An Econometric Model of the Market For Fresh New England Groundfish with Emphasis on the Role of Canadian Imports

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Most econometric studies of the groundfish sector have suggested that either imports are not sensitive to U.S. prices, or that domestic prices are not much affected by imports, or both. Using a six equation model of the domestic fresh groundfish market we obtained contrasting results. For example, a 5.82 percent tariff of the type proposed by the U.S. International Trade Commission in 1986 would, if it applied to both whole fish and fillets, lower imports of fresh fish 3.7 percent and raise domestic ex-vessel prices 2.6 percent in the long run. The main reasons for the different results appear to be our inclusion of exchange rate effects and a more accurate measure of total fresh imports.

Introduction

Recently, considerable attention has been given to the economic situation of the New England fishing industry, especially the ex-vessel prices received for groundfish and the possible impact of Canadian imports. New England fishermen have claimed that cheap Canadian imports of fresh groundfish have driven down the domestic prices and therefore are a major reason for their decreasing wages and profits. They have argued that since the Canadian fishing industry has been subsidized, the imports constituted unfair competition. They have petitioned for relief in the form of countervailing duties. While Canadian fishermen are undoubtedly subsidized, the relative importance of the subsidy has been a subject of debate. There is controversy about the effect of imports. An International Trade Commission study found that imports cause damage to domestic producers (USITC, 1984). But other econometric studies have concluded that groundfish imports have only minor effects on domestic prices (Bockstael, Wang and Norton) or that tariffs would be ineffective in protecting domestic ex-vessel prices (Crutchfield, 1985c). However, most of the other studies have not focused exclusively on the fresh fish market which is the primary outlet for the groundfish landed by the New England fishermen. We also believe there are other areas of deficiency in previous research. The study reported here uses some new approaches and some data not available to previous researchers and comes up with somewhat different conclusions.

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Background

While not a giant industry, commercial fishing is important to the New England economy. In 1984, total landings were worth $434 million at the dock and, after considering marketing activities and multiplier effects, probably contributed over $1 billion to incomes in the region. Groundfish have traditionally been the most important finfish species in New England and have recently accounted for about three-eighths of the value of total regional landings of finfish and shellfish. Groundfish are mainly cod, haddock, ocean perch and flounders but also include Atlantic pollock, cusk and hake. They are harvested primarily by the otter trawl fleet which operates out of major New England ports.

New England fishermen have harvested groundfish for hundreds of years, but imports have been the primary source of U.S. supply since the 1960s. Imports currently account for about 85 percent of U.S. groundfish consump-

