INTEGRATION OF JAPANESE AND UNITED STATES SABLEFISH MARKETS

DALE SQUIRES,[1] SAMUEL F. HERRICK, JR.,[1] AND JAMES HASTIE[2]

ABSTRACT

As United States sablefish production becomes more tightly interwoven with Japanese markets, the U.S. sablefish fleet could become more vulnerable to changes in Japanese market conditions and government policies, and U.S. policies would have to be formulated with an eye on Japanese conditions. If U.S. ex-vessel and Japanese markets are integrated by prices, then price information transmitted from the Japanese market affects the behavior of the U.S. markets, while in turn, if the markets are not price integrated, U.S. market behavior is independent of price movements in Japan. To assess this likely market integration, this paper examines the price integration of the Pacific coast and Alaska's fixed gear ex-vessel markets and the Tokyo central wholesale market over 1981–1986. The Pacific coast market is found to be segmented from the Tokyo market while a form of price integration exists between the Tokyo and Alaska markets. The paper concludes with a number of implications for policies in both the United States and Japan.

Following the Manguson Fishery Conservation and Management Act (MFCMA) of 1977, United States fishermen have been given an opportunity to replace foreign harvesters of several species as the first link in a chain of supply for some foreign markets. In few fisheries have the results of this industry domestication been more strongly demonstrated than in those for Pacific sablefish. As the Japanese witnessd their harvest in U.S. territorial waters fall from 25,000 to 50,000 thousand metric ton (t) range in the mid-70's to negligible amounts in recent years, U.S. producers expanded their sablefish operations, thereby facilitating greater U.S. exports. Throughout much of the early 1980's, these increases in U.S. exports were accompanied by continued reductions in Japanese harvests.

These factors have combined to increase the ex-vessel sablefish revenue received by Pacific coast and Alaska groundfish fishermen to a level second only to that for Alaska pollock. In contrast to pollock, which is currently harvested predominantly by joint venture operations, sablefish is almost exclusively domestically harvested and processed. The dramatic increase in U.S. production and revenues had coincided with an increase in U.S. sablefish exports to Japan from just 340 t in 1981 to roughly 12,000 t in 1986.

The growing reliance of Japanese sablefish markets on U.S. exports concomitant with an expanding U.S. sablefish fleet suggests the possibility of a growing integration of the Japanese and U.S. ex-vessel sablefish markets. To the extent that U.S. production becomes more tightly interwoven with Japanese markets, the U.S. sablefish fleet will become more vulnerable to changes in Japanese market conditions. Changes in Japanese prices or the exchange rate have a much greater potential for impacting U.S. fishermen today than even 5 or 10 years ago. This possibly increasing integration of U.S. ex-vessel and Japanese sablefish markets by both price and commodity flows and the increased economic dependence on the U.S. export of sablefish for both societies underscores the need for a better understanding of the manner in which these markets are integrated.

This paper empirically examines the integration by prices of U.S. and Japanese sablefish markets over the time period 1981–86. We consider the Tokyo central wholesale (Tsukiji) market and the U.S. ex-vessel markets in Alaska and along the Pacific coast. Because quite a sizable amount of the domestically caught sablefish is retained in the United States, consideration of U.S. markets at some level beyond the ex-vessel might seem desireable, but we restrict our attention to the ex-vessel level because of data availability. We further restrict

[1]Southwest Fisheries Center La Jolla Laboratory, National Marine Fisheries Service, NOAA, P.O. Box 271, La Jolla, CA 92103.

[2]Northwest Fisheries Center Seattle Laboratory, National Marine Fisheries Service, NOAA, 7600 Sand Point Way NE, Seattle, WA 98115.

Manuscript accepted November 1988.
Fishery Bulletin, U.S. 87:341–351.

our analysis to the pot and longline, or fixed gear, sector of the fleet, because these vessels produce the higher quality sablefish desired by Japanese consumers.

We consider Tokyo the central wholesale market, because it is playing an increasingly dominant role in the handling of sablefish in Japan. Before the imposition of harvest restrictions, when the Japanese fishing fleet was responsible for providing most of the domestically consumed sablefish, the centralized market in Tokyo played a less important role in the distribution of sablefish; it may have handled less than 50% of that consumed. As Japan was forced to rely increasingly on imports of sablefish, the clearinghouse in Tokyo has become more prominent by providing a conduit for the imported product. Throughout most of the 1980's, the Tokyo market has generally handled 60–70% of the sablefish sold in Japan.

MARKET INTEGRATION AND PRICE ANALYSIS

This section defines market integration and presents the formal models used to empirically assess the structure of any price integration which may exist.

