986:1	22.1	23.5	28.5	48.1	1.83	1.43	65.6	66.9
1986:2	25.9	20.5	48.8	56.5	0.84	1.33	42.2	44.4
1986:3	25.1	18.4	366.0	370.6	1.12	1.36	446.4	452.0
1986:4	20.6	20.1	59.1	68.3	1.18	1.52	79.8	96.0
1987:1	18.6	20.8	39.6	29.6	1.98	1.90	44.7	51.2
1987:2	24.7	24.6	73.2	68.7	1.46	1.93	33.2	34.3
1987:3	25.8	25.9	318.9	317.8	2.75	1.67	299.6	298.1
1987:4	23.1	25.5	38.8	44.1	2.86	2.66	48.9	56.9
1988:1	23.1	23.5	15.2	17.7	3.45	2.76	22.3	24.2
1988:2	22.8	22.9	59.2	58.7	2.16	2.57	36.6	35.8
1988:3	23.9	24.6	281.5	282.1	2.89	4.00	370.3	368.7
1988:4	18.9	21.6	49.5	51.5	2.68	3.75	93.0	109.9
1989:1	18.1	19.2	31.5	35.4	3.21	3.18	49.0	54.0
1989:2	19.2	18.9	86.9	87.5	1.95	2.99	42.7	45.0
1989:3	18.9	17.6	382.9	384.8	2.29	2.61	445.9	449.3
1989:4	18.2	16.3	58.6	59.3	2.50	2.71	78.1	72.3
1990:1	16.6	17.5	33.3	33.9	3.01	2.74	45.5	39.5
1990:2	16.5	18.2	63.9	65.9	1.78	2.33	39.1	35.3
1990:3	15.3	18.4	460.4	460.8	2.47	2.04	392.1	391.9
1990:4	22.0	19.4	67.7	49.5	2.56	2.24	70.5	63.6
1991:1	21.8	19.6	41.9	26.4	3.09	2.00	41.3	33.2
1991:2	27.4	23.8	66.0	59.9	1.82	1.82	35.1	28.0
1991:3	22.2	21.3	376.4	377.3	2.08	1.93	482.9	483.3

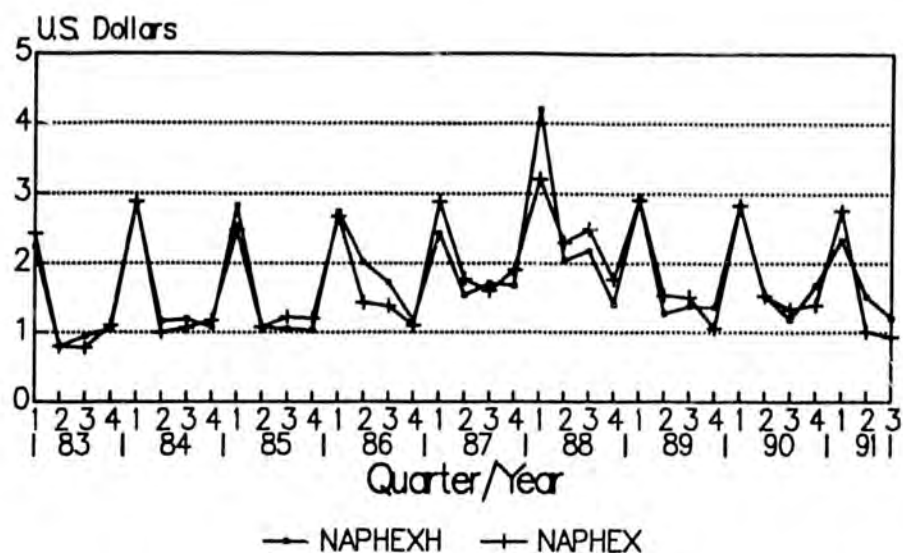


FIGURE 3. Predicted (NAPHEXH) vs. Actual (NAPHEX) North American High-Valued Salmon Exvessel Price (83:1 to 91:3)

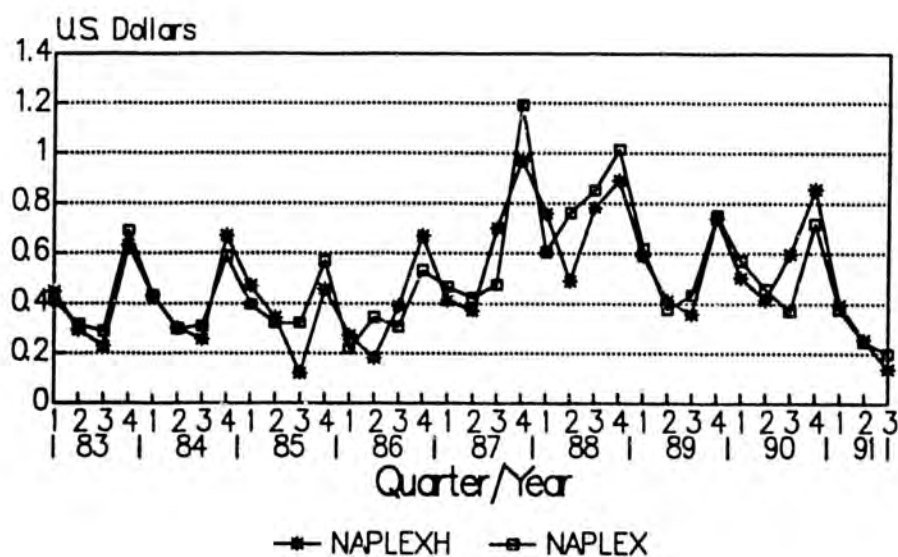


FIGURE 4. Predicted (NAPLEXH) vs. Actual (NAPLEX) North American Low-Valued Salmon Exvessel Price (83:1 to 91:3)

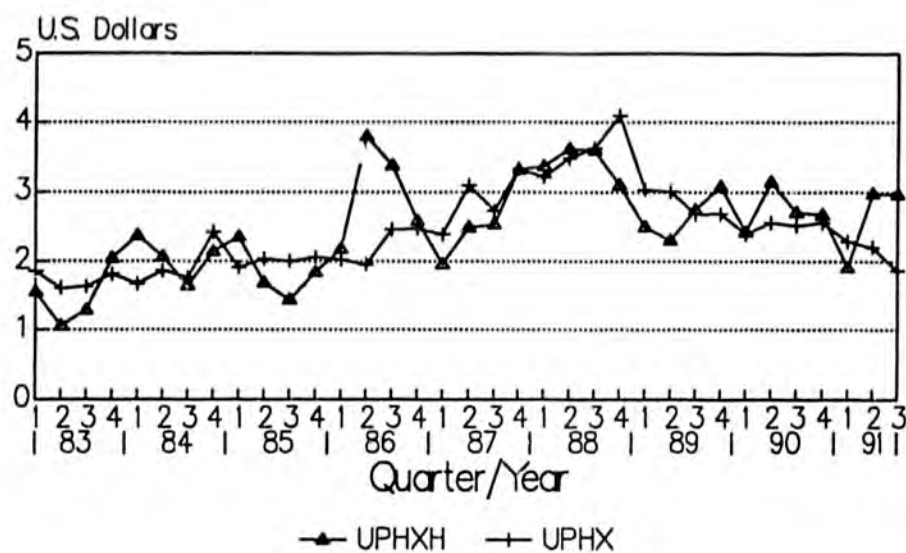


FIGURE 5. Predicted (UPHXH) vs. Actual (UPHX) North American Weighted Average Export Price (83:1 to 91:3)

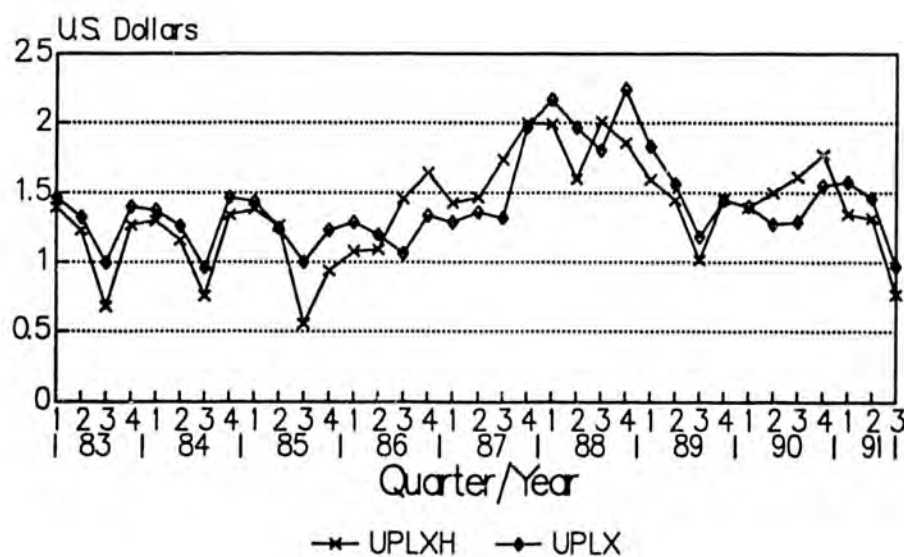


FIGURE 6. Predicted (UPLXH) vs. Actual (UPLX) North American Weighted Average Export Price (83:1 to 91:3)

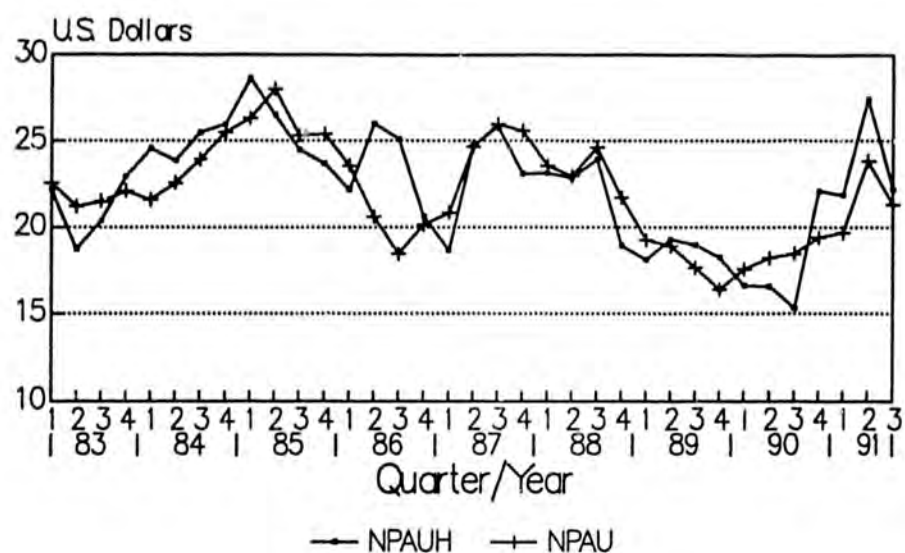


FIGURE 7. Predicted (UPAUH) vs. Actual (UPAU) North American Import Price of Norwegian Farmed Atlantic Salmon (83:1 to 91:3)

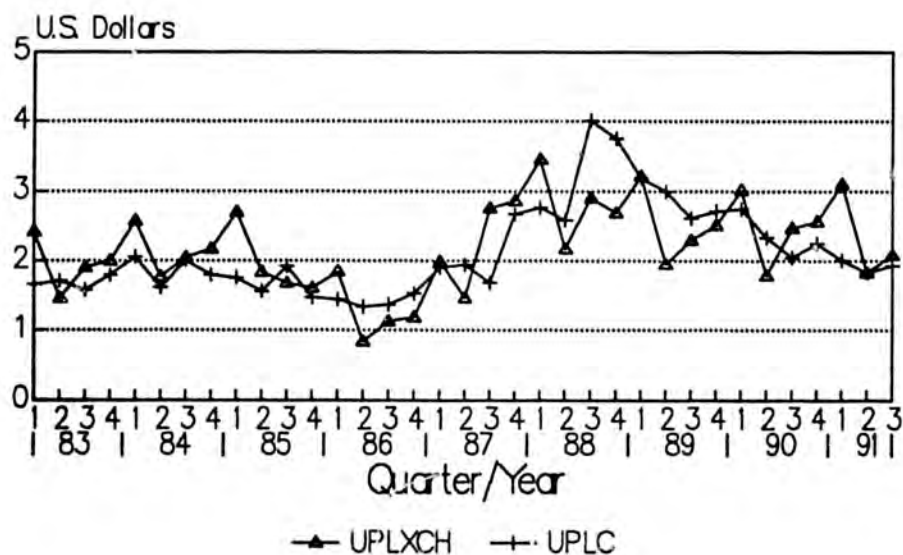


FIGURE 8. Predicted (UPLXCH) vs. Actual (UPLXC) North American Weighted Average Low-Valued Canned Salmon Price (83:1 to 91:3)

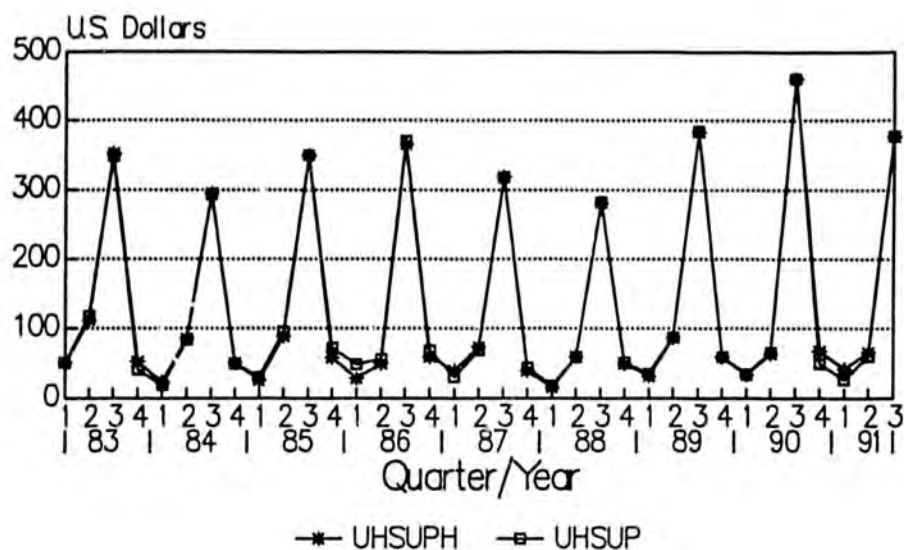


FIGURE 9. Predicted (NHSUPH) vs. Actual (NHSUP) North American Beginning Available Supplies of High-Valued Salmon(83:1 to 91:3)

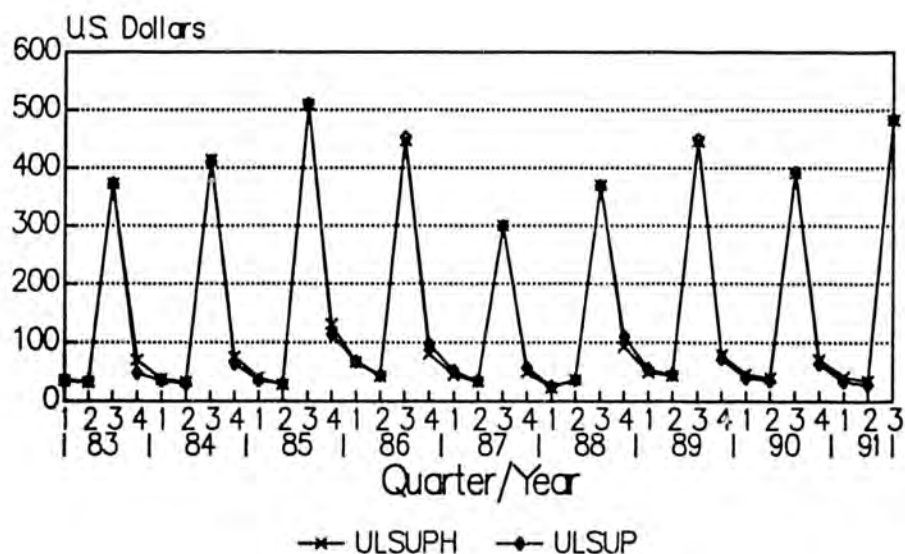


FIGURE 10. Predicted (NLSUPH) vs. Actual (NLSUP) North American Beginning Available Supplies of Low-Valued Salmon (83:1 to 91:3)

The reported prices and quantities tracked pretty well. Examination of Table 3 and figure 3 show an overprediction of the high-valued exvessel price in 1991 partly due to an over prediction for UPHX. It will be easier to examine the exvessel prices as we switch to annual data.