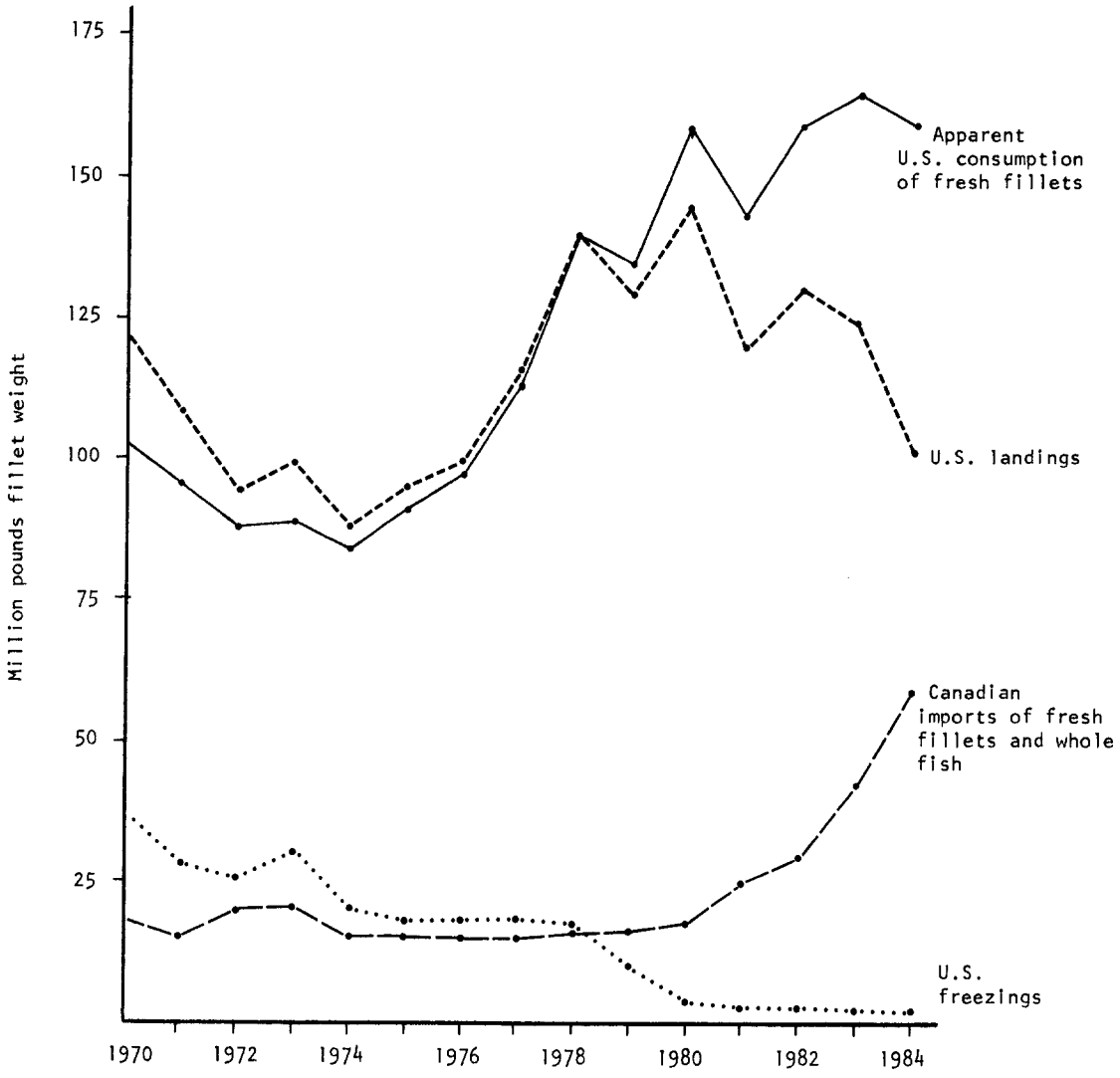

Figure 1. U.S. Groundfish Landings, Freezings, Fresh Imports from Canada, and Apparent Consumption of Fresh Fillets, 1970–1984.

tion.[1] Most of the imports have been frozen products, however. The groundfish market is segmented into three product types: fresh fillets, frozen fillets and frozen blocks and slabs which are used to produce fish sticks and fish portions. The fresh product carries a higher price than the frozen products and is marketed primarily in white tablecloth restaurants, supermarkets and specialty seafood stores. The greater part of the frozen products goes to institutions (hospitals, schools, plant cafeterias, prisons, etc.), fast food restaurants and checkered tablecloth restaurants, although some is also sold in supermarkets.

The higher priced fresh fish market has always been the primary outlet for domestic landings. Only during the occasional periods of excess supply have domestic landings of cod, haddock and flounder been directed to the frozen fish markets. Ocean perch represent an exception, as the traditional primary market for this species has been the frozen fillet market. During the early 1970s freezings accounted for 25 to 30 percent of U.S. landings, but the relative importance of freezings

[1] Our analysis includes only the four most important species: cod, haddock, ocean perch and flounders.

has decreased rather steadily, reaching a level of only two to three percent of landings in the 1980s (Figure 1). The decline in freezings reflects in part a decline in abundance (and therefore a decrease in relative importance) of ocean perch but also stems from an increase in the total market for fresh fillets with an associated reduction in the likelihood of any domestic excess supply.

Examination of the relationship between U.S. consumption of fresh groundfish fillets, U.S. groundfish landings, and Canadian fresh groundfish imports reveals some interesting developments during the 1970 to 1984 period (Figure 1).[2] U.S. landings had dropped somewhat during the early 1970s but increased sharply during the latter part of the 1970s, reached a peak in 1980, and then fell off again. The increase was a result of expansion of the domestic fishing fleet in response to the opportunity provided by the 200 mile exclusive fishing zone established by the Fishery Conservation and Management Act of 1976. But fish stocks apparently could not stand up to the increased fishing pressure, and the U.S. catch started to drop again. Canadian fresh fish imports were relatively constant during the 1970s but jumped upwards in the 1980s.[3] Consumption has been increasing since the mid 1970s, with the increase fed initially by the increase in domestic landings, but later by the increased Canadian imports. By 1984, Canadian imports had swelled to 37 percent of U.S. fresh groundfish consumption, whereas the Canadian import share had been only one-half to one-third that amount in earlier years.

The Tariff Acts of 1922 and 1930 as amended by later trade acts have provided for duties on imported frozen and fresh groundfish fillets and steaks for a long period of time, but the tariffs have been relatively small. During the period 1970 to 1984 a duty of 1.875 cents per pound applied to imports that fell within a quarterly quota, and a higher duty of 2.5 cents per pound applied to the rest of quarterly imports through 1980. Starting in 1981, the higher duty was gradually reduced each year, to 2.04 cents in 1984. The quarterly quota was one-fourth of 15 percent of average annual U.S. consumption during the immediately preceding three years. There was no duty on whole groundfish imports during the period 1970 to 1984.

Since the import duties were fixed monetary amounts from 1970 to 1980 and then declined thereafter, while nominal fish prices were rising substantially (a 217 percent increase in nominal wholesale fresh fillet prices between 1970 and 1984), their relative importance declined throughout the period. In 1970, the "under quota" duty equalled 2.9 percent of the wholesale fresh fillet price and the "over quota" duty equalled 3.9 percent. By 1984, the "under quota" duty had fallen to 0.9 percent and the "over quota" duty was 1.0 percent of the wholesale fresh fillet price.