Market Integration

Markets integrated by prices are those markets in which prices do not behave independently. In market economies, market information to the different participating economic agents is largely transmitted by prices, so that an understanding of the manner in which markets are integrated by prices can contribute to the general process of policy formulation. Markets may be integrated by prices to different degrees and along some dimensions but not others. Geographical links or interregional trade are among the most important. Two major issues of these spatial price linkages have been most frequently examined: whether or not markets are integrated by prices, and if so, the extent and nature of this integration.

Regression analysis is the preferred method of assessing market integration. This procedure implicitly assumes that prices of commodities in spatially dispersed markets can independently move in a nonintegrated market system. Changes in weather patterns or government policies affecting the quantity and price of a commodity in a market should not have an impact on prices in other markets when the market system is not integrated by the price mechanism. Price movements across markets would be fundamentally independent, and price movements within markets would reflect local responses to local conditions.

Dynamic Spatial Price Differentials

Ravallion (1986) recently proposed a dynamic model of spatial price differentials from a central market to local markets for a tradeable good. Ravallion's model permits each local price series to have its own dynamic structure, allows for any correlated local seasonality or other characteristics, and provides for an interlinkage with other local markets. Moreover, the alternative hypotheses of integration of markets by price and market segmentation are encompassed within a more general model, thereby allowing for nested statistical testing. Finally, Ravallion's dynamic model distinguishes between the concepts of instantaneous market integration and the less restrictive idea of integration as a long-run target of the short-run dynamic adjustment process. Thus, while short-run adjustment could be statistically rejected by the data, so that trade does not immediately adjust to spatial price differentials, it is still possible to determine if there is any long-run tendency toward market integration.

Ravallion (1986) proposed the following econometric model of a T-period series of prices for N regions:

$$P_{it} = \sum_{j=1}^{J} a_{ij}P_{it-j} + \sum_{j=0}^{J} b_{ij}P_{1t-j} + c_iX_{it} + e_{it}, \quad i = 2,\ldots,N, \qquad (1)$$

where market 1 is the central market (here Tokyo), X_i ($i = 1,2,\ldots,N$) is a matrix of nonprice influences on local markets, the e_{it}'s are appropriate error processes, J is the number of time periods to be lagged, and the a's, b's, and c's are parameters to be estimated.

Several hypotheses about interregional trade and market integration can be formulated as linear parameter restrictions on Equation (1) and tested by F-tests (Ravallion 1986):

Market Segmentation

The null hypothesis of local market segmentation states that changes in the central market prices will have no effect, immediate or lagged, on prices in the ith local market. Market i could be called segmented if

$$b_{ij} = 0, \quad j = 0,1,2,\ldots,J, \tag{2}$$

which can be determined by imposing the parameter restriction of Equation (2) on Equation (1), and testing this restricted model against the unrestricted model of Equation (1) with an F-test. Nonrejection of the linear restrictions or null hypothesis indicates that the price in local market i depends only on its own lagged values and local market characteristics.

Short-Run Market Integration

A price change in the central market will be immediately and fully passed on to the ith local market price if

$$b_{i0} = 1. \tag{3}$$

This hypothesis, in addition, requires that there be no lagged effects on prices in the future:

$$a_{ij} = b_{ij} = 0, \quad j = 1,2,\ldots,J. \tag{4}$$

If both Equations (3) and (4) are accepted as parameter restrictions, then market i is integrated with the central market within one time period.

A weaker form of short-run market integration will also be tested, in which the lagged effects need only vanish on average:

$$\sum_{j=1}^{J} a_{ij} + \sum_{j=1}^{J} b_{ij} = 0. \tag{5}$$

An additional indicator of short-run market integration occurs if $b_{i0} = 1$, but Equation (4) or (5) do not hold (Heytens 1986). In this case, short-run market integration cannot be accepted, yet economic forces causing central market price changes are generally being reflected in the local price level. A form of integration is occurring, even though the central and local markets are not being fully linked in the short run; that is, changes in the price margin between the central and local markets are not being fully passed on.

Absence of Local Market Characteristics

This hypothesis assumes that

$$c_i = 0, \tag{6}$$

where c_i is a vector if there is more than one local market characteristic. Testing this hypothesis is of interest when local prices are suspected to have different seasonality than the central market. In this case, X_{it} can be defined as a matrix of dummy variables.

Long-Run Market Integration

A long-run equilibrium is one in which market prices are constant over time, undisturbed by any local stochastic effects. Thus, when $P_{it} = P_i^*, j = 2,\ldots,n$, $P_{1t} = P_1^*$, and $e_{it} = 0$ for all t, Equation (2) takes the form

$$P_i^* = \frac{P_1^* \sum_{j=0}^{J} b_{ij} + X_{it}c_i}{1 - \sum_{j=1}^{J} a_{ij}}. \tag{7}$$

Long-run market integration now requires that

$$\sum_{j=1}^{J} a_{ij} + \sum_{j=0}^{J} b_{ij} = 1. \tag{8}$$

If this linear parameter restriction is not rejected by an F-test, then the short-run process of price adjustment described by the model is consistent with an equilibrium in which a unit increase in the central market price is fully passed on in local market prices. Markets where previous central market prices and past spatial price differentials are the primary determinants of local prices (rather than previous local prices) are well connected in the sense that supply and demand conditions in the central market are communicated effectively to local markets. In the long run, the central market influences local market prices irrespective of previous local conditions, even though traders may fail to connect the two markets through commodity flows in the short run (cf Timmer 1974). Acceptance of the short-run restrictions implies long-run market integration, but the reverse is not necessarily true.