Annual Data

Only annual Alaska regional salmon exvessel prices are reported by CFEC. Thus, linking the quarterly predicted NAPHEX and NAPLEX to the appropriate regional exvessel prices required converting the quarterly predictions to annual predictions. This was accomplished by weighting the predicted quarterly exvessel prices by the associated harvest levels.

The goodness of fit statistics for the converted annual predictions of NAPLEX and NAPHEX are presented in Table 5.

Table 5. Goodness of Fit Statistics for the Low-Valued Annual Exvessel Prices (NAPLEX) and the High-Valued Annual Exvessel Prices (NAPHEX) for 1983 to 1991.

Mean Variable		Abs % Error		RMS % Error	
NAPLEX		28.43		32.37	
NAPHEX		14.67		16.93	
Variable	Corr (R)	Bias (UM)	Reg (UR)	Dist (UD)	Theil U
NAPLEX	0.830	0.001	0.333	0.666	0.2763
NAPHEX	0.895	0.017	0.046	0.937	0.1460

The model performed fairly good as indicated by the goodness of fit statistics. The modelling of the high-valued exvessel price equation performed better than the low-valued exvessel price equation. In order to further illustrate the models historical predictive power the predicted versus actual NAPHEX and NAPLEX are provided in Table 6 and Figures 11-12.

Table 6. Actual and Predicted Historical Prices for North American High-Valued Exvessel Price (NAPHEX and NAPHEXH), and North American Low-Valued Exvessel Price (NAPLEX and NAPLEXH), 1983 to 1991.

YR	NAPLEX	NAPLEXH	NAPHEX	NAPHEXH
83	0.297	0.241	0.790	0.916
84	0.318	0.273	1.061	1.192
85	0.342	0.152	1.193	1.058
86	0.325	0.406	1.378	1.732
87	0.526	0.705	1.641	1.685
88	0.867	0.779	2.435	2.138
89	0.442	0.373	1.510	1.360
90	0.398	0.608	1.355	1.225
91	0.201	0.141	0.941	1.244

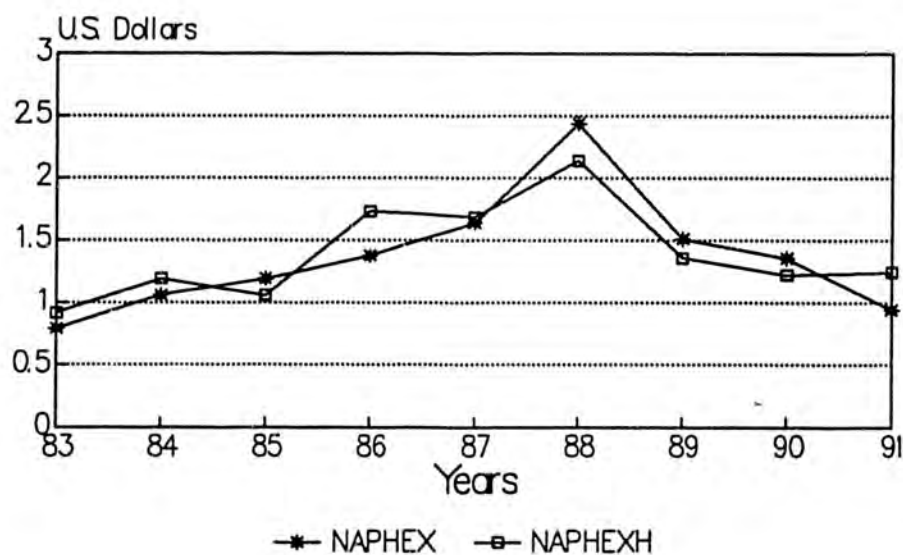


FIGURE 11. Actual (NAPHEX) vs. Predicted (NAPHEXH) Annual North American High-Valued Salmon Exvessel Price (1983 to 1991)

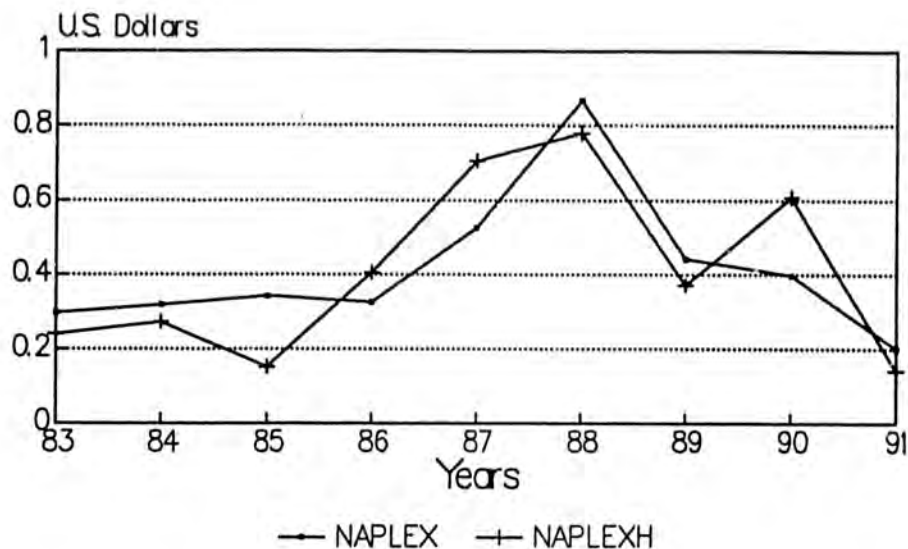


FIGURE 12. Actual (NAPLEX) vs. Predicted (NAPLEXH) Annual North American Low-Valued Salmon Exvessel Price (1983 to 1991)

Bloc 2 Estimates

The estimated exvessel prices for high- and low-valued salmon (NAPHEXH and NAPLEXH, respectively) will be utilized to derive the exvessel prices for the five salmon species harvested in the various regions. This derivation is based on the premise that there is a strong relationship, or equivalently, strong correlation, between NAPLEX and the various regional sockeye, chinook, and coho exvessel prices, as well as NAPLEX and the various regional pink and chum exvessel prices.

Correlation refers to the degree of the relationship which exists between various variables. Two variables are said to be positively correlated if the variables increase or decrease together. An example of two positively correlated variables is presented in figure 13. This figure presents pairs of annual exvessel prices for Cook Inlet sockeye salmon purse seine fishery (CIRPS) and NAPLEX. Diagrams of this type are referred to as scatter diagrams, showing the scatter of various data points.

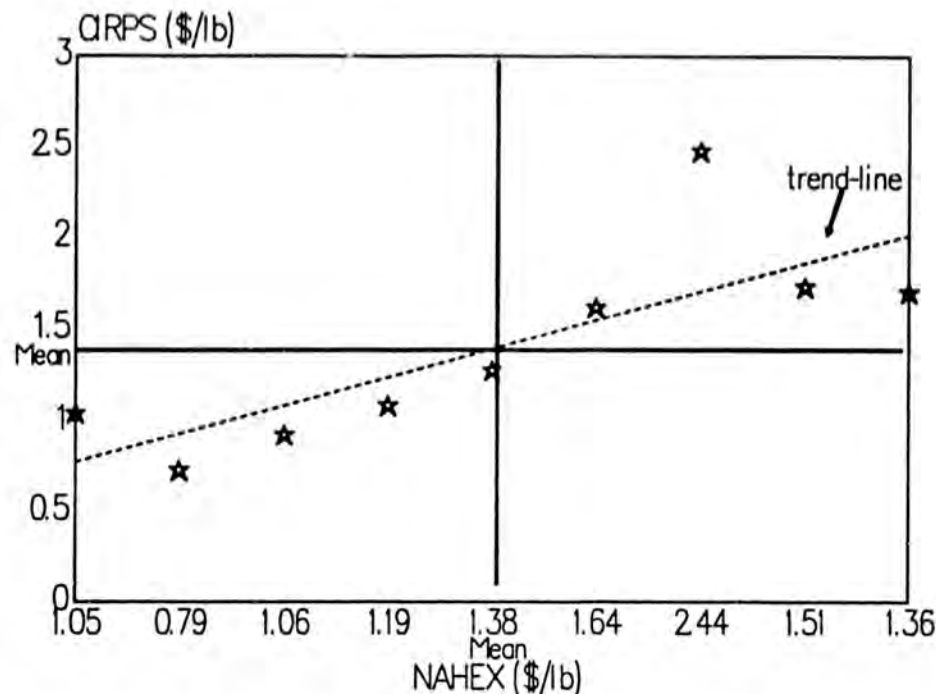


Figure 13. A Scatter Diagram Showing the Correlation Between Annual Cook Inlet Sockeye Salmon Purse Seine Fishery (CIRPS) and Weighted Average North American Exvessel Price of Sockeye, Chinook, and Coho (NAPHEX) from 1982 to 1990.

Examination of Figure 13 reveals that high (low) values of CIRPS are accompanied by high (low) values of NAPHEX. The degree of the relationship between the two variables is indicated by how closely the points are clustered around the linear trend line included in the figure. If all points lie directly on the trend line the two variables would be perfectly correlated. In this case the points, with few exceptions, are tightly clustered around the trend line, indicating that there is a strong degree of correlation between the two variables.

An example of a weaker correlation between two variables is shown in Figure 14. This figure provides a scatter diagram of exvessel price for the Cook Inlet chinook salmon purse seine fishery (CIKPS) and NAPHEX. Inspection of the figure reveals that the scatter of data points are dispersed widely around the positively sloped linear trend line. This indicates, that while the two variables are positively correlated, the relationship is relatively weak (a more detailed discussion of the relationship between salmon exvessel prices and NAPHEX is provided later in this section).

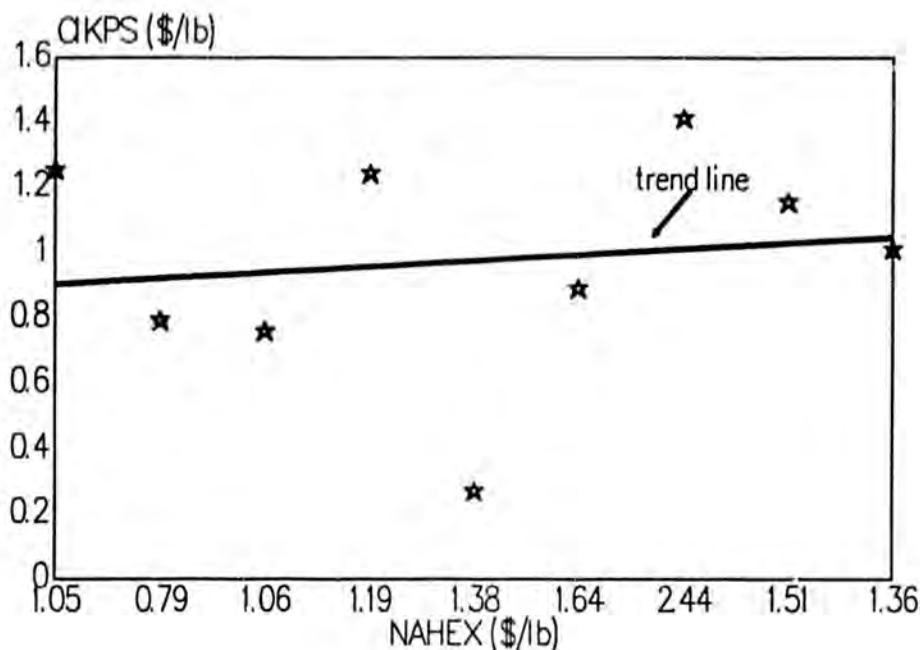


Figure 14. A Scatter Diagram Showing the Correlation Between Annual Cook Inlet Chinook Salmon Purse Seine Fishery (CIKPS) and Weighted Average North American Exvessel Price of Sockeye, Chinook, and Coho (NAPHEX) from 1982 to 1990.

Table 7 provides the means and standard deviations of the various exvessel prices. This is followed in Table 8-12 of the correlation coefficients between the various regional exvessel prices and the appropriate North American exvessel price. A glossary of the variable definitions are provided in Tables 13 and 14.

For example, Table 8 provides the exvessel price correlation coefficients associated with the sockeye salmon fisheries. The first row of Table 8 provides the correlation coefficients between the regional exvessel sockeye prices and NAPHEX. The first entry in this row is the correlation coefficient for NAPHEX and the Prince William Sound sockeye purse seine fishery (PWRPS). The value of 0.96 indicates that there is a strong positive correlation between the two exvessel prices. The correlation coefficient which corresponds to the relationship between CIRDG and NAPHEX that is represented in Figure 13, is given by the fourth entry of column one. The coefficient of 0.96, confirms that the two variables have a high positive correlation.

The remaining rows in Table 8 provide the interregional sockeye salmon exvessel price coefficients. For example, the eighth entry of the first column, 0.97, provides the correlation coefficient for the Prince William Sound sockeye purse seine (PWRPS) and Southeast sockeye hand troll (SERHT) fisheries.

In general, the exvessel price correlation coefficients for the sockeye salmon fisheries are quite high. This indicates, that as expected, a strong degree of correlation between

exvessel prices exists across the various sockeye salmon fisheries. In addition, the sockeye salmon exvessel prices are strongly correlated with the aggregate North America high value exvessel price (NAPHEX).

The correlation coefficients range from a low of 0.91, for the Prince William Sound drift gill net (PWRDG) and the Juneau power troll (JURPT) fisheries, to a high of 0.99 for the Cook Inlet sockeye purse seine (CIRPS) and Cook Inlet sockeye drift gill net (CIRDG) fisheries. In part, this strong relationship is due to sockeye salmon having the highest annual harvest among the high value species, and therefore having the greatest weight in deriving the aggregate North America high exvessel price.

The correlation coefficients for the various coho salmon fisheries are provided in Table 9. Correlation coefficients are provided for each pair of fisheries and for each fishery and NAPHEX. The correlation coefficients, while in general lower than those for the respective sockeye salmon exvessel prices, still indicate that the exvessel prices across the various coho salmon fisheries are highly correlated with each other and the aggregate exvessel price NAPHEX. The exvessel price correlation coefficients for coho salmon range from a low of 0.80 for Prince William Sound coho purse seine fishery (PWSPS) and NAPHEX, to a high of 0.98 for Juneau coho power troll (JUSPT) and Prince William Sound coho purse seine (PWSPS) fisheries.

Among the high-valued salmon species, the chinook salmon exvessel prices displayed the weakest relationship (see Table 10) with each other and with NAPHEX. The exvessel price correlation coefficients range from a low of 0.14 for the Prince William Sound chinook purse seine (PWKPS) and Kodiak chinook purse seine (KOKPS) fisheries, to a high value of 0.95 for the Juneau chinook power troll (JUKPT) and hand troll (JUKHT) fisheries.

In part, low correlations associated with several of the chinook salmon fisheries is attributable to chinook salmon not being the targeted species in several regions. This results in low harvests, and subsequently the reported exvessel prices can easily be distorted by the activities of a single, or few, fishery participants. An example of this relates to the low correlation coefficient between CIKPS and PWKPS. Recall, CIKPS was one of the two exvessel prices included in Figure 14. Inspection of the figure shows that this fishery reported a exvessel price low for the data period of \$0.27. This price corresponded to the 1986 fishery. In this same year, all other chinook salmon fisheries received substantially higher exvessel prices. For example, the 1986 exvessel prices in Prince William Sound purse seine and drift gill net fisheries were \$0.877 and \$1.463, respectively. The low exvessel price in this Cook Inlet fishery is apparently a direct consequence of the extremely low, 619 pound harvest. Similarly, the 1985 Prince William Sound purse seine fishery reported exvessel price of \$0.249 was substantially below all other 1985 reported chinook salmon exvessel prices. Again, the low exvessel price corresponded to a low fishery harvest; the reported 1985 harvest was only 11,000 pounds.

The exvessel price correlation coefficients for pink salmon and the aggregate North America low exvessel price (NAPLEX) is reported in Table 11. Correlation coefficients report the degree of correlation between the various pink salmon fisheries, and the pink salmon fisheries and NAPLEX. The reported statistics indicate that the various regional exvessel prices are highly correlated with both each other and NAPLEX. The correlation coefficients range from a low of 0.88 for the Cook Inlet pink drift gill fishery (CIPDG) and NAPLEX, to a high of 0.99 for the Prince William Sound pink purse seine (PWPPS) and the Kodiak pink Set gill net (KKPSG) fisheries. In general, the correlation coefficients are greater than 0.90.