In response to the New England fishermen's petition for relief from what they felt was unfair competition from the subsidized Canadian fishermen, a Federal investigation of Canadian subsidies was conducted between 1983 and 1985. The U.S. International Trade Administration determined in 1986 that Canadian subsidies amounted to 5.82 percent. In a surprising turn of events, a companion Federal agency, the International Trade Commission, then announced that imported fresh whole Canadian groundfish would be subject to a 5.82 percent duty but that fresh groundfish fillets would enter the U.S. duty free. Whole groundfish imports had gradually increased from 14 percent of total fresh imports (fillet weight equivalent) in 1970 to 42 percent in 1984.

Review of Other Research

Over the years various studies of the groundfish market have been carried out. Some of the earlier studies focused on the demand for individual species, often at the ex-vessel level (Ahmad, Bell, Farrell and Lampe, Houtsma, Waugh and Norton). More recent work of this type has been done by Tsoa, Shrank and Roy and by Wang and Norton.

The modeling approach most closely related to ours, where groundfish species are aggregated and different market levels are considered, started with Bockstael's extensive study in 1977. She designed a model of 13 equations

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[2] Figure 1 shows average annual observations for the different series so that general trends may be seen clearly. Within-year variations are also important and will be considered in our analysis which uses quarterly observations. Landings and consumption are generally lowest in the first and last quarters of the year, higher in the second quarter and highest in the third quarter.

[3] Virtually all of the fresh groundfish imports during this period were from Canada. A small quantity of air shipments from Scandinavian countries and Iceland has entered the U.S., but most has been marketed in western and central parts of the country, so it has been ignored in this discussion.

that attempted to explain the behavior of retail consumption, prices, domestic freezings and imports. Cod, haddock, flounder and ocean perch were aggregated into three product types: fresh fillets, frozen fillets and sticks and portions. A block recursive approach was applied to break the model into submodels (blocks) such that the relationship between blocks was causal or recursive while the relationship within blocks was simultaneous. The model was estimated from monthly data covering the period 1964 to 1974. Bockstael lumped fresh and frozen imports together. She concluded that a 10 percent increase in aggregate fillet imports would reduce U.S. ex-vessel prices by only one percent. However, she found the fillet imports were fairly responsive to U.S. wholesale prices, with a supply price elasticity of 0.69, suggesting that a tariff would be a fairly strong deterrent to imports.

Crutchfield has carried out the most recent, comprehensive studies of demand for New England groundfish (Crutchfield 1985a, 1985b, 1985c). Crutchfield's model uses the same general format as the model developed by Bockstael. In addition to a later time series (1970 to 1982), the basic diference is that Crutchfield added new equations to differentiate between fresh and frozen groundfish. His model consists of 16 equations: eight demand equations, three import supply equations, and five price linkage equations (plus three implicitly defined identities for import prices). He estimated that import supply price elasticities were respectively: 0.16 for frozen fillets, 0.37 for fresh fillets, and 0.75 for frozen blocks (Crutchfield, 1985b). The relatively low fresh import supply price elasticity, together with other results of his study, suggested that tariffs would not be effective devices for improving the economic situation of domestic fishermen. We later provide a more detailed comparison of his results with those we obtained.

Wang and Norton's unpublished 1985 work estimated partial adjustment price models for individual species using 1974 to 1982 data. They concluded that in 1982 a 10 percent reduction in groundfish imports would raise ex-vessel prices by less than four percent.

Generally, then, other studies have suggested either that groundfish imports are not sensitive to U.S. prices, or that U.S. fishermen's prices are not much affected by import quantities, or both. But we have some new modeling approaches to report which lead, as it turns out, to somewhat different results.

Specification of the Model

Following the same approach as Bockstael and Crutchfield, we have aggregated the four most important Atlantic groundfish species (or species groupings) of cod, haddock, ocean perch and flounders into a single commodity.[4] In addition to the rather considerable simplication and convenience provided by this approach, there are both empirical and theoretical justifications. Consumer studies have revealed a great degree of substitutability among the different species (Hamilton and Bennett). A comparison of coefficient estimates when the species are treated separately indicates a degree of similarity in demand (Ahmad, Bell, Wang and Norton, and Waugh and Norton). Further, Grunfeld and Griliches have argued that the gains from reducing specification errors by aggregating may exceed the losses due to aggregation bias.

Unlike most of the other studies, including Bockstael and Crutchfield, we have chosen to focus exclusively on the fresh groundfish fillet market. Fresh fillets are to a large degree marketed in different outlets than the frozen products and typically command higher prices. It seems reasonable to assume that there is a separate market for fresh groundfish.

