Haddock Price-response Analysis

Hsiang-tai Cheng, Timothy J. Dalton, and Lili Dang

Haddock and a few other fish species native to New England waters are being developed for aquaculture in the region and Atlantic Canada. Development of additional species that can be economically grown is critical to Maine's aquaculture industry, which for the last three decades has concentrated on Atlantic salmon production; in recent years this production has decreased dramatically due to salmon disease and environmental problems.

This study is part of an interdisciplinary research effort to develop a financially viable haddock aquaculture system in Maine. Technical advances have been made in juvenile haddock production, including the production of live feed for larval development, and haddock grow-out in netpens. To evaluate the economic feasibility of haddock production in the region, this study analyzed the market demand for fresh haddock in the United States.

Using monthly data from 1990 to 2001, a simultaneous-equation model was developed and estimated to measure the responses of U.S. ex-vessel price and price of fresh haddock imports, primarily from Canada, to changes in quantities supplied. Other economic factors investigated in the model include consumer income and the trend and seasonality in demand for haddock. Findings of this study can be used in the development of marketing plans for cultured haddock

Haddock Price-response Model

The supply of haddock from wild catch, though correlated with fishing effort, is largely determined by fish-stock abundance, fishing regulations, weather, and other non-economic factors. Hence the supply of fish at the ex-vessel level is usually considered exogenous in price-determination models (Cheng and Townsend 1993). A price-dependent demand or price-response model was used in the study to assess "what price will clear the market of the given supply" (Tomek and Robinson 1990).

While Canadian landings are considered exogenous, the export of fresh whole haddock to the U.S. market should be responsive to price changes. Ideally, a model would incorporate the Canadian supply of fresh whole haddock to all markets, including the U.S. The present model maintains the exogenous-supply assumption.

Using the price-response concept, the real ex-vessel price of haddock in the U.S. (RP_{US}) and the real price of imported fresh whole haddock from Canada (RP_{IM}) are specified as dependent variables in two price-response functions:

(1) $RP_{US} = f_{us}(Q_{us}, RP_{IM}, RI, T, S)$, and

(2) $RP_{IM} = f_{im}(Q_{im}, RP_{US}, RI, T, S)$.

Each of these prices responds to changes in their respective quantity supplied (Q_{US} and Q_{IM}) and, in addition, haddock from U.S. and Canadian sources are hypothesized to be substitutes and the reciprocal price relationship is considered in the model. Other factors included in the model are the consumer real income (RI), a time trend (T), and seasonal variation in demand (S). The seasonal cycle of demand is estimated as a trigonometric function of monthly time periods. Monthly time periods, t, are transformed as $\sin\left(\frac{2\pi}{12}t\right)$ and $\cos\left(\frac{2\pi}{12}t\right)$, to determine whether a sinusoidal price pattern is evident. The resulting econometric model is

$$(3)\quad RP_{US} = \alpha_1 + \alpha_2 \ln Q_{us} + \alpha_3 RP_{IM} + \alpha_4 \ln RI + \alpha_5 T + \alpha_6 \sin\left(\frac{2\pi}{12}t\right) + \alpha_7 \cos\left(\frac{2\pi}{12}t\right) + \varepsilon_1,$$

$$(4)\quad RP_{IM} = \beta_1 + \beta_2 \ln Q_{IM} + \beta_3 RP_{US} + \beta_4 \ln RI + \beta_5 T + \beta_6 \sin\left(\frac{2\pi}{12}t\right) + \beta_7 \cos\left(\frac{2\pi}{12}t\right) + \varepsilon_2,$$

The authors are associate professor, assistant professor, and graduate assistant, respectively, Department of Resource Economics and Policy, University of Maine.

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(where ln(.) represents the natural logarithm and e_1 and e_2 are random errors. The logarithm of Q and RI allows price changes to vary with the size of quantity supplied and real consumer income. Hence the parameters associated with ln(Q) and ln(RI) measure the price response to a proportional change in quantity supplied and real income, respectively.

The econometric model, with two endogenous variables RP_{US} and $RP_{IM,}$ was estimated simultaneously. Each specified equation was also economically identified. It was expected that parameters associated with the quantity supplied Q would have negative signs, and for parameters associated with the cross prices and income would have positive signs.

Estimation Results

From 1990 to 1994 annual U.S. haddock landings decreased to a low of 0.7 million pounds, but since then have risen, reachingd 12.85 million pounds in 2001. While monthly landings fluctuated, the real ex-vessel price remained relatively stable. During 1999-2001, monthly haddock landings varied between 0.37 and 1.65 million pounds, and the real price (in 1982–84 dollars) ranged from $0.54/lb and $0.97/lb.

An increase in fresh haddock imports, from 9.6 million to 17.5 million pounds per year, was also observed between 1994 and 2001. During the three-year period between 1999 and 2001, monthly fresh haddock imports fluctuated between 0.21 and 2.59 million pounds, while the prices in real terms varied between $0.61/lb and $0.75/lb.