Table 12 presents the correlations coefficients measure the degree correlation between the various chum fisheries and NAPLEX. In general, the correlation coefficients indicate that exvessel prices for the various regions, and between the regions and NAPLEX have a high degree of correlation. The low correlation coefficient of 0.84 is reported for the Prince William Sound chum drift gill (PWCDG) and Juneau chum power troll (JUCPT) fisheries. The high correlation coefficient, 0.99, is reported for the Kodiak chum purse seine (KKCPS) and Kodiak chum set gill net (KKCSG) fisheries. The vast majority of the correlation coefficients exceed 0.90.

In summary, correlation coefficients for each species of salmon across all the relevant fisheries were reported in this section. The correlation coefficients measure the degree of correlation between the various exvessel prices within a given species. The reported statistics indicate that in general, within a given species, exvessel prices are highly correlated across all fisheries, and between the fisheries and the relevant aggregate North American exvessel price (either NAPHEX for high valued species, or NAPLEX for low valued species). This provides confidence that the exvessel prices for the various regions can be estimated on the basis of the historical relationship between each of the respective fishery exvessel prices and the appropriate North American exvessel price.

One area of concern is that several of the exvessel prices for the chinook salmon fisheries were weakly correlated with the aggregate North America high exvessel price. This problem was partially attributed to low harvests for specific fisheries within given years.

Table 7. Mean and Standard Deviation for Alaskan Salmon Exvessel Prices.

Variable	Mean	SD
PWKPS	1.22	0.59
PWKDG	1.90	0.68
CIKPS	0.98	0.34
CIKDG	1.23	0.20
KKKPS	1.12	0.21
KKKSG	1.11	0.25
SEKPT	2.51	0.60
SEKPT	2.56	0.61
PWRPS	1.44	0.54
PWRDG	1.71	0.72
CIRPS	1.39	0.53
CIRDG	1.44	0.53
KKRPS	1.45	0.56
KKRSG	1.46	0.56
SERHT	1.74	0.78
SERPT	1.75	0.77
PWSPS	0.79	0.40
PWSDG	0.99	0.40
CISPS	0.73	0.38
CISDG	0.75	0.25
KKSPS	0.82	0.20
KKSSG	0.70	0.26
SESH	1.54	0.69
SESPT	1.53	0.69
PWPPS	0.35	0.20
PWPDG	0.34	0.19
CIPPS	0.32	0.19
CIPDG	0.26	0.11
KKPPS	0.36	0.20
KKPSG	0.33	0.19
SEPHT	0.43	0.17
SEPPT	0.43	0.18
PWCPS	0.47	0.25
PWCDG	0.50	0.25
CICPS	0.41	0.197
CICDG	0.47	0.155
KKCPS	0.46	0.258
KKCSG	0.45	0.274
SECHT	0.79	0.361
SECPT	0.77	0.366

Table 8. Correlations Coefficients for Alaskan Sockeye Salmon Exvessel Prices.

SOCKEYE

	PWRPS	PWRDG	CIRPS	CIRDG	KKRPS	KKRSG	SERHT	SERPT
NAPHEX	0.96	0.92	0.96	0.96	0.98	0.98	0.98	0.98
PWRPS	1.00	0.93	0.97	0.97	0.96	0.96	0.97	0.97
PWRDG	0.93	1.00	0.97	0.96	0.95	0.97	0.92	0.91
CIRPS	0.97	0.97	1.00	0.99	0.95	0.98	0.95	0.95
CIRDG	0.97	0.96	0.99	1.00	0.96	0.98	0.96	0.96
KKRPS	0.96	0.95	0.95	0.96	1.00	0.98	0.98	0.97
KKRSG	0.96	0.97	0.98	0.98	0.98	1.00	0.97	0.97
SERHT	0.97	0.92	0.95	0.96	0.98	0.97	1.00	0.99
SERPT	0.97	0.91	0.95	0.96	0.97	0.97	0.99	1.00

Table 9. Correlations Coefficients for Alaskan Coho Salmon Exvessel Prices.

COHO

	PWSPS	PWSDG	CISPS	CISDG	KKSPS	KKSSG	SESHT	SESPT
NAPHEX	0.80	0.84	0.85	0.92	0.87	0.81	0.89	0.89
PWSPS	1.00	0.94	0.91	0.92	0.84	0.83	0.93	0.93
PWSDG	0.94	1.00	0.92	0.94	0.87	0.93	0.97	0.97
CISPS	0.91	0.92	1.00	0.89	0.85	0.84	0.96	0.95
CISDG	0.92	0.94	0.89	1.00	0.94	0.86	0.96	0.96
KKSPS	0.84	0.87	0.85	0.94	1.00	0.85	0.90	0.91
KKSSG	0.83	0.93	0.84	0.86	0.86	1.00	0.92	0.92
SESHT	0.93	0.97	0.96	0.96	0.90	0.92	1.00	0.99
SESPT	0.93	0.97	0.95	0.96	0.91	0.92	0.99	1.00

Table 10. Correlations Coefficients for Alaskan Chinook Salmon Exvessel Prices.

CHINOOK

	PWKPS	PWKDG	CIKPS	CIKDG	KKKPS	KKKSG	SEKHT	SEKPT
NAPHEX	0.74	0.94	0.93	0.37	0.87	0.72	0.82	0.74
PWKPS	1.00	0.73	0.39	0.70	0.14	0.41	0.73	0.75
PWKDG	0.73	1.00	0.53	0.89	0.66	0.75	0.77	0.68
CIKPS	0.39	0.53	1.00	0.73	0.48	0.43	0.50	0.59
CIKDG	0.70	0.89	0.73	1.00	0.69	0.82	0.81	0.82
KKKPS	0.14	0.66	0.48	0.69	1.00	0.81	0.65	0.56
KKKSG	0.41	0.75	0.43	0.82	0.81	1.00	0.73	0.72
SEKHT	0.73	0.77	0.50	0.81	0.65	0.73	1.00	0.95
SEKPT	0.75	0.68	0.59	0.82	0.56	0.72	0.95	1.00

Table 11. Correlations Coefficients for Alaskan Pink Salmon Exvessel Prices.

PINK

	PWPPS	PWPDG	CIPPS	CIPDG	KKPPS	KKPSG	SEPHT	SEPPT
NAPLEX	0.98	0.98	0.96	0.87	0.93	0.98	0.95	0.94
PWPPS	1.00	0.99	0.99	0.92	0.96	0.99	0.96	0.96
PWPDG	0.99	1.00	0.98	0.93	0.96	0.99	0.97	0.97
CIPPS	0.99	0.98	1.00	0.92	0.97	0.98	0.93	0.93
CIPDG	0.92	0.93	0.92	1.00	0.95	0.92	0.92	0.92
KKPPS	0.96	0.96	0.97	0.95	1.00	0.95	0.90	0.90
KKPSG	0.99	0.99	0.98	0.92	0.95	1.00	0.96	0.95
SEPHT	0.96	0.97	0.93	0.92	0.90	0.96	1.00	0.99
SEPPT	0.96	0.97	0.93	0.92	0.90	0.95	0.99	1.00

Table 12. Correlations Coefficients for Alaskan Chum Salmon Exvessel Prices.

CHUM

	PWCPS	PWCDG	CICPS	CICDG	KKCPS	KKCSG	SECHT	SECPT
NAPLEX	0.89	0.85	0.90	0.85	0.94	0.94	0.93	0.94
PWCPS	1.00	0.98	0.97	0.92	0.94	0.93	0.83	0.84
PWCDG	0.98	1.00	0.93	0.92	0.94	0.93	0.81	0.83
CICPS	0.97	0.93	1.00	0.95	0.95	0.94	0.89	0.87
CICDG	0.92	0.92	0.95	1.00	0.96	0.95	0.92	0.90
KKCPS	0.94	0.94	0.95	0.96	1.00	0.99	0.95	0.96
KKCSG	0.93	0.93	0.94	0.95	0.99	1.00	0.94	0.95
SECHT	0.83	0.81	0.89	0.92	0.95	0.94	1.00	0.99
SECPT	0.84	0.83	0.87	0.90	0.96	0.95	0.99	1.00

Table 13. Glossary -- Bloc 2 Regional Fisheries by Area, Species, and Gear Type

PWKPS, PWKDG - Price William Sound chinook purse seine and drift gill net fishery, respectively
 CIKPS, CIKDG - Cook Inlet chinook purse seine and drift gill net fishery, respectively
 KKKPS, KKCSG - Kodiak chinook purse seine and set net fishery, respectively
 SEKHT, SEKPT - Southeast chinook hand and power troll fishery, respectively
 PWRPS, PWRDG - Price William Sound sockeye purse seine and drift gill net fishery, respectively
 CIRPS, CIRDG - Cook Inlet sockeye purse seine and drift gill net fishery, respectively
 KKRPS, KKRSG - Kodiak sockeye purse seine and set net fishery, respectively
 SERHT, SERPT - Southeast sockeye hand and power troll fishery, respectively
 PWSPS, PWSDG - Price William Sound coho purse seine and drift gill net fishery, respectively
 CISPS, CISDG - Cook Inlet coho purse seine and drift gill net fishery, respectively
 KKSPS, KKSSG - Kodiak coho purse seine and set net fishery, respectively
 SESHT, SESPT - Southeast coho hand and power troll fishery, respectively
 PWPPS, PWPDG - Price William Sound pink purse seine and drift gill net fishery, respectively
 CIPPS, CIPDG - Cook Inlet pink purse seine and drift gill net fishery, respectively
 KKPPS, KKPSG - Kodiak pink purse seine and set net fishery, respectively
 SEPHT, SEPPT - Southeast pink hand and power troll fishery, respectively
 PWCPS, PWCDG - Price William Sound chum purse seine and drift gill net fishery, respectively
 CICPS, CICDG - Cook Inlet chum purse seine and drift gill net fishery, respectively
 KKCPS, KKCSG - Kodiak chum purse seine and set net fishery, respectively
 SECHT, SECPT - Southeast chum hand and power troll fishery, respectively

In order to smooth out some of the outlier problems with the individual regional data and to somewhat simplify the Bloc 2 estimations the prices were aggregated across gear types before correlation with the exvessel prices from bloc 1. Table 14 gives the new glossary for the regional exvessel prices.

Table 14. Glossary -- Bloc 2 Species Aggregated across Gear Types

PWKP PWSP PWRP PWCP PWPP is the exvessel price in the Prince William Sound fishery for chinook, coho, sockeye, chum, and pink salmon respectively.

CIKP CISP CIRP CICP CIPP is the exvessel price in the Cook Inlet fishery for chinook, coho, sockeye, chum, and pink salmon respectively.

KKKP KKSP KKRK KKCP KKPP is the exvessel price in the Kodiak fishery for chinook, coho, sockeye, chum, and pink salmon respectively.

SEKP SESP SERP SECP SEPP is the exvessel price in the Southeast fishery for chinook, coho, sockeye, chum, and pink salmon respectively.

Based on the generally high correlations between each of the high-valued Alaska regional Salmon exvessel prices (chinook, sockeye, and coho) and NAPHEX, and each of low-valued Salmon exvessel prices (pink and chum) and NAPLEX, the regional exvessel prices were estimated in Bloc 2 as a linear function of the appropriate North American exvessel price using ordinary-least-squares regression (OLS). In order to reduce the estimated number of exvessel price equations (and facilitate future simulations of the combined Bloc 1 and Bloc 2 models), one exvessel price per area and species was estimated. Thus, the estimated exvessel price for a given region and species represents a weighted average value of the associated exvessel prices across gear types. Regional exvessel prices for sockeye, coho, chinook, pinks, and chum were estimated for four regions Prince William Sound (PWRP, PWSP, PWKP, PWPP, and PWCP, respectively), Kodiak (KKRP, KKSP, KKKP, KKPP, and KKCP, respectively), and Southeast (SERP, SESP, SEKP, SEPP, and SECP, respectively). In addition, an aggregate all-other exvessel price equation incorporating all-other regions in Alaska was specified for each species, Sockeye, Coho, Chinook, Pink, and Chums (AKORP, AKOSP, AKOKP, AKOPP, and AKOCP, respectively). All equations were estimated for the 1983-91 time period.

In this section, estimation results are presented by species. For each species, the OLS regression results are provided first. This is followed by presentation of ex-post (historical) simulation results. The ex-post simulations provide a more robust evaluation of model performance. The simulations are performed by combining either the estimated NAPHEX (for sockeye, coho, and chinook) or NAPLEX (for pinks and chums), estimated in Bloc 1, with the appropriate Alaska regional price parameters, estimated in Bloc 2, to generate simulation predicted 1983-1991 Alaska regional exvessel prices.

Sockeye Salmon Exvessel Price Equations

The estimation results for the sockeye salmon exvessel price equations are presented in Table 15. The equations performed very well in estimating the Alaska regional and statewide sockeye exvessel prices for the 1983-1991 time period. The R^2 s for the exvessel price equations ranged from 0.80 (PWRP) to 0.96 (SERP). Recall, R^2 represents the proportion of variation in the endogenous variables (regional exvessel prices) explained by variation in the exogenous variables (NAPHEX). For example, the R^2 of 0.89 for CIRP can be interpreted as stating that 89 percent of the variation in CIRP is explained by variation in the exogenous variable, NAPHEX.

Table 15. Estimation and Historical Simulation Result for Prince William Sound, Cook Inlet, Kodiak, Southeast, and Rest-of-Alaska, Sockeye exvessel prices, PWRP, CIRP, KKR, SERP, and AKORP, respectively. For the 1983-91 time period (t-values are presented parenthetically).

Exvessel Price	Constant	NAPHEX* Coefficient	R^2	DW
PWRP	-0.332 (-0.93)	1.435 (5.76)	0.81	1.96
CIRP	-0.099 (-0.54)	1.096 (8.51)	0.90	2.01
KKRP	-0.271 (-1.22)	1.224 (7.94)	0.88	1.66
SERP	-0.369 (-1.75)	1.370 (9.34)	0.92	1.47
AKORP	-0.234 (-1.37)	0.995 (8.34)	0.90	1.83

*NAPHEX is a weighted average exvessel price for North American high-valued Salmon (Sockeye, Coho, and Chinook).

The ex-post simulation goodness-of-fit statistics for the Alaska regional and statewide sockeye salmon exvessel price equations are provided in Table 16. The statistics are indicative of the model performing satisfactorily in predicting the sockeye exvessel prices. The correlation coefficients (r) exceed 0.80, with the exception of PWRP, $r=0.736$ (correlation coefficients measure the degree of linear dependence between the Alaska exvessel prices and the exogenous variables in each of the equations). The UD statistics approach 1.0, indicating that virtually all the forecast error in the various

models are attributable to random disturbances. Finally, the low Theil U statistics are indicative of the models accurately hitting turning points.

Table 16. Ex-post (historical) Simulation Forecast Goodness-of-Fit Statistics for Prince William Sound, Cook Inlet, Kodiak, Southeast, and Rest-of-Alaska, Sockeye Exvessel Prices (PWRP, CIRP, KKR, SERP, and AKORP, respectively), 1983-1991 Time Period.

Exvessel Price	Corr (R)	Bias (UM)	Reg (UR)	Dist (UD)	THEIL U
PWRP	0.730	0.008	0.004	0.989	0.2521
CIRP	0.819	0.000	0.004	0.996	0.1920
KKRP	0.834	0.006	0.004	0.990	0.1969
SERP	0.854	0.000	0.014	0.985	0.1969
AKORP	0.936	0.008	0.132	0.860	0.1372

The predictive ability of the models are further illustrated in Figures 15-19. These figures provide the simulation generated predicted and actual values of PWRP, CIRP, KKR, SERP, and AKORP, respectively. Examination of the figures reveals that the equations accurately track changes in the various sockeye exvessel prices for the 1983-91 time period. The equations did suffer from the common trait of underpredicting the high 1988 exvessel prices, and overpredicting the low 1991 exvessel prices.