If the linear restriction for long-run market integration is not rejected, then more efficient estimates of the remaining parameters and more powerful statistical tests are possible if the model is reestimated with long-run market integration imposed. Equation (1) under long-run integration can be written in the following equivalent form (Ravallion 1986):

$$P_{it} - P_{it-1} = (a_{it} - 1)(P_{it-1} - P_{1t-1}) + \sum_{j=2}^{J} a_{ij}(P_{it-j} - P_{1t-j})$$

$$+ b_{10}(P_{1t} - P_{1t-1}) + \sum_{j=1}^{J-1} (b_{10} - 1 - \sum_{k=1}^{J} a_{ik} + b_{ik})$$

$$\times (P_{1t-j} - P_{1t-j-1}) + c_i X_{it} + e_{it}. \quad (9)$$

Changes in local market prices, $P_{it} - P_{it-1}$, are then attributable to changes in central market prices and past spatial price differentials between local and central market prices. The latter variables allow for the possibility that the markets are not observed in an integrated equilibrium at a given time period, so that there is feedback from prior disequilibria.

Ravallion (1986) proposed the following sequence of nested F-tests for the different null hypotheses. First, test for long-run integration. If long-run market integration is not rejected, then it should be imposed on the model with subsequent tests based on a restricted form such as Equation (9). If the null hypothesis of long-run market integration is rejected, then short-run market integration and market segmentation are tested.

Specification Issues

Central and local market prices in Equation (1) might be simultaneously formed. This possibility leads to a simultaneous equation problem, so that parameter estimates could be biased and inconsistent. Ravallion (1986) noted that the simultaneity in the system can be easily dealt with by using an appropriate instrumental variables estimator. This paper uses the two-stage least squares estimate of Equation (1) formed by replacing P_{1t} with its predicted values from the reduced form equation obtained from a regression of P_{1t} against its own values lagged one period, the values of prices in all local markets lagged one period, all dummy variables, and the time trend variable.

Several nonprice influences (X_{it}) are possible. First, the influence of seasonality is accounted for by quarterly dummy variables for winter, spring, summer, and fall. Second, the possibility of long-term effects from increasing U.S. exports coupled with continued reductions in Japanese harvest are captured by a linear time trend. Third, a dummy variable for the years 1984–86 is included to capture any effects from the reduction of Japanese sablefish catch within the U.S. 200 mile zone and concomitant increase in U.S. harvests and exports of sablefish that experienced an important increase beginning in 1984 (Hastie 1988).

Lagged Effects

Any lagged effects in the model are likely to arise from sluggishness in price adjustment, delays in transportation, cold storage inventory holdings, and expectations formation under price uncertainty (Ravallion 1986). A maximum lag of six months was chosen. This relatively long lag length allows for Tokyo's fall prices to influence Alaska's spring prices and ex-vessel markets after Alaska harvesting has tapered off over the winter months.

A 6 mo lag length also accommodates the effects of commodity flows from the Alaska's spring harvests on price formation in the Tokyo market. The peak Alaska harvests occur in late spring and early summer. The major Tokyo wholesale purchases (approximately 65% of the year's total) are concentrated from late May through October. After these purchases, cold storage inventories become particularly important in order to accommodate the major Japanese consumption, which takes place in the fall and winter months. Thus, the major inventory holdings in the marketing chain occur at a higher level than that which our study examines and should not directly affect the model.[3]

U.S. inventory holdings and transportation lags make only a minor contribution to price formation. Sablefish are shipped frozen. Cold storage holdings prior to export are relatively small and declining in

[3]While multicollinearity from current price and six lagged prices could present a problem in estimates and tests of significance for individual regression coefficients, the hypothesis tests in this paper are for the joint effects, requiring tests on the joint confidence region, so that multicollinearity presents far less of problem than it ostensibly might appear.

importance. Beginning in 1984, these inventory holdings were generally 15% of the exports. Before 1984, cold storage holdings formed a greater proportion of exports, because exports were substantially more limited in quantity. Shipping lags are somewhat seasonal, and while no specific information is available, shipments certainly require only a relatively limited time.