Since our model is most similar to Crutchfield's, some major differences between ours and his will be summarized here. First, we include the exchange rate as a variable in our import supply equation, while he did not. While exchange rates were fixed prior to 1971, making omission of their consideration insignificant in earlier studies, the fluctuating rates since 1971 make their consideration quite important for recent periods of analysis. Second, data on whole fresh fish imports were not available when Crutchfield did his analysis, so he included only fillets in his fresh imports series. However, whole fish imports had gradually increased to 42 percent of total fresh imports (fillet weight equivalent) by 1984. We obtained data which made it possible to combine whole and fillet imports in our analysis. They were treated as a single product since both end up as fillets when they are consumed. Third, in combining the prices of different species to formulate aggregate prices at the ex-vessel, wholesale and retail levels, we used Divisia price indexes as a basis for calculating weighted average prices rather than using

[4] Some groundfish are harvested by U.S. Pacific Coast fishermen but they were not included in the analysis.

simple weighted average prices. Divisia price indexes give a better accounting of changes in the composition of the aggregate than do simple weighted averages.[5] Fourth, U.S. landings are treated as exogenous in Crutchfield's model. We feel that the specification is made more theoretically sound by including them as an endogenous variable though there are obvious practical problems since no good measure of biological abundance is available. Fifth, we were able to extend the 1970-1982 time series by including 1983 and 1984 data, although first for comparison purposes we estimate the model using 1970-1982 data. Finally, we used quarterly data while Crutchfield used monthly data.

The model specified in our study includes five behavioral equations and one identity. Its basic structure can be outlined as follows. In the fresh market there are two domestic demands: for fresh consumption (equation 1) and for freezing (treated as exogenous). There are two supply sources: domestic landings (equation 6) and Canadian fresh imports (equation 5). The total amount supplied and consumed is balanced in an identity (equation 4). On the domestic side, linkages in the marketing chain connect retail and wholesale prices (equation 2), and wholesale and ex-vessel prices (equation 3). It could be argued that a single linkage between retail and ex-vessel prices would be sufficient. However, in order to simulate the behavior of wholesale price and because it seems the natural price level influencing entry of imports, two linkage equations are specified. Quarterly observations for the period 1970 to 1984 are used as the basis for estimation. All U.S. monetary quantities are deflated by the U.S. Consumer Price Index, and Canadian monetary quantities are deflated by the Canadian Consumer Price Index.

In deriving the retail demand equation it has been assumed that the consumer engages in decentralized budgeting and that there is a separability in the consumption of various commodity groups. Thus, the demand for fresh groundfish fillets can be derived from the consumer's demand for a commodity group consisting of animal protein sources. Retail demand is expressed as a function of own retail price, prices of frozen groundfish fillets, poultry prices, meat prices and disposable personal income. Wholesale rather than retail price is used for frozen fillets, because a high percentage of those products is consumed away from home (see Bockstael), and because the quality of the available wholesale price series is judged superior as a signal of the price of these substitute products. Historically, consumption is generally lowest in the first and last quarters, higher in spring and highest in summer. Although some of the seasonal variation can be explained by price effects, a part appears to be caused by change in taste. Warm weather, increased tourism and more vacation meals eaten away from home combine to stimulate demand for groundfish in the spring and summer. Therefore, retail demand for fresh groundfish is defined as:

$$(1)\quad Cf = f(PRf, PWz, CPIm, CPIp, Y, Q1, Q2, Q3)$$

where:

- Cf = Apparent U.S. consumption of fresh groundfish fillets in thousand of pounds.
- PRf = U.S. real retail price of fresh groundfish fillets in cents per pound. A Divisia price index constructed from retail prices and landings (fillet weight) of cod, haddock, and flounder.
- PWz = U.S. real wholesale price of frozen groundfish fillets in cents per pound. The wholesale price for five pound packages of Canadian cod at Boston is used to represent the wholesale price of all frozen fillets.
- CPIm = Consumer price index for meat (1967 = 100).
- CPIp = Consumer price index for poultry (1967 = 100).
- Y = Total real disposable personal income in the U.S. in billions of dollars.
- Q1, Q2, Q3 = Dummy variables for first, second and third quarter respectively.

The first price linkage, equation 2, does not specify retail price of fresh fillets simply as markup of wholesale price of fresh fillets but also includes ex-vessel price. To account for the price stickiness often noted at the retail

[5] An explanation of the methodology for constructing Divisia indexes is provided in Diewert.

level, retail price lagged one quarter is also included. The first price linkage equation is:

(2) $PRf = f(PRf\text{-}1, PWf, Pe)$

where:

PRF-1 = PRf lagged one quarter.
PWf = U.S. real wholesale price of fresh groundfish fillets in cents per pound. A Divisia price index constructed from wholesale prices and landings (fillet weight) of cod, haddock and flounder.
Pe = U.S. real ex-vessel price of groundfish in cents per pound. A Divisia price index constructed from ex-vessel prices and landings of cod, haddock, ocean perch and flounder.