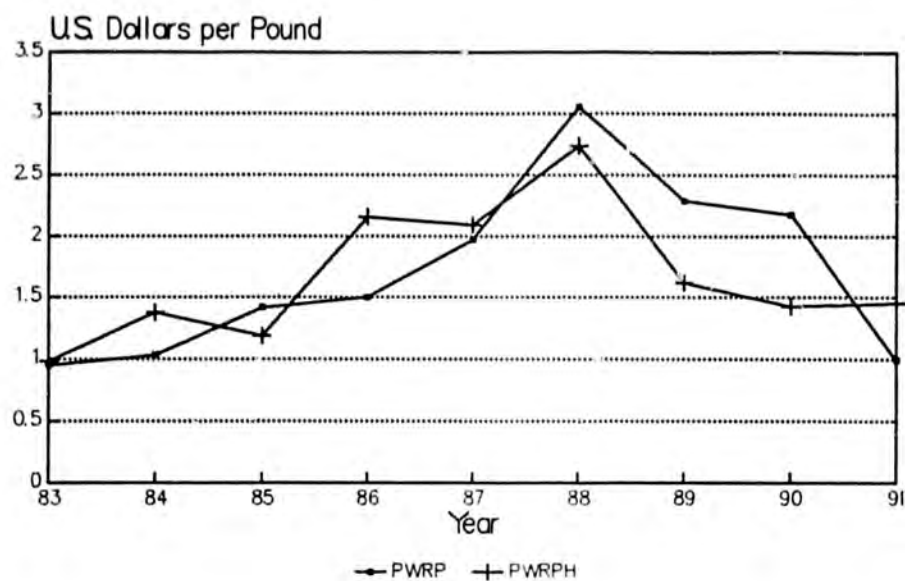


FIGURE 15. Actual (PWRP) versus Predicted (PWRPH) Historical Prince William Sound Sockeye Annual Exvessel Price (1983-1991)

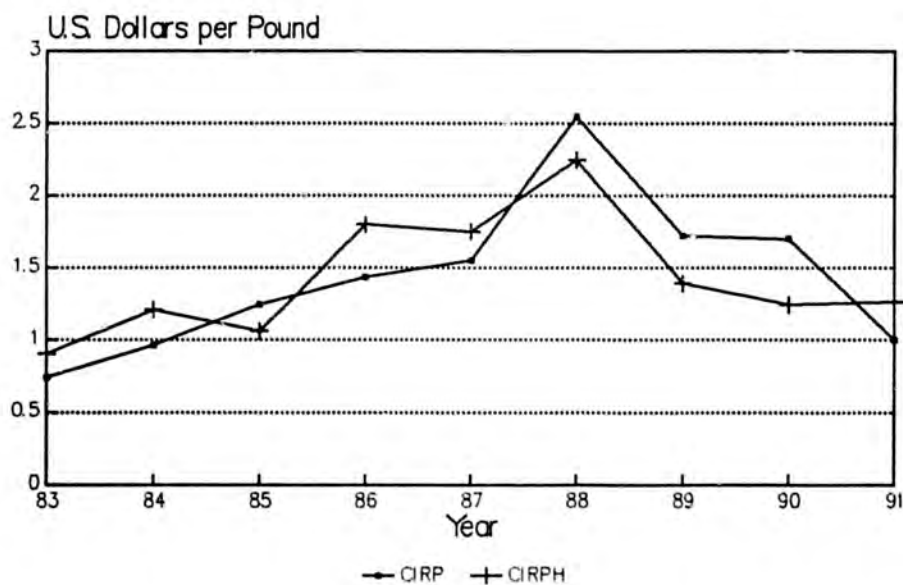


FIGURE 16. Actual (CIRP) versus Predicted (CIRPH) Historical Cook Inlet Sockeye Annual Exvessel Price (1983-1991)

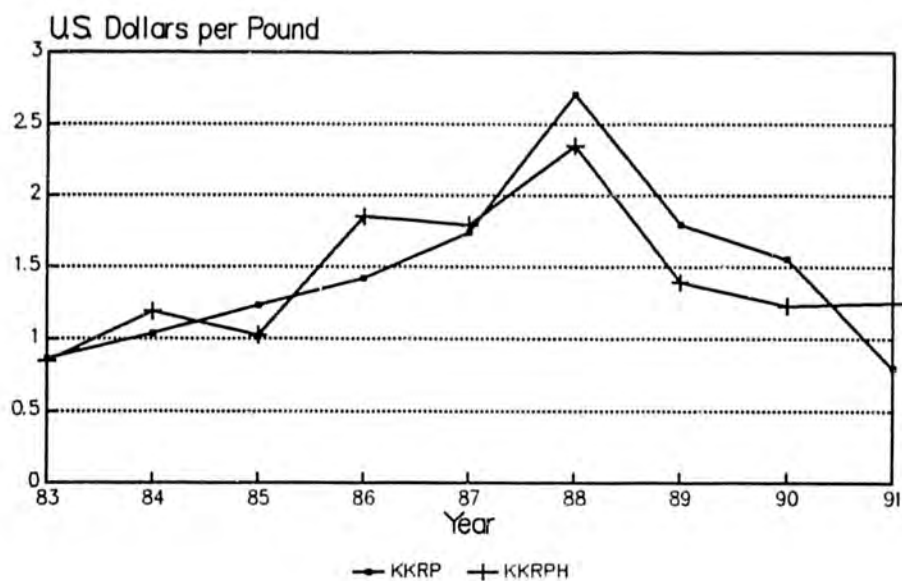


FIGURE 17 Actual (KKRP) versus Predicted (KKRPH) Historical Kodiak Sockeye Annual Exvessel Price (1983-1991)

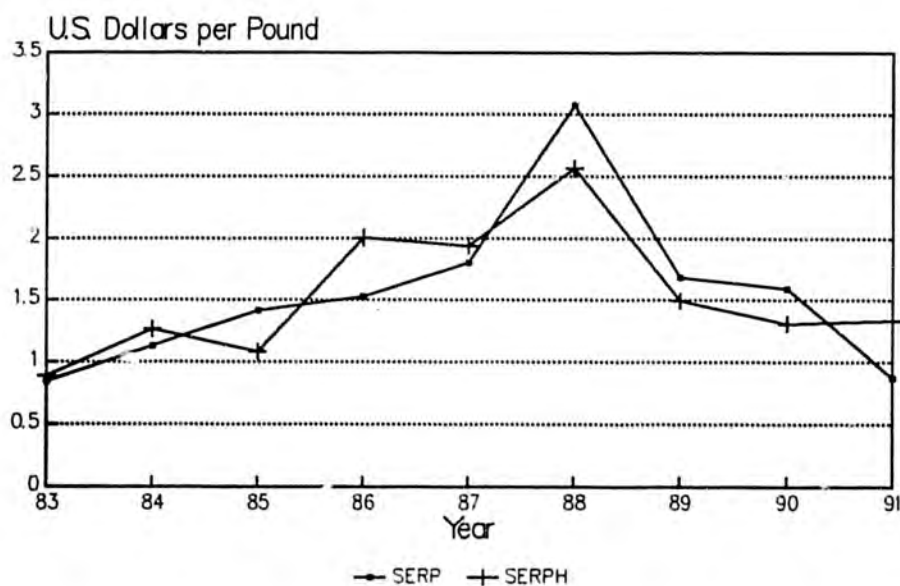


FIGURE 18 Actual (SERP) versus Predicted (SERPH) Historical Southeast Sockeye Annual Exvessel Price (1983-1991)

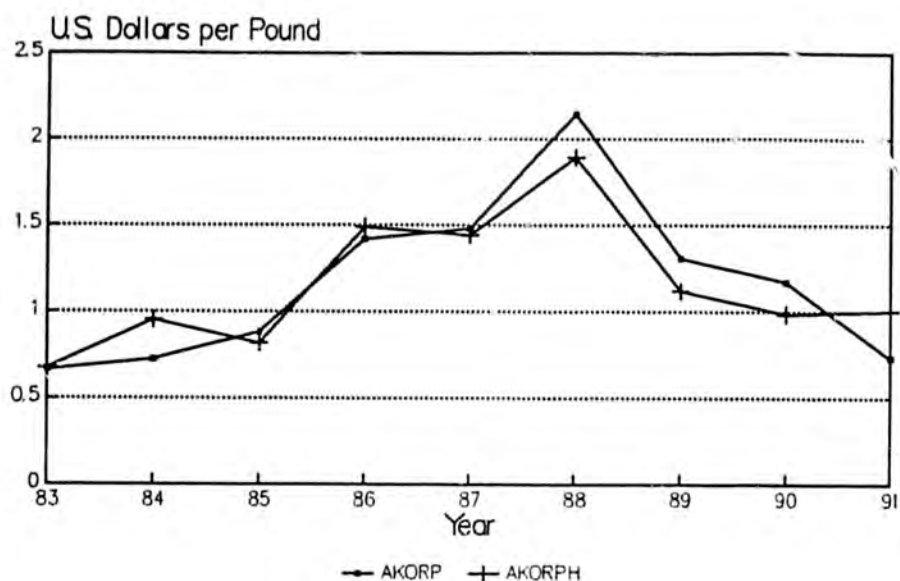


FIGURE 19 Actual (AKORP) versus Predicted (AKORPH) Historical Rest-of-Alaska Sockeye Annual Exvessel Price (1983-1991)

Coho Salmon Exvessel Price Equations

Alaska regional coho exvessel prices, PWSP, CISP, KKSP, SESP, and AKOSP, were estimated as linear functions of NAPHEX. The estimation results are provided in Table 17. The models performed satisfactorily, although not as well as the sockeye salmon exvessel price equations. The R^2 s for the coho exvessel price equations ranged from 0.50 (KKSP) to 0.79 (CISP and AKOSP).

Table 17. Estimation Results for Prince William Sound, Cook Inlet, Kodiak, Southeast and Rest-of-Alaska, Coho Exvessel Prices, PWSP, CISP, KKSP, SESP, and AKOSP, respectively, for the 1983-1991 Time Period (t-values are presented parenthetically).

Exvessel Price	Constant	NAPHEX* Coefficient	R ²	DW
PWSP	-0.035 (-0.14)	0.722 (4.08)	0.68	2.32
CISP	0.025 (0.19)	0.511 (5.46)	0.79	1.80
KKSP	0.186 (0.91)	0.404 (2.85)	0.50	1.54
SESP	-0.190 (-0.64)	1.079 (5.23)	0.77	1.99
AKOSP	-0.025 (0.64)	0.578 (5.52)	0.79	0.74

*NAPHEX is a weighted average exvessel price for North American high-valued Salmon (Sockeye, Coho, and Chinook).

The ex-post simulation goodness-of-fit statistics for the coho exvessel price equations are provided in Table 18. The statistics provide a general indication that the models adequately forecast the historical coho exvessel prices. The correlation coefficients range from 0.657 (KKSP) to 0.837 (AKOSP). All of the UD statistics exceed 0.95, suggesting that model error is attributable to random disturbances. And Theil U statistics are all less than 0.250, indicating that the models are generally accurate in forecasting turning points of the exvessel prices.

Table 18. Ex-post (historical) Simulation Forecast Goodness-of-Fit Statistics for Prince William Sound, Cook Inlet, Kodiak, Southeast, and Rest-of-Alaska, Coho Exvessel Prices (PWSP, CISP, KKSP, SESP, and AKOSP, respectively), 1983-1991 Time Period.

Exvessel Price	Corr (R)	Bias (UM)	Reg (UR)	Dist (UD)	THEIL U
PWSP	0.755	0.000	0.017	0.983	0.2491
CISP	0.786	0.006	0.012	0.982	0.2096
KKSP	0.657	0.005	0.012	0.983	0.2494
SESP	0.809	0.003	0.026	0.971	0.2329
AKOSP	0.837	0.002	0.042	0.956	0.1972

The models predictive ability may also be evaluated by comparing the simulation predicted and actual coho exvessel prices, PWSP, CISP, KKSP, SESP, and AKOSP in Figures 20-24, respectively. As with the sockeye salmon exvessel price equations, the coho exvessel price equations failed to fully capture sharp upward movements in 1988 exvessel prices, and the dramatic downturn in 1991 exvessel prices.

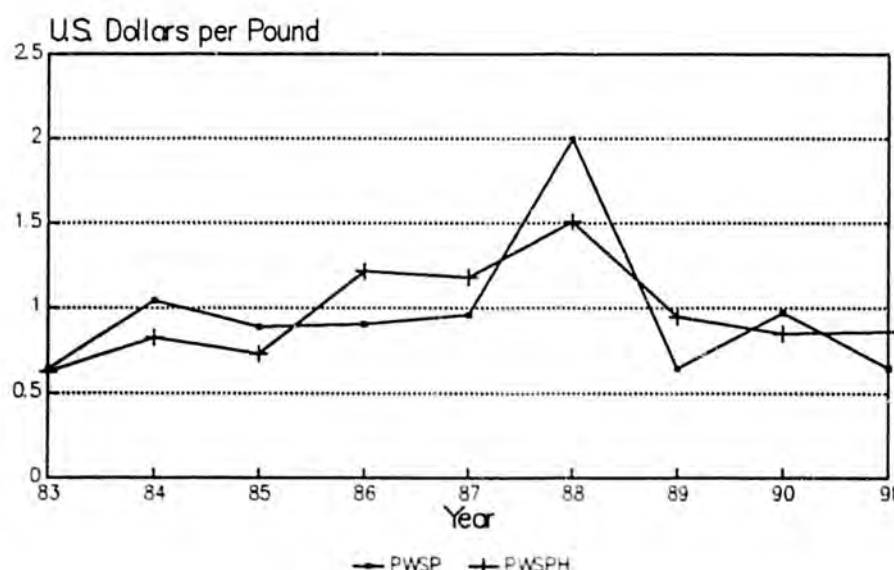


FIGURE 20. Actual (PWSP) versus Predicted (PWSPH) Historical Prince William Sound Coho Annual Exvessel Price (1983-1991)

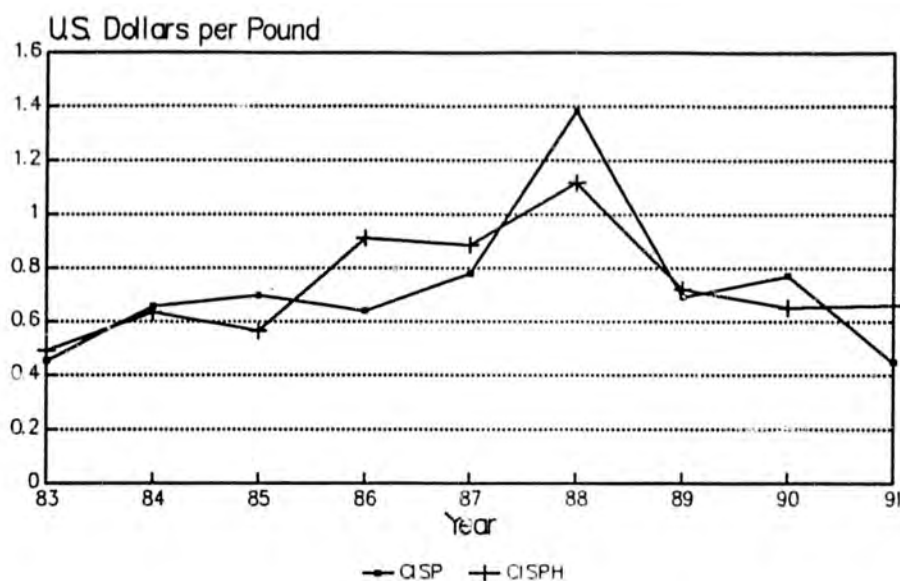


FIGURE 21. Actual (CISP) versus Predicted (CISPH) Historical Cook Inlet Coho Annual Exvessel Price (1983-1991)

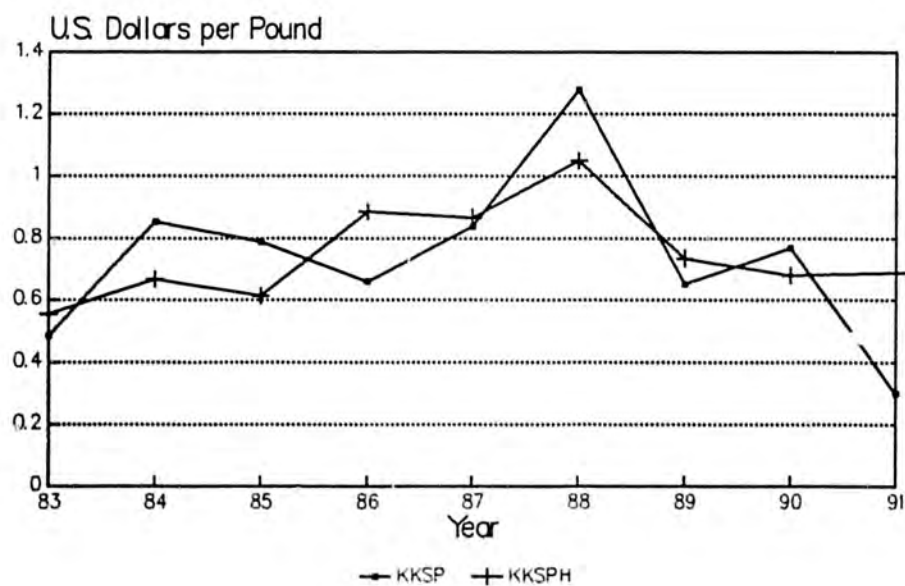


FIGURE 22 Actual (KKSP) versus Predicted (KKSPH) Historical Kodiak Coho Annual Exvessel Price (1983-1991)