The estimation result of the price-response model using the three-stage least-square (3SLS) method is presented in Table 1. The prices of U.S. haddock catch and fresh whole haddock imports from Canada are predominantly affected by quantity available in the market. The results also show a strong substitution effect between the two sources of fresh haddocks. There is no strong evidence to suggest any seasonal variation in demand for haddocks.

The own-quantity effects on U.S. ex-vessel price and price of fresh imports are rather small: –0.0359 and –0.0398, respectively, and not statistically significantly different at a 1% significance level. The price flexibility calculated at the mean prices[1] is about -0.05 and -0.06 for the U.S. harvest and imports, respectively, meaning that there is about a 5% to 6% price response to a 10% change in quantity supplied. These, however, are partial effects that do not include the cross-price effects.

A strong cross-price relationship between U.S.-caught haddock and fresh haddock import was found, indicating that they are close substitutes. The cross-price effect is $\partial P_{US}/\partial P_{IM} = 1.237$, and is statistically significant. In addition, this cross-price coefficient is not statistically significantly different from unity, which implies that a change in the import price results in an equal change in the U.S. ex-vessel price. On the other hand, the effect of a change in U.S. ex-vessel price in imported price ($\partial P_{IM}/\partial P_{US}$) is 0.348, statistically less than 1. This may be due to the relatively small market share of the U.S.-caught haddock, averaging only 22% annually between 1990 and 2001.

The U.S. ex-vessel price is also found to be positively correlated with income level, and the statistically significant time trend indicates a downward trend in the real price of U.S. haddock. By contrast, these two factors do not have statistically significant impact on the import price.

The estimation result presented in Table 1 provides information on the demand structure of U.S. catch and that of imports. A change in quantity supplied from one source would have an impact on its own price and on the price of substitutes. To measure the "total effect" of changes in quantity on prices, analytical reduced-form results, derived from the parameter estimates, are presented in Table 2.

Overall, a change in quantity supplied has a greater impact on the price of U.S. haddock than on the price of imports, regardless of the origin of the supply change. However, the magnitude of price response to a change in quantity is relatively small. The price-flexibility, calculated at the mean of prices, indicates that a 10% change in quantity would cause the real price to change by less than 1%.

Summary

Maine's aquaculture industry, concentrating on Atlantic salmon production, is susceptible to increas-

[1] $\partial RP_{US}/\partial \ln Q_{US} = \partial RP_{US}/(\partial \ln Q_{US}/Q_{US}) = -0.0349$. Price flexibility at the mean $\overline{RP}_{US} = 0.71$ is then $\partial RP_{US}/\partial \ln Q_{US} = \partial RP_{US}/(\partial \ln Q_{US}/Q_{US}) = -0.0349/0.71 = -0.05$. Similarly, $\overline{RP}_{IM} = 0.66$ and the price flexibility for imported haddock is −0.06.

Table 1. 3SLS Price-response Equation Estimates.

	U.S.	Import
Dependent Variable	RP_{US}	RP_{IM}
ln (Q_{us})	-0.0349**	
	(0.0115)	
ln (Q_{im})		-0.0398*
		(0.0157)
RP_{im}	1.2371**	
	(0.2055)	
RP_{us}		0.3484**
		(0.0985)
ln (RI)	1.3800**	-0.4462
	(0.5190)	(0.3140)
T	-0.0416**	0.00701
	(0.0151)	(0.0093)
$\sin\left(\frac{2\pi}{12}t\right)$	0.0015	0.0126
	(0.0166)	(0.0083)
$\cos\left(\frac{2\pi}{12}t\right)$	-0.0106	0.0158*
	(0.0102)	(0.0067)
Intercept	-11.1452**	4.4106
	(4.1831)	(2.5864)

Standard errors are in parentheses.
* Statistically significant at the 5% level.
** Statistically significant at the 1% level.

Table 2. Analytical Reduced-form Results.

	Endogenous variable	
Exogenous Variable	RP_{US}	RP_{IM}
ln (Q_{us})	-0.0613	-0.0214
ln (Q_{im})	-0.0865	-0.0699
ln (RI)	3.0003	1.0453
T	-0.0905	-0.0315

ing regulatory and market challenges. To decrease the risk associated with the production of a single species, Maine's aquaculture industry is focusing on developing the production of alternative species, including haddock, clams, groundfish, urchins, and scallops.

The estimation results of the econometric model describing the behavior of real prices for U.S. and imported haddock show that price response to proportional changes in own-quantity supplied are symmetric for the U.S. catch and for imports. The estimation results also confirm that domestic and imported haddock are close substitutes. Of special interest is the asymmetry in the substitutability between the two sources of haddock in the U.S. market. After taking into account the impact of changes in quantity supplied and price interactions, there is no evidence to indicate any seasonal pattern in price variation within the year.

The monthly price of fresh haddock, either from the U.S. catch or from imports, is fairly stable. Given that the price response is low relative to a change in quantity, there is a market potential for the development of haddock aquaculture production in Maine and the region without depressing the market price. There is no evidence to indicate that strategic marketing in any one month will generate greater-than-average revenues.

References

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