In equation 3 there is an assumption that wholesalers do not simply mark down their ex-vessel price offer below wholesale price but adjust the markdown depending on quantity of landings. A dummy variable is included to reflect the structural change that took place with the extension to 200 miles of the U.S. fishing zone in 1976. The second price linkage equation is therefore:

(3) $Pe = f(L, PWf, FCMA)$

where:

L = U.S. groundfish landings in thousands of pounds of fillet weight equivalent. Total New England landings of cod, haddock, ocean perch and flounder.
FMCA = The U.S. 200 mile fishing zone. FCMA = 0 through the first quarter of 1976 and 1 thereafter.

The supply of groundfish originates from two sources: domestic landings and Canadian imports. Domestic landings are either consumed as fresh fillets or go into domestic freezings.[6] U.S. apparent consumption then is equal to domestic landings plus Canadian imports minus domestic freezings. Therefore, the market clearing equation is the following identity:

(4) $Cf = L + IFcan - FRz$

where:

IFcan = U.S. imports of all species of fresh Canadian groundfish in thousands of pounds of fillet weight equivalent.
FRz = U.S. freezings of groundfish fillets in thousands of pounds. Total U.S. freezings of cod, haddock, ocean perch and flounder.

Canadian fish processing plants transform the groundfish catch into four product forms which, after their domestic market has been satisfied, are directed to exports. Seventy-eight percent of Canada's groundfish landings were exported in 1980, with three-quarters of the exports going to the U.S. (Kirby). The real relative wholesale prices of different product forms determines processor strategy. We first use U.S. wholesale prices for fresh fillets, frozen fillets and blocks, where the U.S. is the primary market. Salted fish go primarily into other markets; the Icelandic price is used as an indicator. The exchange rate between the U.S. and the Canadian dollar (EXcan) indicates the profits to be made from sales in the U.S. market. A rising real value of the U.S. dollar encourages more Canadian exports to the United States.

A more detailed specification would have Canadian exports a function of Canadian domestic prices for the various product forms. These would be converted into a common base by multiplying them by the ratio of U.S. dollars to the Canadian dollar. (If the exchange rate were inverted and all foreign prices converted to Canadian dollar equivalents, this would have the same effect.) We have taken the simpler route of treating the Canadian domestic product as a composite whose real price is expressible by the exchange rate alone.

Of the four product forms, frozen fillets and blocks are the most labor intensive. As a result, when wages in the Canadian fish processing industry (WR) increase, fish processing firms might be expected to reduce freezings, with a subsequent increase in fresh fillet supply. It is reasonable to assume that an increase in landings of Atlantic groundfish in Canada (Lcan) will have a positive impact on imports. To represent seasonal variations and the stick-

[6] A problem which we share with other studies is that domestic freezings data do not distinguish between Atlantic and Pacific groundfish freezings. Therefore the domestic freezings variable includes freezings of Pacific groundfish. While Pacific groundfish landings were very unimportant in the earlier part of the 1970-84 period, by 1984 they had grown to 39 percent of the total. Since only 10 to 15 percent of domestic landings are frozen, the consequences of this measurement error are felt to be minor.

iness in supply due to long term contracts, lagged values for imports are used to explain current period Canadian imports. A dummy shift variable for 1983 and 1984 is also added to this equation to capture the otherwise inexplicable surge in Canadian exports to the U.S. The Canadian import supply equation is defined as:

(5) IFcan = f(IFcan-1, IFcan-4, PWf, PWz, PWb, Ps, Lcan, WR, EXcan, D)

where:

IFcan-1, IFcan-4 = IFcan lagged one quarter and four quarters respectively.
PWb = U.S. real wholesale price for groundfish blocks in cents per pound. The wholesale price for cod blocks at the Boston market is used to represent the wholesale price of all groundfish blocks.
Ps = The real price of salted groundfish in dollars per metric ton. The price paid to Icelandic salted cod producers is used, and is expressed in U.S. dollars.
Lcan = Canadian groundfish landings in thousands of metric tons.
WR = Hourly real wage rate paid in the Canadian fish processing industry in Canadian dollars.
EXcan = Exchange rate of Canadian dollars for U.S. dollars (Canadian dollars divided by U.S. dollars).
D = A dummy variable to indicate a shift in the supply of Canadian imports starting in 1983. D = 0 before 1983 and D = 1 thereafter.

To close the model, an equation for domestic supply is defined. In equation 6, domestic landings (L) are expressed as a function of past landings, representing seasonal variations in availability and access to fish stocks, own price (Pe), the price of scallops (Pesc), representing a possible alternative use for groundfish trawlers, and a dummy indicating a shift in the intercept with the extension of the U.S. fishing zone in 1976 (FCMA). Ex-vessel prices for groundfish and scallops are lagged by three quarters to account for time intervals needed for fishermen to decide to adjust to changes in relative prices of the two alternative target species. Gear changes can be made fairly quickly, but a comparison of results indicated that the biggest influence was from prices lagged three periods. The domestic supply equation is:

(6) L = f(L-1, L-2, L-3, L-4, Pe-3, Pesc-3, FCMA)

where:

L-1, L-2, L-3, L-4 = L lagged one, two, three and four quarters respectively.
Pe-3 = Pe lagged three quarters.
Pesc-3 = U.S. real ex-vessel price of sea scallops in cents per pound, lagged three quarters. The Massachusetts price is used.