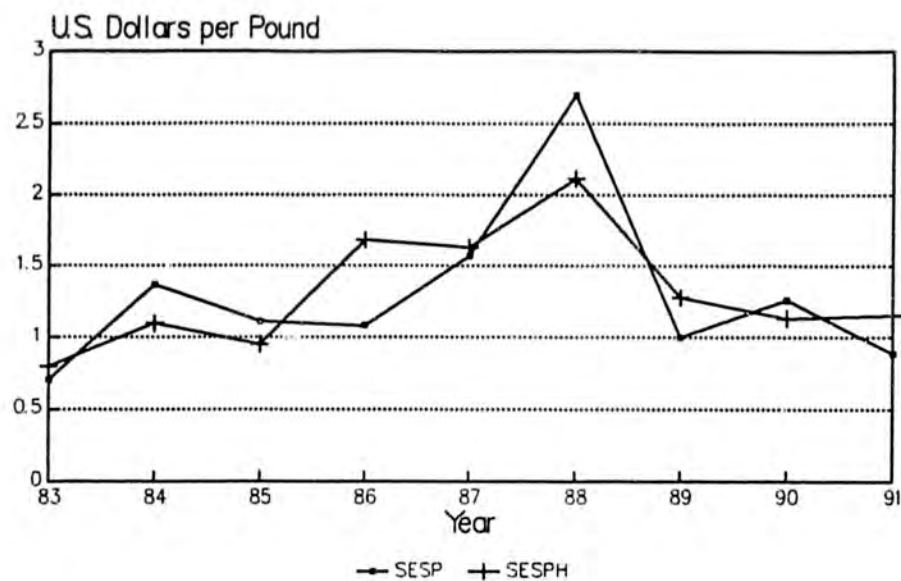


FIGURE 23 Actual (SESP) versus Predicted (SESPH) Historical Southeast Coho Annual Exvessel Price (1983-1991)

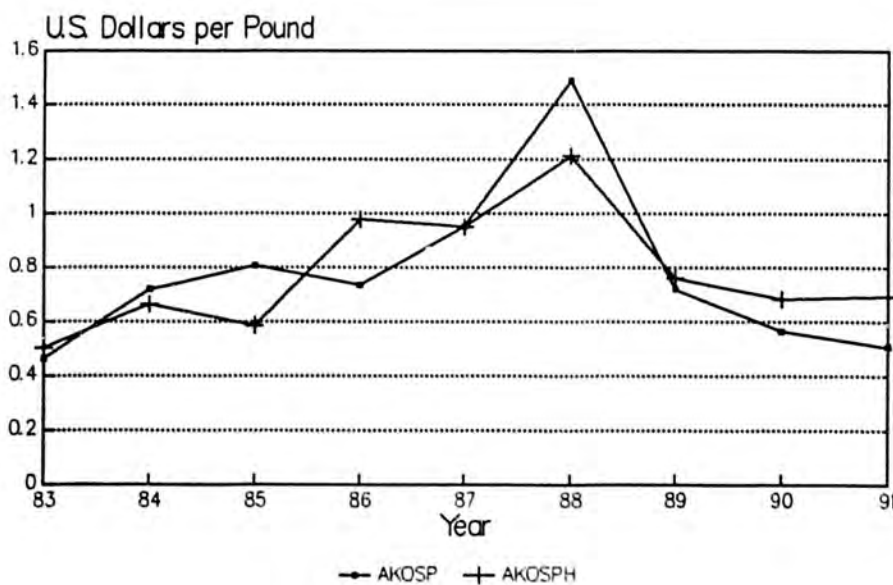


FIGURE 24 Actual (AKOSP) versus Predicted (AKOSPH) Historical Rest-of-Alaska Coho Annual Exvessel Price (1983-1991)

Chinook

The chinook salmon regional exvessel price estimation completes the modelling of 'regional' exvessel prices for high valued salmon species. The estimation results are presented in Table 19. As expected, the R^2 on several of the chinook equations are relatively low. It was noted in the previous section that chinook exvessel prices had the weakest relationship with NAPHEX among all high valued salmon species. This was attributed, in part, to chinook salmon not being the targeted species in several fisheries. The R^2 range from a relatively low 0.43 (CIKP) to 0.85 (PWKP).

Table 19. Estimation Results for Prince William Sound, Cook Inlet, Kodiak, Southeast and Rest-of-Alaska, Chinook Exvessel Prices, PWKP, CIKP, KKKP, SEKP, and AKOKP, respectively, for the 1983-91 Time Period (t-values are presented parenthetically).

Exvessel Price	Constant	NAPHEX* Coefficient	R^2	DW
PWKP	-0.040 (-0.14)	1.375 (6.72)	0.85	2.07
CIKP	0.678 (5.08)	0.386 (4.14)	0.68	1.76
KKKP	0.609 (3.03)	0.347 (2.47)	0.43	1.43
SEKP	1.147 (2.61)	0.944 (3.07)	0.54	1.88
AKOKP	0.641 (1.95)	0.614 (2.68)	0.47	0.70

*NAPHEX is a weighted average exvessel price for North American high-valued Salmon (Sockeye, Coho, and Chinook).

The ex-post simulation goodness-of-fit statistics for the regional chinook exvessel price equations are provided in Table 20. The correlation coefficients range from 0.506 (AKOKP) to 0.724 (CIKP). The Thiel UD are either equal to close to 1.0, indicating that model error is nonsystematic. The Thiel U statistics are generally quite good, particularly when considering the aforementioned data inconsistencies.

Table 20. Ex-post (historical) Simulation Forecast Goodness-of-Fit Statistics for Prince William Sound, Cook Inlet, Kodiak, Southeast, and Rest-of-Alaska, Chinook Exvessel Prices (PWKP, CIKP, KKKP, SEKP, and AKOKP, respectively), 1983-1991 Time Period.

Exvessel Price	Corr (R)	Bias (UM)	Reg (UR)	Dist (UD)	THEIL U
PWKP	0.724	0.001	0.004	0.996	0.2258
CIKP	0.686	0.012	0.000	0.987	0.1255
KKKP	0.534	0.000	0.000	1.000	0.1777
SEKP	0.703	0.015	0.020	0.966	0.1667
AKOKP	0.506	0.001	0.006	0.993	0.2166

Figure 25-29 illustrate the predicted versus actual Alaska regional chinook exvessel prices, PWKP, CIKP, KKKP, SEKP, and AKOKP, respectively. The models adequately track the general movements in exvessel prices over 1983-1991 time periods. There are specific years in which the models generally perform less well. For example, the models generally overestimate 1986 exvessel prices.

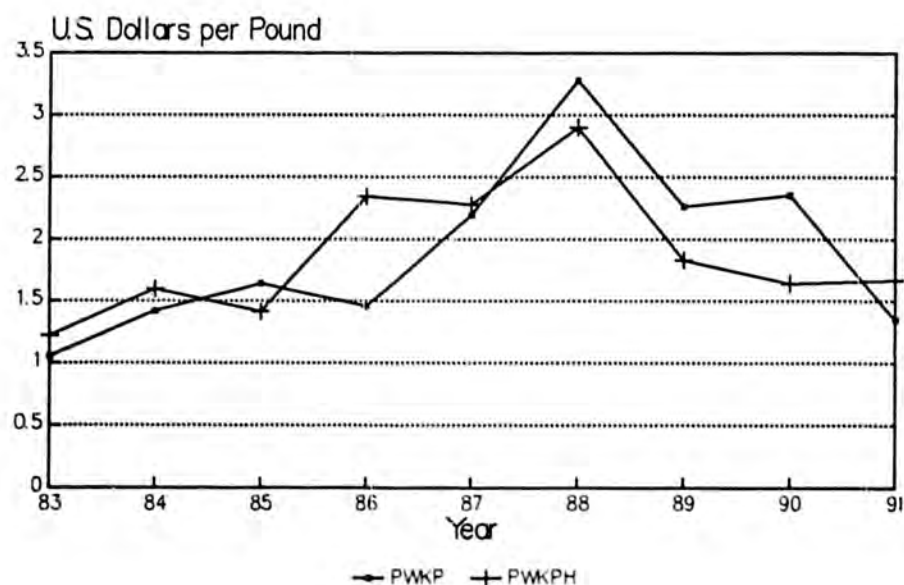


FIGURE 25 Actual (PWKP) versus Predicted (PWKPH) Historical Prince William Sound King Annual Exvessel Price (1983-1991)

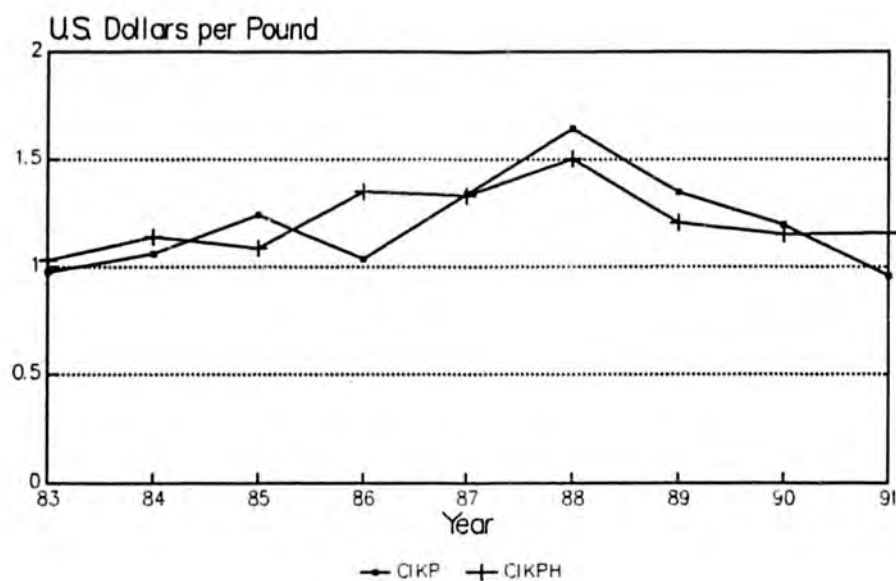


FIGURE 26 Actual (CIKP) versus Predicted (CIKPH) Historical Cook Inlet King Annual Exvessel Price (1983-1991)

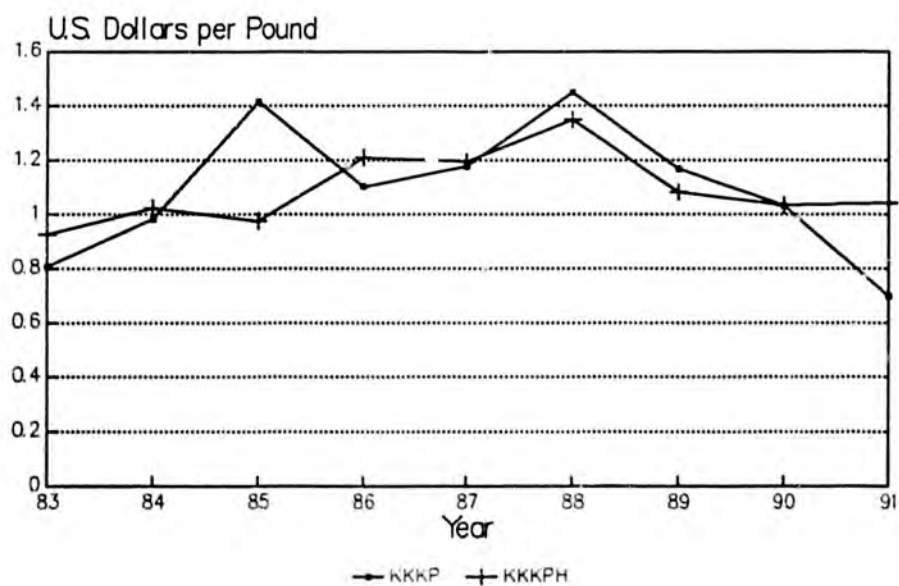


FIGURE 27 Actual (KKKP) versus Predicted (KKKPH) Historical Kodiak King Annual Exvessel Price (1983-1991)

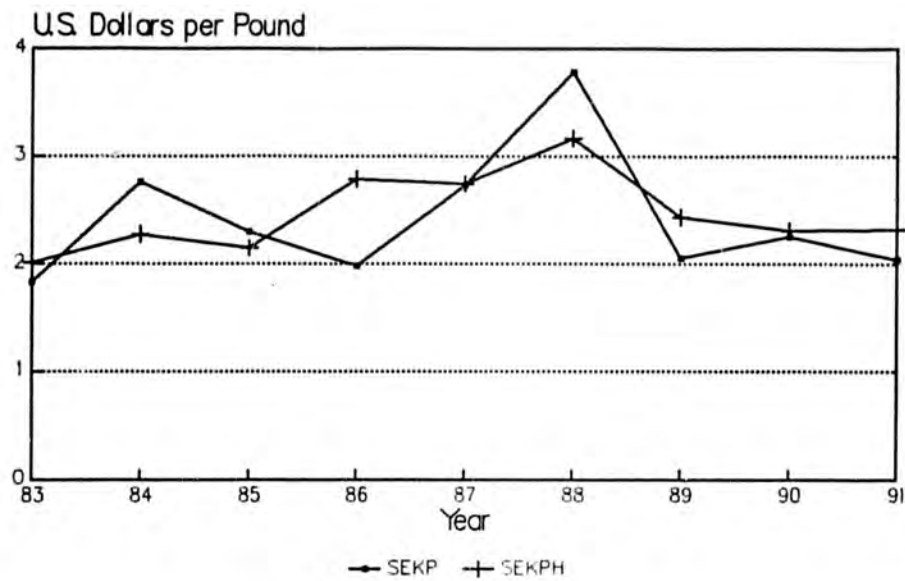


FIGURE 28 Actual (SEKP) versus Predicted (SEKPH) Historical Southeast King Annual Exvessel Price (1983-1991)

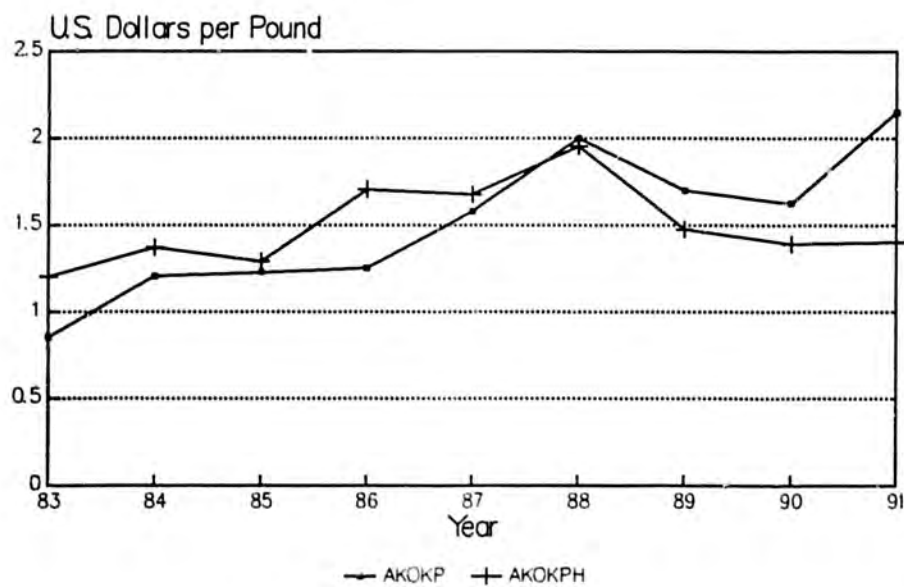


FIGURE 29 Actual (AKOKP) versus Predicted (AKOKPH) Historical Rest-of-Alaska King Annual Exvessel Price (1983-1991)

Pink Salmon Exvessel Price Equations

Alaska regional pink exvessel prices, PWPS, CIPS, KKPS, SEPS, and AKOPS, were estimated as linear functions of NAPLEX for the 1983-1991 time periods. Table 21 provides the estimation results. The models performed extremely well, with the R^2 s ranging from 0.92 (CIPP and SEPP) TO 0.99 (KKPP and SEPP).

Table 21. Estimation Results for Prince William Sound, Cook Inlet, Kodiak, Southeast and Rest-of-Alaska, Pink Exvessel Prices, PWPP, CIPP, KKPP, SEPP, and AKOPP, respectively, for the 1983-91 Time Period (t-values are presented parenthetically).

Exvessel Price	Constant	NAPLEX* Coefficient	R^2	DW
PWPP	-0.112 (-4.77)	1.089 (20.55)	0.98	1.51
CIPP	-0.055 (-1.37)	0.838 (9.30)	0.91	1.48
KKPP	-0.109 (-5.49)	1.053 (23.57)	0.98	1.37
SEPP	-0.095 (-4.63)	1.075 (23.09)	0.98	2.24
AKOPP	-0.029 (-0.73)	0.867 (9.61)	0.91	1.76

*NAPLEX is a weighted average exvessel price for North American low-valued Salmon (Pink and Chum).

A more robust evaluation of the pink exvessel price equations are provided through models simulations. Replacement of the actual NAPLEX with the values predicted in Bloc 1, leads to a general reduction in the equations predictive accuracy. The simulation goodness-of-fit statistics are provided in Table 22. The correlation coefficients (r) range from 0.749 (CIPP) to 0.819 (KKPP). The majority of model error is attributable to random disturbances. However, there is significant systematic component to the model error, as evidence by the high UR values. Additionally, the models experience some difficulty in hitting the various turning points, as indicated by the Theil U statistics.

Table 22. Ex-post Simulation Forecast Goodness-of-Fit Statistics for Prince William Sound, Cook Inlet, Kodiak, Southeast, and Rest-of-Alaska, Pink Exvessel Prices (PWPP, CIPP, KKRPP, SEPP, and AKOPP, respectively), 1983-1991 Time Period.

Exvessel Price	Corr (R)	Bias (UM)	Reg (UR)	Dist (UD)	THEIL U
PWPP	0.800	0.005	0.333	0.662	0.3687
CIPP	0.749	0.008	0.316	0.676	0.3717
KKPP	0.819	0.005	0.336	0.658	0.3533
SEPP	0.812	0.004	0.332	0.663	0.3479
AKOPP	0.801	0.019	0.341	0.640	0.3120

Evaluation of the pink exvessel price equations is completed by comparing the actual and simulation predicted values of PWPP, CIPP, KKPP, SEPP, and AKPP presented in Figures 30-34, respectively. The models are generally successful in tracking changes in pink exvessel prices. The exvessel price predictions fall short of the actual high 1988 exvessel prices and the low 1991 exvessel prices.

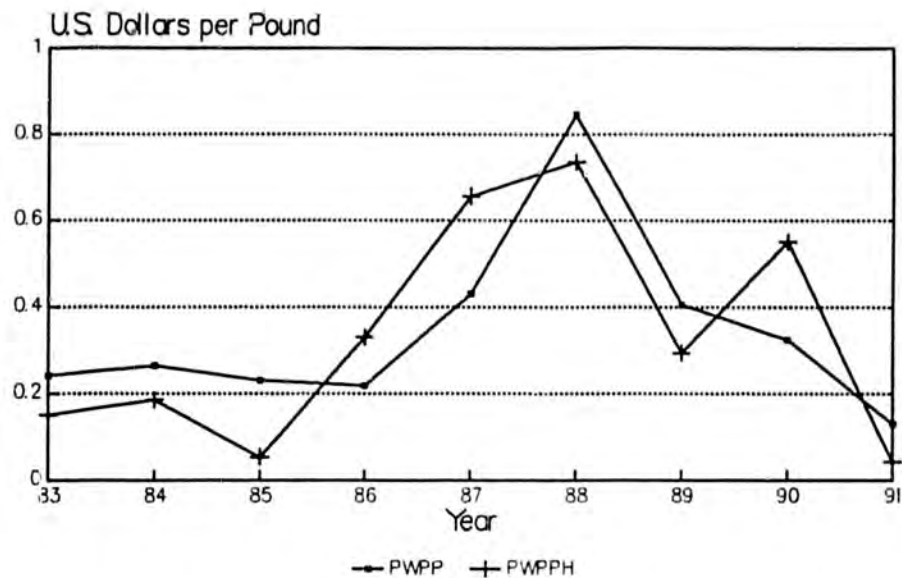


FIGURE 30 Actual (PWPP) versus Predicted (PWPPH) Historical Prince William Sound Pink Annual Exvessel Price (1983-1991)

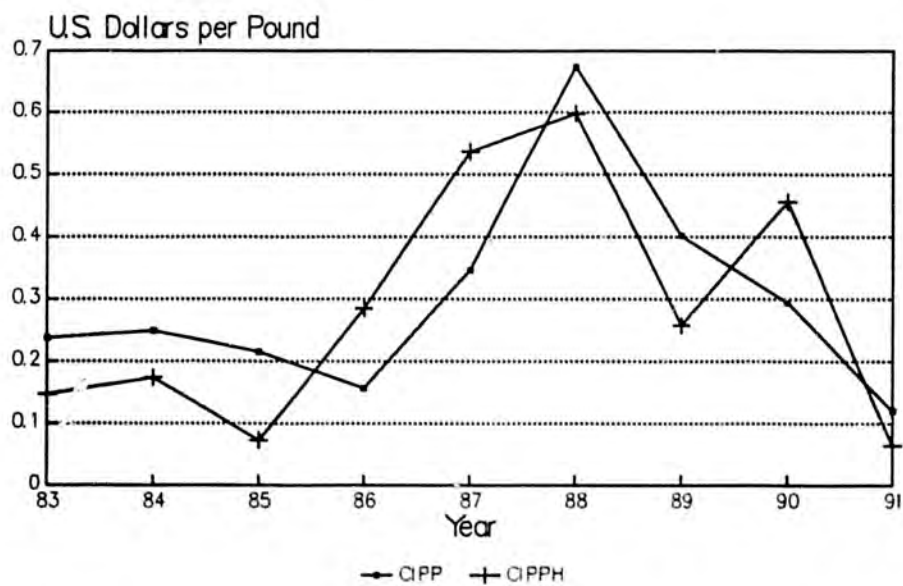


FIGURE 31 Actual (CIPP) versus Predicted (CIPPH) Historical Cook Inlet Pink Annual Exvessel Price (1983-1991)

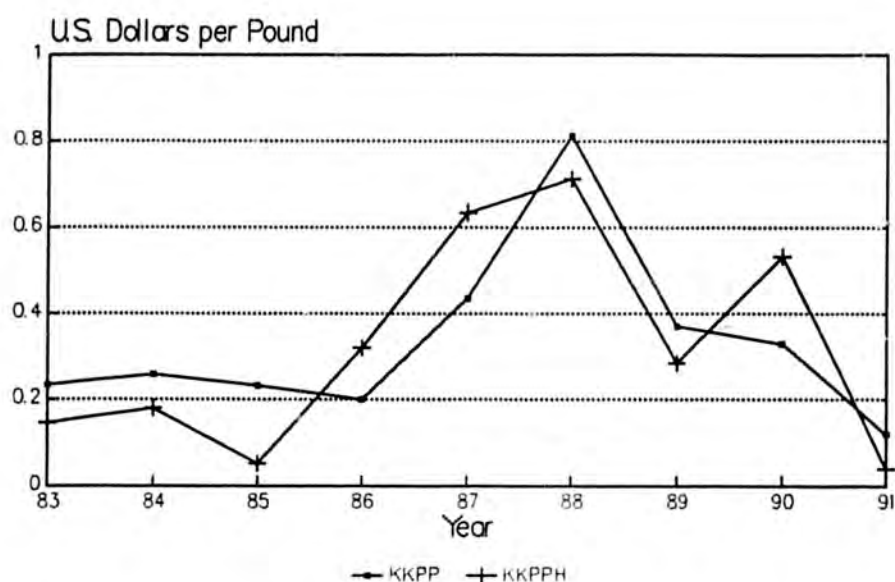


FIGURE 32 Actual (KKPP) versus Predicted (KKPPH) Historical Kodiak Pink Annual Exvessel Price (1983-1991)

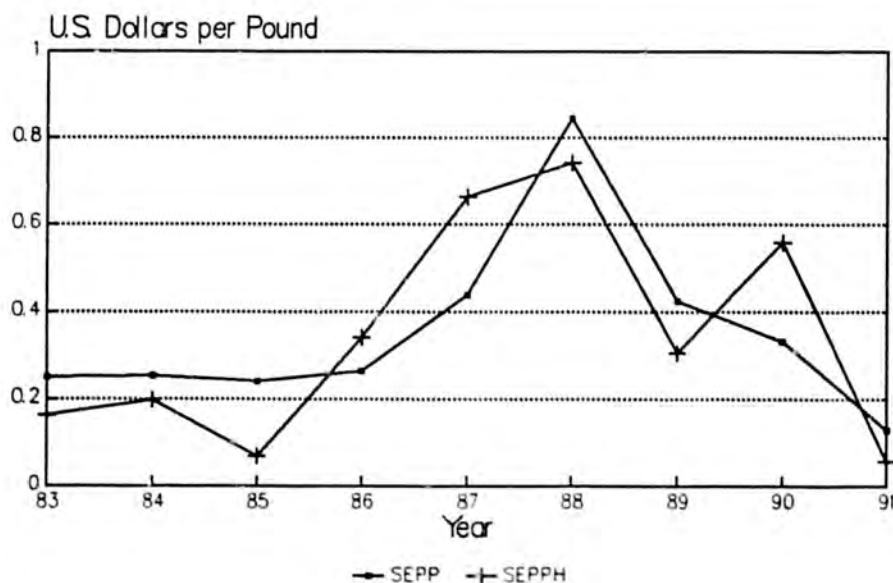


FIGURE 33 Actual (SEPP) versus Predicted (SEPPH) Historical Southeast Pink Annual Exvessel Price (1983-1991)

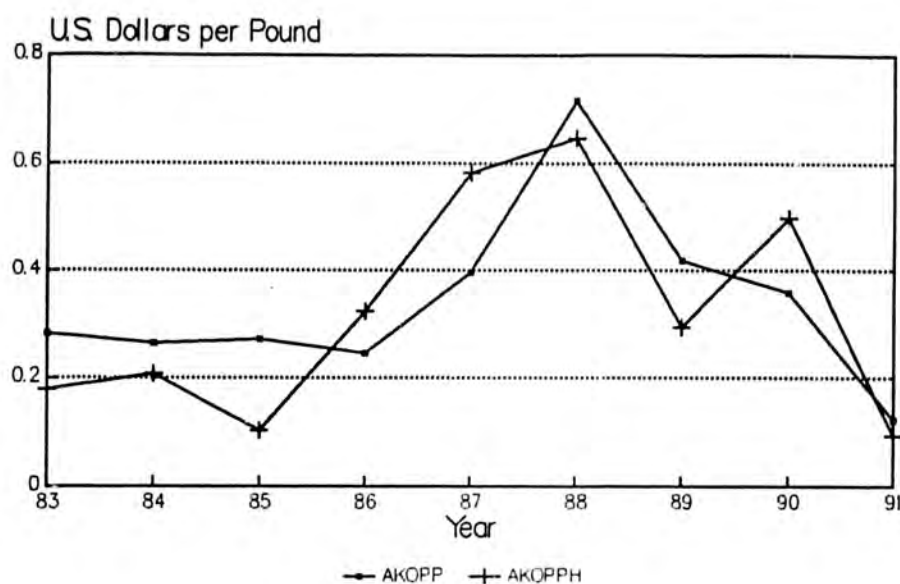


FIGURE 34 Actual (AKOPP) versus Predicted (AKOPPH) Historical Rest-of-Alaska Pink Annual Exvessel Price (1983-1991)

Chum Salmon Exvessel Price Equations

The estimation results for the various regional and statewide chum salmon exvessel price equations are presented in Table 23. As with pink salmon, chum exvessel prices were estimated as linear functions of NAPLEX. The equations performed moderately well. The reported R^2 s for the chum exvessel price equations ranged from (PWCP) to 0.97 (SECP).

Table 23. Estimation Results for Prince William Sound, Cook Inlet, Kodiak, Southeast and Rest-of-Alaska, Chum Exvessel Prices, PWCP, CICP, KKCP, SECP, and AKOCP, respectively, for the 1983-91 Time Period (t-values are presented parenthetically).

Exvessel Price	Constant	NAPLEX* Coefficient	R ²	DW
PWCP	-0.025 (-0.24)	1.205 (5.22)	0.77	2.081
CICP	0.137 (2.18)	0.773 (5.44)	0.79	2.67
KKCP	-0.112 (1.70)	1.341 (9.00)	0.91	2.86
SECP	0.025 (0.72)	1.246 (16.09)	0.97	2.071
AKOCP	0.149 (3.58)	0.530 (5.63)	0.80	1.81

*NAPLEX is a weighted average exvessel price for North American low-valued Salmon (Pink and Chum).

The chum exvessel price equations, like the pink equations, perform adequately, although there are certain problems. The correlation coefficients range from 0.696 (AKOCP) to 0.803 (PWCP). The UR statistics were somewhat high, indicating some systematic error in the equations. Additionally, the Theil U statistics were considered somewhat high, exceeding 3.0 for two of the equations.

Table 24. Ex-post Simulation Forecast Goodness-of-Fit Statistics for Prince William Sound, Cook Inlet, Kodiak, Southeast, and Rest-of-Alaska, Chum Exvessel Prices (PWCP, CICP, KKCP, SECP, and AKOCP, respectively), 1983-1991 Time Period.

Exvessel Price	Corr (R)	Bias (UM)	Reg (UR)	Dist (UD)	THEIL U
PWCP	0.803	0.003	0.175	0.823	0.3052
CICP	0.700	0.001	0.220	0.778	0.2722
KKCP	0.743	0.001	0.286	0.713	0.3979
SECP	0.822	0.000	0.302	0.698	0.2719
AKOCP	0.696	0.008	0.246	0.746	0.2380

Concern over the high Theil U statistics is tempered by comparison of the simulation predicted and actual chum exvessel prices. Examination of Figures 35-39 (which provide actual and predicted PWCP, CICP, KKCP, SECP, and AKOCP, respectively), reveal that much of the prediction error is due to over-prediction of 1987 exvessel prices and under prediction of 1985 exvessel prices. The important criterion for measuring model success, in the context of this study, is whether the models are accurate in predicting average exvessel prices over time. Thus, the individual misses in 1987 and 1985 are not considered a general liability when evaluating model performance.