Estimation Procedure and Results

Data used to estimate the model came primarily from the U.S. National Marine Fisheries Service's computer data base entitled "DB-Fish," with updates provided by NMFS offices in Washington, D.C. and Woods Hole, Massachusetts. Some data were obtained from other NMFS publications, or from general U.S. economic data sources. Canadian imports, landings and wage rate data were obtained from Statistics Canada. The price of salted cod came from the Annual Reports of the Association of Icelandic Fish Exporters.

Although data were available as monthly observations we chose to aggregate them into quarterly units. In doing so we followed the tradition of earlier studies. One of the few studies with monthly observations (Tsoa et al.) had to use monthly dummy variables. Demand and supply vary more predictably by quarter of the year rather than by the month of the year. Also, we hypothesized lagged relationships of some variables, and they were easier to deal with in the quarterly formulation.

The model was estimated by the three-stage least squares method over two intervals, first from 1970 to 1982 (to enable comparisons with Crutchfield's results), and second, using observations from 1970 through 1984. The computer program SHAZAM (White) was used. All equations were estimated in double log form.

Estimation results are presented in Table 1. The system R^2 in both models is over .99. All equations except equation 1 appear to be fairly stable with respect to the two different time intervals. The change in results for equation 1 could indicate a shift in consumers' preferences or could signal deficiencies in the specification. It is noteworthy that the coefficient for own price in the retail demand equation is in both models lower than estimated in most previous studies. Income appears to have a strong impact on demand. Poultry prices do not have the expected substitute effect, but meat prices are significant substitutes in the 1970 to 1984 model. As expected, demand is higher in the second and third quarters of the year.

Most of the results for equations 2 and 3 are in accordance with expectations, although the t-ratio for wholesale prices in equation 2 is very small. The Canadian import supply equation, equation 5, has the expected and significant results for U.S. wholesale fresh fillet prices, the U.S. block price, and lagged import quantities. The exchange rate appears to have an important role. Surprisingly, Canadian landings, Canadian wages, U.S. frozen fillet prices and salted groundfish prices do not appear to affect Canadian exports. The unimpressive results for equation 6 were not surprising; only coefficients on landings in the same quarter one year earlier and the ex-vessel price of scallops had significantly large t-ratios.

Table 2 compares some of the coefficients from our 1970-1982 model and Crutchfield's model. It should be noted that variables used in the present study sometimes differ from those used by Crutchfield, both in containing data revisions and in using different aggregation formulas. There are some important differences between the two models. Price elasticity of demand at the retail level is estimated to be −1.27 in our 1970-1982 model whereas Crutchfield's model gives a value of −4.66 for retail price elasticity. Crutchfield's estimate of fresh fillet import supply price elasticity is 0.37—a value that is less than half of the 0.88 estimated in our 1970-1982 model for fresh fillet and whole fish imports combined. Both models estimated similar ex-vessel price flexibilities.

Table 1. Estimation Results for Two Different Observation Periods: 1970-1982 and 1970-1984

	1970-1982		1970-1984	
Variable	Parameter Estimate	T-ratio	Parameter Estimate	T-ratio
Equation 1: Retail demand for fresh groundfish fillets				
Dependent variable: Consumption of fresh groundfish fillets (Cf)				
PRf	−1.271	3.98	−0.751	2.70
PWz	0.035	0.29	0.140	1.18
Y	3.922	6.51	2.353	6.15
CRIp	−0.109	0.37	−0.803	4.32
CPIm	−0.085	0.27	0.524	2.20
Q1	−0.067	1.71	−0.088	2.28
Q2	0.137	3.73	0.120	3.25
Q3	0.102	2.81	0.116	3.31
Interc.	−9.588	2.95	−1.530	0.63
Equation 2: Price relationships at three groundfish market levels				
Dependent variable: Retail price of fresh groundfish fillets (PRf)				
PRf-1	0.606	10.87	0.571	10.74
PWf	−0.059	0.70	0.041	0.61
Pe	0.320	6.25	0.262	6.16
Interc.	1.372	4.85	1.295	4.84
Equation 3: Ex-vessel groundfish prices				
Dependent variable: Ex-vessel groundfish price (Pe)				
L	−0.377	5.56	−0.449	7.29
PWf	0.832	6.79	0.743	6.84
FCMA	0.164	4.96	0.194	6.57
Interc.	3.160	2.96	4.303	4.56
Equation 5: Import supply of fresh Canadian groundfish				
Dependent variable: Imports of fresh Canadian groundfish (IFcan)				
IFcan-1	0.372	3.66	0.273	2.76
IFcan-4	0.355	3.30	0.308	2.91
Lcan	−0.018	0.31	−0.006	0.10
PWf	0.882	2.23	0.865	2.51
PWz	0.367	1.21	0.384	1.28
PWb	−0.682	2.26	−0.732	2.60
Ps	−0.288	1.51	−0.236	1.30
EXcan	2.495	3.98	2.542	4.35
WR	−0.029	0.13	−0.098	0.42
D1			0.362	3.04
Interc.	1.714	0.88	2.725	1.48
Equation 6: Domestic groundfish supply				
Dependent variable: Landings of groundfish in New England (L)				
L-1	0.054	0.54	0.036	0.38
L-2	−0.106	1.07	−0.101	1.08
L-3	0.004	0.04	0.004	0.04
L-4	0.793	7.08	0.787	7.09
Pe-3	0.146	1.08	0.135	1.11
Pesc-3	−0.181	1.83	−0.217	2.64
FCMA	0.114	1.73	0.769	1.28
Interc.	3.029	1.59	3.470	1.96