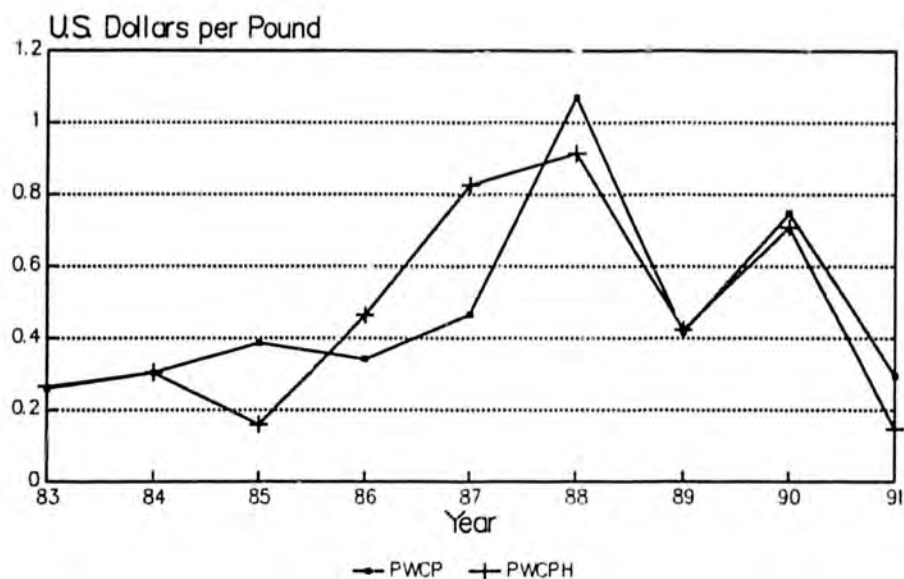


FIGURE 35 Actual (PWCP) versus Predicted (PWCPH) Historical Prince William Sound Chum Annual Exvessel Price (1983-1991)

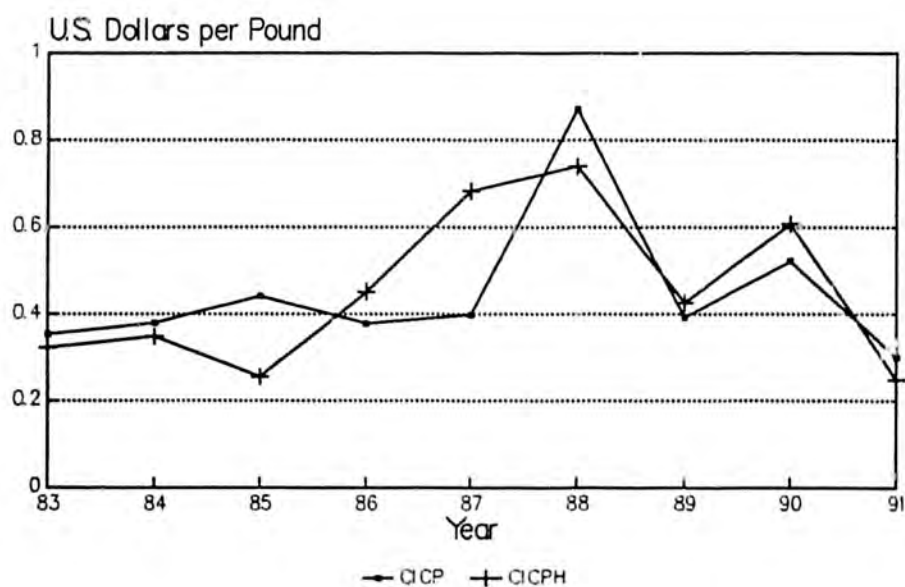


FIGURE 36 Actual (CICP) versus Predicted (CICPH) Historical Cook Inlet Chum Annual Exvessel Price (1983-1991)

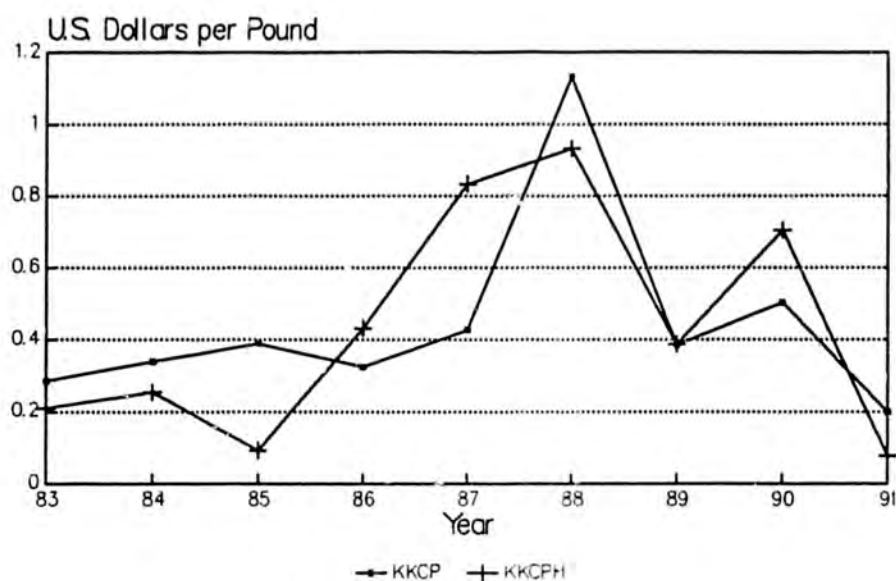


FIGURE 37 Actual (KKCP) versus Predicted (KKCPH) Historical Kodiak Chum Annual Exvessel Price (1983-1991)

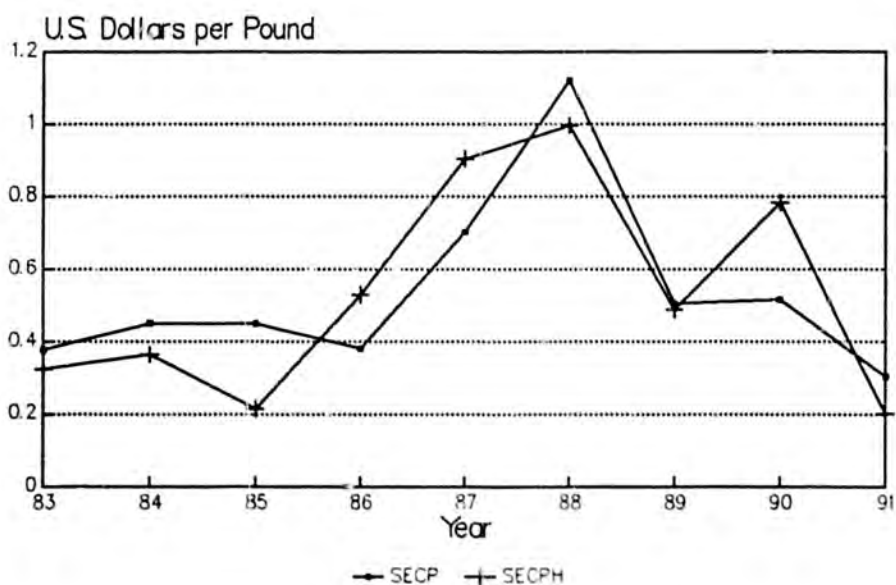


FIGURE 38 Actual (SECP) versus Predicted (SECPH) Historical Southeast Chum Annual Exvessel Price (1983-1991)

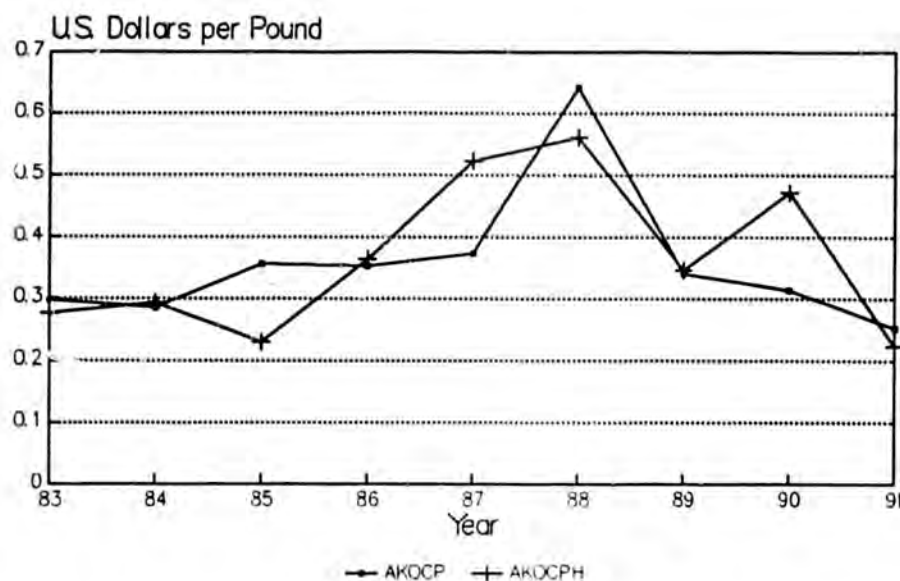


FIGURE 39 Actual (AKOCP) versus Predicted (AKOCPH) Historical Rest-of-Alaska Chum Annual Exvessel Price (1983-1991)

Forecasting

Forecasts of future salmon price levels are important for enhancement evaluation so policymakers and operators can make efficient resource allocation decisions. Three factors are critical in forecasting salmon prices. First, the estimated model must be a reasonably accurate representation of equilibrium price and quantity formation within salmon markets. One way to measure this accuracy is to see how well the model tracks the historical data, as was done in the previous sections. Second, past market structure, upon which the salmon models are based, need to continue into the future. And third, the predetermined explanatory variables in the model must be accurately forecasted. In this study the predicted salmon prices will be "real" prices. Real prices are prices that have been discounted to today's value. The use of discounted prices will also simplify the construction of future explanatory variable values.

Forecasting prices for any commodity is difficult at best. Uncertainty as to the future conditions under which the modelled markets will operate and the future values of predetermined variables have always plagued forecasters. In addition, changing exchange rates further compound the uncertainty about future price levels. Salmon price forecasting is further complicated by the recent emergence of the farmed salmon industry. This is a relatively new market that is still in its development stages. It is not possible to fully model the impact of this market on salmon prices given its continuing transition and brief history. Inability to fully capture structural changes in the salmon markets attributable to farmed salmon led to the inclusion of several indicator variables in the salmon price models. Since such changes cannot be

anticipated ex ante, prices may deviate from the forecasted predictions. Nevertheless, it is hoped that the forecasted prices will at least indicate magnitudes and directions of price movement.

Forecasting Exogenous Variables

Forecasting salmon prices over a 15 year time horizon requires specifying values for all exogenous variables for the forecast period 1992-2006. Various methods were employed in specifying future exogenous variables including: econometric techniques involving time trends, holding the values of certain variables constant, and basing future values on the researchers knowledge of the industry and expert opinion.

Below are a list of all the exogenous variables for which future values were specified.

Indicator Variables

DQ_is = quarterly indicator variables for quarter i, where DQ_i is 1 in quarter i and 0 elsewhere, including the time period through 2006.

C = a constant assigned a value of through 2006

D86 = an indicator variable which is assigned a value of 1 in 1986, and zero elsewhere, including the time period of 1993-2006.

D87 = an indicator variable which is assigned a value of 1 in 1987, and zero elsewhere, including the time period of 1993-2006.

D89 = an indicator variable which is assigned a value of 1 in 1989, and zero elsewhere, including the time period of 1993-2006.

D91 = an indicator variable which is assigned a value of 0 between 1983 and 1990 and a value of 1 in 1991. For all equations except the high-valued exvessel equation the value of D91 was assigned 0 between 1992 and 2006. In the high-valued exvessel equation the value remained at 1 between 1992 and 2006.

D22 = an indicator variable which is assigned a value of 1 in the second quarter of 1986 and zero elsewhere, including the time period from 1992 to 2006.

DSEPT90 = An indicator variable that equals one beginning in the fourth quarter of 1990, and zero otherwise, including 1992-2006.

DMAR91 = An indicator variable that equals one beginning in the first quarter of 1991, and zero otherwise, including 1992-2006.

DISEASE = an indicator variable assigned a value of 1 for the last two quarters of 1986 and the first two quarters of 1987 and a value of 0 elsewhere including 1992-2006.

D4T = an indicator variable which is assigned a value of 1 for quarter four and is multiplied by a time variable which starts at 1 for 1981 and ends at 26 for 2006, and is assigned a value of 0 elsewhere.

In future forecast models of low-valued salmon the indicator variable D91 is set equal to one in 1991, and zero in all other years through 2006. This indicator variable captured unexplained variation in low-valued salmon prices that led to the extremely low 1991 prices.

In the high-valued salmon equation, D91 was given the value of one through 2006. High-valued salmon prices in 1991, were probably low, in part due to high volumes of salmon in the market including farmed salmon. D91 was specified to capture structural changes associated with the influx of additional salmon onto the market. Since these structural changes are expected to continue into the future, D91 was not turned off (given a zero value) in forecasting future high-valued salmon prices.

Exogenous variable predicted using ordinary-least-squares

EPOP = the population of the EEC, in millions.

JPOP = the population of the Japan, in millions.

UPOP = the population of the United States, in millions.

JYR = the "real" food consumption expenditure in Japan, in billions of lbs.

EYR = the "real" private consumption expenditure in the EEC, in millions of lbs.

Future values for each of the above variables were extrapolated on the basis of observed 1983 to 1991 growth rates.

Variables which had future values maintained at 1991 levels.

ECUUSA = the ECU/U.S. dollar exchange rate.

NORUSA = the Norwegian kroner/U.S. dollar exchange rate.

JAPUSA = the Norwegian kroner/U.S. dollar exchange rate.

NORJAP = the Norwegian kroner/Japanese yen exchange rate.

NORECU = the Norwegian kroner/ECU exchange rate.

ECPI = the EEC consumer price index for food.

UCPI = the U.S. producer price index for food.

JCPI = the Japanese consumer price index for food.

UTAX = the U.S. tariff placed on fresh imports of Norwegian farmed Atlantic salmon

ETAX = the EEC tariff placed on imports of fresh/frozen salmon

JTAXF = the Japanese tariff placed on imports of fresh/frozen salmon

JTAXC = the Japanese tariff placed on imports of canned/frozen salmon

JINT = the Japanese discount rate.

PTUNAR = the weighted average "real" price of a "high-valued" substitute fish consisting of fresh tuna, measured in yens per pound.

PSQUIDR = the weighted average "real" price of a "lower-valued" substitute fish consisting of fresh squid, measured in yens per pound

Each of the above variables were assigned the values observed in the fourth quarter of 1991, which was the first period to be predicted by the model. By assigning the values for the consumer price indices to the fourth quarter of 1991, the predicted prices will be in real terms at the beginning of 1992.

Variables in which expert opinion were used

UYR = the "real" United States personal disposable income, in millions of U.S. Dollars.

NXQSUP = total Norwegian exports of farmed Atlantic Salmon, in millions of lbs.

QSCOT12 = the estimated quantity of Scottish and Irish farmed Atlantic salmon remaining in the EEC countries in millions of lbs.

CFARMP = the sum of Chilean, Canadian Pacific, and Canadian Atlantic salmon exported to the United States in millions of lbs.

A 3 percent annual growth rate for U.S. real personal disposable income was specified, as based on discussions with macroeconomists. The total supply of farmed Atlantic salmon was held at its 1991 level, coinciding with the opinions of many experts that growth has reached its maximum sustainable point. However, there are some current indications that the industry may expand in the future. Farm salmon from Canada and Chile were allowed to grow at 3 percent quarterly.

Bloc 2 - Wild and farmed salmon harvests

All wild salmon harvests for Canada, Washington, Oregon, and California, were estimated based on 10-year historical averages. All Alaska non-hatchery wild salmon harvest were estimated on the same basis, with the exception of Prince William Sound Pinks, Cook Inlet sockeye, Kodiak sockeye and pink, and Southeast chinook salmon. Wild and hatchery harvests for these salmon species were predicted by Jerome Collie of UAF at Juneau. The 10-year average harvest was agreed upon by Ginny Fay of Senator Cotten's office and Jeff Hartman of FRED division and communicated to the principle investigators in a September meeting at Fairbanks Alaska.

The future hatchery harvests for the other Alaska regions and species were estimated by the hatchery operators in a survey conducted by the FRED division of ADF&G.

Forecast Results

The 1992-2006 forecasted prices by species, for the modelled regions of Prince William Sound, Cook Inlet, Southeast, and Kodiak are presented below. Also, a weighted average price for all other Alaska regions is included in the forecasted prices.

Table 25. Predicted Real Prices for the Selected Sockeye Fisheries of Prince William Sound (PWRPH), Cook Inlet (CIRPH), Kodiak (KKRPH), Southeast (SERPH), and Alaska--All Other Regions (AKORPH) for 1992-2006.

YEAR	PWRPH	CIRPH	KKRPH	SERPH	AKORPH
1992	1.30	1.15	1.12	1.19	0.90
1993	1.38	1.21	1.19	1.26	0.95
1994	1.34	1.18	1.15	1.23	0.92
1995	1.40	1.23	1.21	1.29	0.97
1996	1.45	1.26	1.25	1.33	1.00
1997	1.51	1.31	1.30	1.39	1.04
1998	1.57	1.35	1.35	1.44	1.08
1999	1.60	1.38	1.38	1.48	1.11
2000	1.63	1.40	1.41	1.51	1.13
2001	1.67	1.43	1.43	1.54	1.15
2002	1.71	1.46	1.47	1.58	1.18
2003	1.75	1.50	1.51	1.62	1.21
2004	1.80	1.53	1.55	1.67	1.25
2005	1.85	1.57	1.59	1.71	1.28
2006	1.90	1.60	1.63	1.76	1.31

Table 26. Predicted Real Prices for the Selected Pink Fisheries of Prince William Sound (PWPPH), Cook Inlet (CIPPH), Kodiak (KKPPH), Southeast (SEPPH), and Alaska--All Other Regions (AKOPPH) for 1992-2006.