Table 2 also presents the results of an ex-post forecasting exercise. The Crutchfield model was used to forecast monthly series for 1983, and the model developed here was used to predict quarterly observations for 1983 and 1984.[7] On the basis of mean square errors (MSEs) and Theil's U coefficients, the two models' forecasting performance can be compared. Neither model gives a particularly good forecast. With Theil's U of 1 or higher, a simple extrapolation forecast would have done a better job. However, the model developed here gives better forecasts than the Crutchfield model.

Table 2. Comparison of Our 1970-1982 Model with the Crutchfield Model: Elasticity Estimates and Forecasting Performance

Parameter Estimated and Forecasting Performance Criterion	Our Model (1970-1982): Forecasting 1983-1984	Crutchfield's Model: Forecasting 1983
Dependent variable: Consumption of fresh groundfish fillets (Cf)		
Retail price (PRf)	−1.27	−4.66
t-ratio	3.98	6.52
MSE	0.088	0.081
Theil's U	1.633	2.431
Dependent variable: Ex-vessel groundfish price (Pe)		
Landings (L)	−0.38	−0.36
t-ratio	5.56	7.76
Wholesale price (PWf)	0.83	0.14*
t-ratio	6.79	0.81
MSE	0.009	0.081
Theil's U	0.457	4.484
Dependent variable: Imports of fresh Canadian groundfish (IFcan)**		
Wholesale price (PWf)	0.88	0.37*
t-ratio	2.23	1.82
Real exchange-rate (EXcan)	2.49	NA
t-ratio	3.98	
MSE	0.102	2.498
Theil's U	1.181	3.798

* Our PWf was the wholesale price for fresh fillets; Crutchfield used the import price for fresh fillets.
** Our IFcan included fresh whole fish and fillets, Crutchfield included only fillets in his fresh import series.

Simulation of the Impact of Countervailing Duties

The model estimated from 1970 to 1984 data was used to simulate the impact of various countervailing duties. All variables were held at 1984 levels, and the effects of three alternative levels of countervailing duty were simulated over a ten year period. Levels chosen included the 5.82 percent rate that was actually announced by the ITA in 1986 and two higher levels.[8] The simulations were done with TSP35 (Time Series Processor) using the method developed by Fletcher and Powell. Simulated impacts on key price and quantity variables are shown in Table 3. For example, the table shows that a 5.82 percent duty on fresh groundfish imports would reduce imports by 2.4 percent from what they otherwise would have been in the first year, by 3.1 percent in the second year, by 3.9 percent in the fifth year, and by 3.7 percent in the tenth year. Generally, the simulation suggested that imports would be reduced and domestic fishermen's prices would be increased, but that consumers would pay higher prices and eat less fish if tariffs were to be imposed. While the projected responses in each of these areas are proportionately less than the change in the countervailing duty, they are greater than those suggested by most other, recent econometric studies. For example, Crutchfield (1985c) projected that a 20 percent duty on fresh fillet imports would decrease fillet import quantities by only 2.6 percent and would increase U.S. ex-vessel prices by only 2.4 percent. By contrast, our model suggests that a 20 percent duty on all fresh imports (whole fish and fillets) would decrease imports by 8.9 percent in the first year (and by over 14 percent by the tenth year) and would increase ex-vessel prices by 10.7 percent in the first year (and by slightly less than 10 percent by the tenth year).

The model indicated that variations in the U.S.-Canadian dollar exchange rate have a particularly strong effect on imports and the other key variables shown in the table. Another simulation showed that a 5 percent increase in the value of the U.S. dollar relative to the Canadian dollar would more than offset the impact of a 5.82 percent tariff. In other words, a 5 percent increase in the exchange value of the dollar coupled with a 5.82 percent tariff would result in increased imports and

[7] Crutchfield's data series were not available for 1984, so the forecasting performance of his model could be observed only for 1983.