YEAR	PWPPH	CIPPH	KKPPH	SEPPH	AKOPPH
1992	0.28	0.24	0.27	0.29	0.28
1993	0.27	0.24	0.26	0.28	0.27
1994	0.28	0.24	0.27	0.29	0.28
1995	0.26	0.23	0.25	0.27	0.26
1996	0.26	0.23	0.25	0.27	0.27
1997	0.27	0.24	0.26	0.28	0.28
1998	0.27	0.24	0.26	0.28	0.27
1999	0.27	0.24	0.26	0.28	0.28
2000	0.28	0.25	0.27	0.29	0.28
2001	0.30	0.26	0.29	0.31	0.30
2002	0.30	0.26	0.29	0.31	0.30
2003	0.30	0.26	0.29	0.31	0.30
2004	0.32	0.28	0.31	0.33	0.32
2005	0.34	0.29	0.33	0.35	0.33
2006	0.35	0.31	0.35	0.37	0.34

Table 27. Predicted Real Prices for the Selected Chum Fisheries of Prince William Sound (PWCPH), Cook Inlet (CICPH), Kodiak (KKCPH), Southeast (SECPH), and Alaska--All Other Regions (AKOCPH) for 1992-2006.

YEAR	PWCPH	CICPH	KKCPH	SECPH	AKOCPH
1992	0.40	0.41	0.37	0.47	0.34
1993	0.39	0.41	0.35	0.46	0.33
1994	0.41	0.41	0.37	0.47	0.34
1995	0.38	0.40	0.34	0.44	0.33
1996	0.39	0.40	0.35	0.45	0.33
1997	0.40	0.41	0.36	0.46	0.33
1998	0.40	0.41	0.36	0.46	0.33
1999	0.40	0.41	0.36	0.47	0.34
2000	0.41	0.42	0.37	0.48	0.34
2001	0.43	0.43	0.39	0.49	0.35
2002	0.43	0.43	0.39	0.49	0.35
2003	0.43	0.43	0.39	0.49	0.35
2004	0.46	0.45	0.42	0.52	0.36
2005	0.48	0.46	0.45	0.54	0.37
2006	0.49	0.47	0.47	0.56	0.38

Table 28. Predicted Real Prices for the Selected Coho Fisheries of Prince William Sound (PWSPH), Cook Inlet (CISPH), Kodiak (KKSPH), Southeast (SESPH), and Alaska--All Other Regions (AKOSPH) for 1992-2006.

YEAR	PWSPH	CISPH	KKSPH	SESPH	AKOSPH
1992	0.79	0.61	0.65	1.04	0.63
1993	0.82	0.63	0.67	1.09	0.66
1994	0.81	0.62	0.66	1.07	0.65
1995	0.84	0.64	0.67	1.11	0.67
1996	0.86	0.66	0.69	1.15	0.69
1997	0.89	0.68	0.70	1.19	0.72
1998	0.92	0.70	0.72	1.24	0.74
1999	0.94	0.71	0.73	1.26	0.75
2000	0.95	0.72	0.74	1.29	0.77
2001	0.97	0.74	0.75	1.31	0.78
2002	0.99	0.75	0.76	1.34	0.80
2003	1.01	0.77	0.77	1.38	0.82
2004	1.04	0.79	0.79	1.41	0.84
2005	1.06	0.80	0.80	1.45	0.85
2006	1.09	0.82	0.81	1.49	0.87

Table 29. Predicted Real Prices for the Selected Chinook Fisheries of Prince William Sound (PWKPH), Cook Inlet (CIKPH), Kodiak (KKKPH), Southeast (SEKPH), and Alaska--All Other Regions (AKOKPH) for 1992-2006.

YEAR	PWKPH	CIKPH	KKKPH	SEKPH	AKOKPH
1992	1.53	1.11	1.00	2.22	1.34
1993	1.60	1.13	1.02	2.27	1.37
1994	1.56	1.12	1.01	2.25	1.36
1995	1.62	1.14	1.03	2.29	1.38
1996	1.66	1.15	1.04	2.32	1.40
1997	1.72	1.17	1.05	2.36	1.43
1998	1.80	1.18	1.07	2.40	1.45
1999	1.81	1.19	1.08	2.42	1.47
2000	1.84	1.20	1.08	2.44	1.48
2001	1.87	1.21	1.09	2.46	1.50
2002	1.91	1.22	1.10	2.49	1.51
2003	1.96	1.23	1.11	2.52	1.53
2004	2.01	1.25	1.12	2.55	1.56
2005	2.05	1.26	1.14	2.58	1.57
2006	2.10	1.27	1.15	2.62	1.60

For all fisheries the price gradually increases from 1992 to 2006. The accuracy of these predictions are predicated on the accuracy of the estimated model, the structure of the salmon fishery remaining constant over the next 15 years, and all the explanatory

variables, including wild harvests, being accurately forecasted. To the extent that these assumptions are violated the predictions will stray from actual future prices.

The model predicts that sockeye prices will rise 40 to 60 cents, on average, over the next 15 years at projected harvests as specified in base case scenario 1. Bristol Bay has the state's largest sockeye salmon harvest. Therefore, the "Other Alaska" column, which displays an increase of \$0.90 to \$1.30, is compromised mainly of Bristol Bay reds.

The pink salmon price is predicted to remain relatively low until the end of this decade when increases in demand surpass growth in supply, and the necessary levels of canned salmon are depleted. The overall growth in real prices for pink salmon is predicted to grow by approximately 7 cents, (in real terms) on average, over the 15 year period. The chum salmon fishery predicted real prices increase approximately 10 cents on average over the 15 year period. The coho fishery also shows a growth in real prices, from 25 cents to 50 cents on average over the 15 year period. The chinook prices display approximately the same growth, with prices remaining highest in Southeast.

The above predictions should not be judged on their accuracy for any given year or other short time periods. The model was designed to predict real price trend, so that the average real price for the entire 15 year period would be closer than naive speculation.

The price increases for sockeye, chinook, and coho salmon may be on the upper end of actual price increases. In other words, they may be overestimated if the general increase in prices from expanding demand induces greater activity in the farm salmon sector than predicted. The farmed production forecasts for the future were based on experts opinions. These opinions were formed during a period of low current prices. An increase in future salmon prices may provide an incentive for producers to increase farmed salmon supply. This would dampen real price increases for the high-end valued Pacific salmon such as chinook, coho and sockeye.

Confidence Intervals

Explanatory variables cannot be forecasted with great accuracy. Therefore, the above price forecasts will deviate from actual prices, in part, due to deviations between predicted future values and actual values of the explanatory variables. For this reason, the impact of deviations in the forecasted exogenous variables to predicted prices were examined. The price impact of the following changes in exogenous variable were examined:

- 1) Real forecasted income in the U.S., the EEC, and Japan was varied by 2 percent per year;
- 2) The Japanese-U.S. forecasted exchange rate was varied 25 percent per year;
- 3) The ECU-U.S. forecasted exchange rate was varied by 20 percent per year;
- 4) The real prices of substitute fish in Japan was varied by 20 percent per year;
- 5) Farm production from all regions was varied by 15 percent per year from forecasted levels.

These variations were made from examination of historical fluctuations in these variables. To construct the confidence intervals the explanatory variable listed above were simultaneously varied in the direction that would give the greatest increase to salmon prices, then varied in the opposite direction. The two set of exogenous variables were then used in the simulated cases. Figures 40 to 44 below show the average, high, and low predicted weighted Alaska exvessel prices resulting from the forecasts using actual predicted exogenous variable levels and the adjusted exogenous variable values.

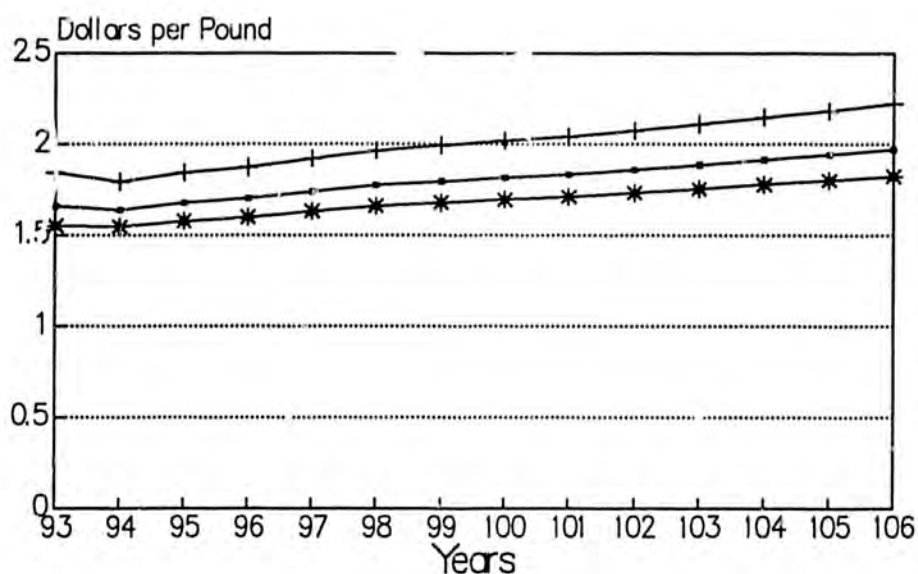


Figure 40. Predicted Annual Alaska Average, High, and Low Chinook Exvessel Prices, 1993-2006.

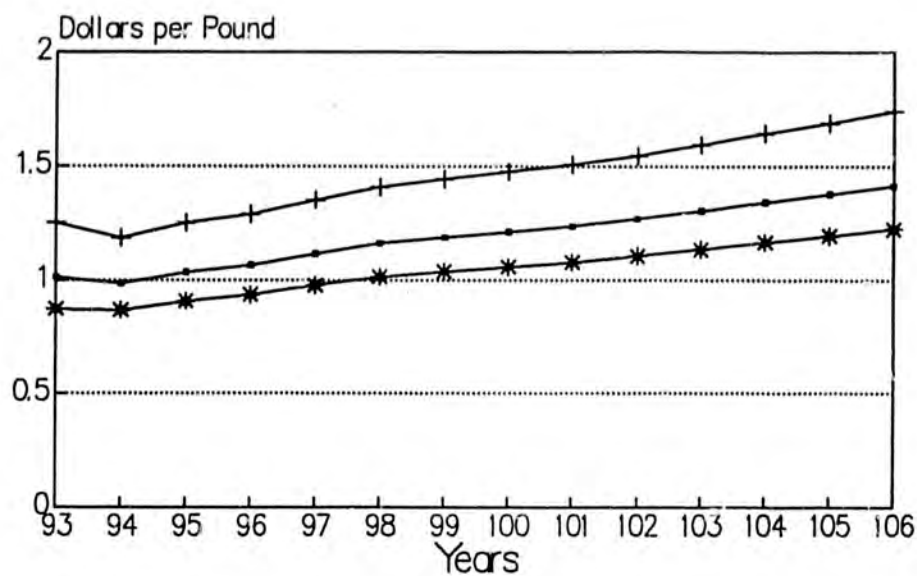


Figure 41. Predicted Annual Alaska Average, High, and Low Sockeye Exvessel Prices, 1993-2006.

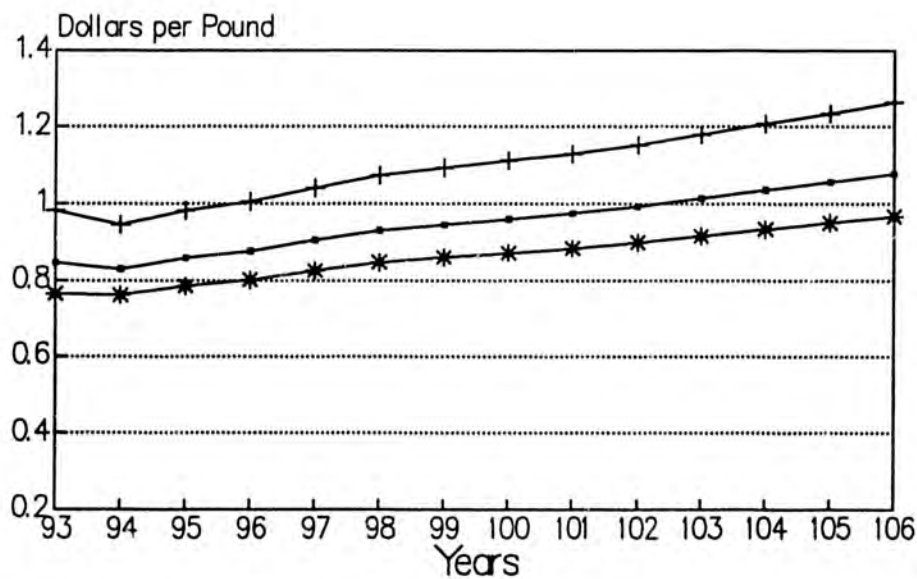


Figure 42. Predicted Annual Alaska Average, High, and Low Coho Exvessel Prices, 1993-2006.

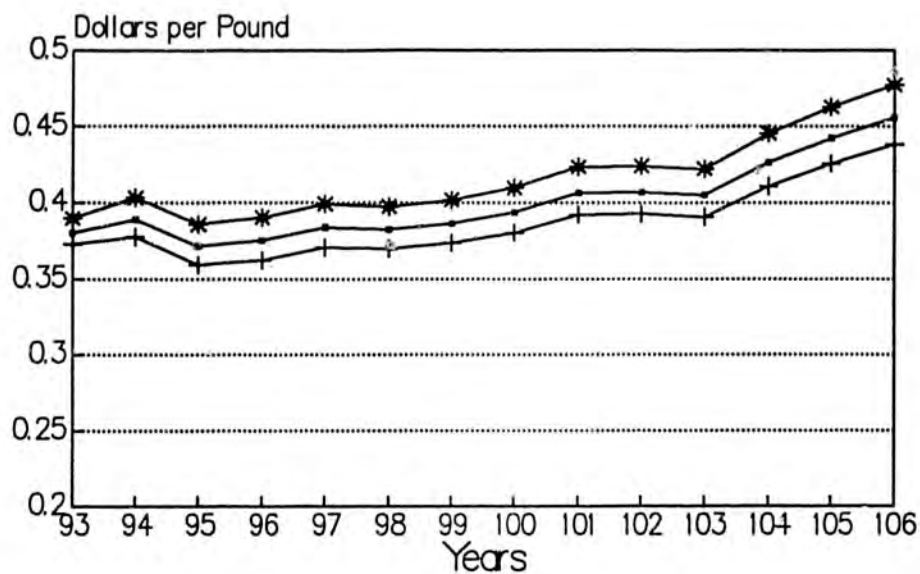


Figure 43. Predicted Annual Alaska Average, High, and Low Chum Exvessel Prices, 1993-2006.

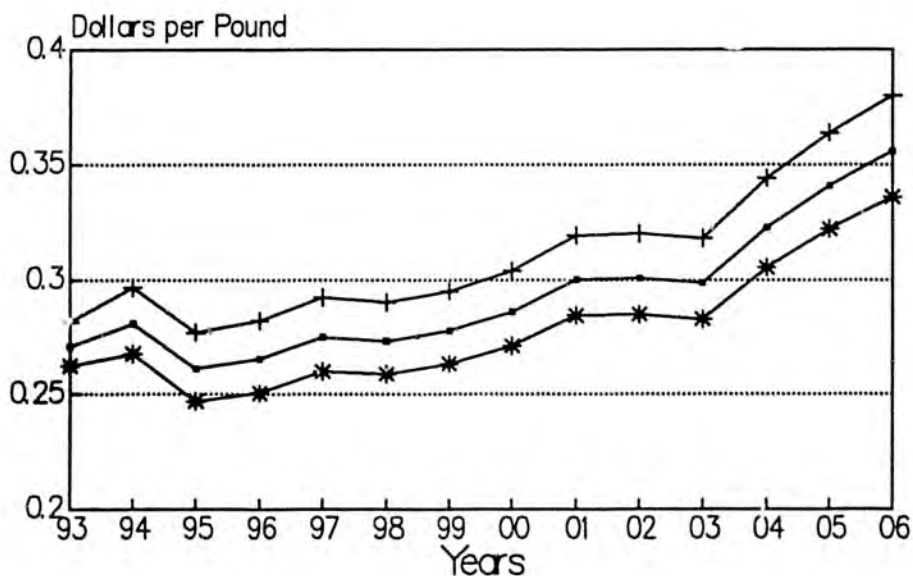


Figure 44. Predicted Annual Alaska Average, High, and Low Pink Exvessel Prices, 1993-2006.