[8] Our model treated fresh whole fish and fresh fillets as the same product. Since the 1986 ITA decision imposed 5.82 percent duty on whole fish but not fillets, our simulation does not correspond exactly to their decision.

Table 3. The Impact (Percentage Change) on Key Prices and Quantities of Different Countervailing Duty Rates on Fresh Canadian Groundfish Imports

Item Impacted and Time Period	Countervailing Duty Rate		
	5.82	10	20
	(Percentage change compared to no duty)		
Fresh Canadian groundfish imports (IFcan)			
1st year	−2.4	−4.2	− 8.9
2nd year	−3.2	−5.3	−12.0
5th year	−3.9	−6.9	−14.2
10th year	−3.7	−6.9	−14.4
Ex-vessel groundfish prices (Pe)			
1st year	+2.8	+4.9	+10.7
2nd year	+3.1	+5.4	+10.8
5th year	+2.6	+4.6	+ 9.8
10th year	+2.6	+4.5	+ 9.7
Retail fresh groundfish fillet prices (PRf)			
1st year	+1.5	+2.6	+ 5.5
2nd year	+2.0	+3.3	+ 7.3
5th year	+2.0	+3.5	+ 7.4
10th year	+1.8	+3.3	+ 7.0
Consumption of fresh groundfish (Cf)			
1st year	−1.1	−1.9	− 4.0
2nd year	−1.3	−2.2	− 5.0
5th year	−1.4	−2.5	− 5.2
10th year	−1.2	−2.4	−5.0

Note: The 1970-1984 model was used to simulate the impacts shown in this table.

consumption and decreases in fishermen's prices and retail prices. A decrease in the value of the U.S. dollar relative to the Canadian dollar would, of course, have the opposite effect; it would decrease imports and consumption and increase fishermen's prices and retail prices.

The study also indicated that higher fishermen's prices would induce more fishing effort and catch and consequently, pressure on the already heavily-fished groundfish stocks would increase. In the short-run, catches might increase, but longer-run depleting effects of increased fishing effort might result in decreased revenues to fishermen, thereby offsetting the short-run gains. While we are not very confident about the quantitative accuracy of our domestic supply equation, in a qualitative way at least, these results seem plausible.

Summary and Conclusions

Buildings on other econometric studies, especially the approach started by Bockstael and continued by Crutchfield, but using some different and more recent data and some differences in specification, we have modeled the market for fresh New England groundfish. Particular attention was given to the role of Canadian fresh fish imports which had increased to 37 percent of U.S. fresh groundfish consumption by 1984. Unlike most other studies, ours focused exclusively on the fresh fish market which is of paramount importance to New England fishermen.

Most other econometric studies have suggested either that groundfish imports are not sensitive to U.S. prices, or that U.S. fishermen's prices are not much affected by import quantities, or both. However, our model estimated a Canadian fresh import supply price elasticity (U.S. wholesale price) of 0.88, which is considerably higher than the elasticity indicated by other studies. Our study included whole fish imports, which had grown to 42 percent of the total by 1984, as well as fillets, which were the only imports included in other studies. We also included the U.S.-Canadian exchange rate as an explanatory variable, and it turned out to have an important effect.

We simulated the effect of various levels of countervailing duty over a ten year period and found that tariffs would fairly substantially reduce imports and elevate domestic fishermen's prices, at the cost of higher retail prices and reduced domestic consumption. For example, in the first year a 5.82 percent duty would reduce imports by 2.4 percent compared to what they otherwise would have been, increase ex-vessel prices by 2.8 percent, increase retail prices by 1.5 percent and reduce consumption by 1.1 percent. Longer run effects were somewhat higher for all variables except ex-vessel prices, which ended up 2.6 percent higher in the fifth to tenth years. The 5.82 percent duty used for illustration is the rate proposed by the U.S. International Trade Administration on fresh whole fish imports (but not fillets) in the Spring of 1986. However, since our model treated whole fish and fillets as the same product, the effect of the ITA decision, which is still under review, cannot be simulated accurately. We cannot analyze any shift by Canadian exporters from

whole fish to fillets as a result of this selective tariff.

To the extent that domestic fishermen's prices are elevated by tariffs, it can be expected that fishing effort will increase and therefore that pressure on already heavily-fished groundfish stocks will increase. Our model incorporated this concept, but we did not attempt to model the biological production function for the New England groundfishery. Reduced catches per unit of fishing effort are a distinct longer-run possibility.

New England fishermen enjoyed a few years of good profits following the extension of U.S. fishing limits to 200 miles in 1976. More recently they have suffered reduced profits because of higher costs, loss of some fishing grounds to Canada, and overfishing in the remaining exclusive economic zone. Canadian import competition is only one of their problems. Countervailing duties will help somewhat, according to our model, although at a cost to consumers and at a cost to our trade relations with Canada. But stronger solutions, including better management of the fish stocks, are needed to ensure an economically viable industry.

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