Asymmetric Pricing and Price Transmission

When any form of full short-run market integration is absent, price changes in the market of origin are not immediately and fully passed on to the local markets within one time period. Yet, while the central and local markets may not be fully linked by prices in the short run, if markets are not segmented, a weaker form of short-run market integration may still be taking place. Moreover, the short-run response to rising prices emanating from the central market can differ from the response to price declines. This price stickiness produces asymmetric local market price responses to central market price changes.

While the Ravallion market model does not formally incorporate these forms of market integration—incomplete short-run market integration with asymmetric pricing, a modified Wolfram (1971) framework developed by Young (1980) and Ward (1982) does offer a formal model of price formation for examining this possible form of short-run market integration. The modified Wolfram framework presented in Ward uses a finite distributed lag function:

$$P_{it} = a_{0t} + \sum_{j=1}^{J} [b_j'(P_{1t-j+1} - P_{10}) + (b_j'' - b_j')\, P_{1t-j+1}''] + e_t. \quad (10)$$

where P_{10} indicates the central market price in the initial time period and where

$$P_{1t}'' = (P_{1t-i} - P_{1t-i-1})\, Z_{t-1}'', \quad (11)$$

where $Z_{t-i}'' = 1$ if $P_{1t-1} < P_{1t-i-1}$,

$= 0$ otherwise.

The estimate of $(b_j'' - b_j')$ provides a direct test of the asymmetric condition, where b_j' measures the response to a rising price P_1 and b_j'' relates to a declining price P_1.

Polynomial distributed lags can be substitited into Equation (11) to provide structure, thereby reducing multicollinearity and conserving degrees of freedom. For the case of a second-order polynomial,

$$b_j' = c_0 + c_1 j + c_2 j^2$$

$$\text{and } b_j'' - b_j = d'_0 + d_1 j + d_2 j^2, \quad (12)$$

where the c's and d's are parameters to be econometrically estimated. The values and standard errors of the b's can then be recovered from these estimates of the c's and d's. Significance tests on d_0, d_1, and d_2 as a group (a linear restriction on Equation (10)) provide direct tests of asymmetric price linkages.

DATA

Average monthly market price data for the Tokyo central wholesale market during 1981–86 were obtained from the Tokyo Central Wholesale Market Yearbook. These are implicit prices formed by dividing monthly total revenues by comparable quantities. Most of the sablefish sold in this market are not a homogenous commodity, so that movements of these average sablefish prices may reflect changes in the composition of the product form and quality. However, because we were only able to obtain simple (unweighted) arithmetic average prices formed by linear aggregation, we were forced to assume that different product forms and grades are perfect substitutes for each other. The data are in raw, unseasonalized form, without any prior seasonal adjustments or smoothing (which would otherwise confound the distributed lag relationships).[4]

Alaska and Pacific coast ex-vessel prices tend to be competitively formed. Seattle dominates as the port of export. Many of the prices received by Alaska vessels are formed in a Seattle auction, in which roughly 10–12 processors or brokers bid after the auction has received a call from an Alaska vessel reporting its catch information. Some ex-vessel prices in Alaska and the Pacific coast are directly formed when a vessel lands its catch at a processor.

[4]Because these prices are average implicit prices, they may not be equilibrium prices. Spot prices are available, but a problem with spot prices is that the price of the time and day sampled may not be indicative of the entire month. Also, while spot prices are available for different size classes, proportions in the market mix are unavailable.

Formation of fixed prices and informal contracting occur between some processors and harvesters, but flexibility nonetheless exists in the fixed price negotiated prior to harvesting so that stochastic fluctuations in the size, quality, and composition of landings are accommodated. While wholesalers can be strung out along the coast, seemingly in a strong position to offer noncompetitive prices to vessels, competition is nonetheless stronger than initially appears among wholesalers and processors, and harvesters always have the option to land in different ports if they feel that prices are monopsonistic. In Alaska, approximately 5–7 processors handle the bulk of Alaska's products, although there are at least 50 processors in total. Complete Alaska price data were only available from 1984 through 1986.

Japanese prices were adjusted for inflation by the use of the Japanese Consumer Price Index. Japanese prices were converted to U.S. dollars after adjusting for the yen-dollar exchange rate. Japanese prices were further converted from kilograms to pounds. U.S. prices were adjusted for inflation by the GNP implicit price deflator. Japanese prices are for eastern dressed weights and U.S. prices correspond to round weight, but the empirical results should be unaffected because of a constant adjustment rate between the two product forms.

EMPIRICAL RESULTS

Figure 1 depicts the Tokyo wholesale and the Alaska and Pacific coast ex-vessel sablefish prices by month over the time periods 1984–86 and 1981–86, respectively. All prices are in constant dollars per pound, although as noted above, the Tokyo prices correspond to eastern dressed weight and the U.S. prices correspond to round weight. The figure indicates that the Tokyo wholesale prices are generally more stable than the ex-vessel prices. The

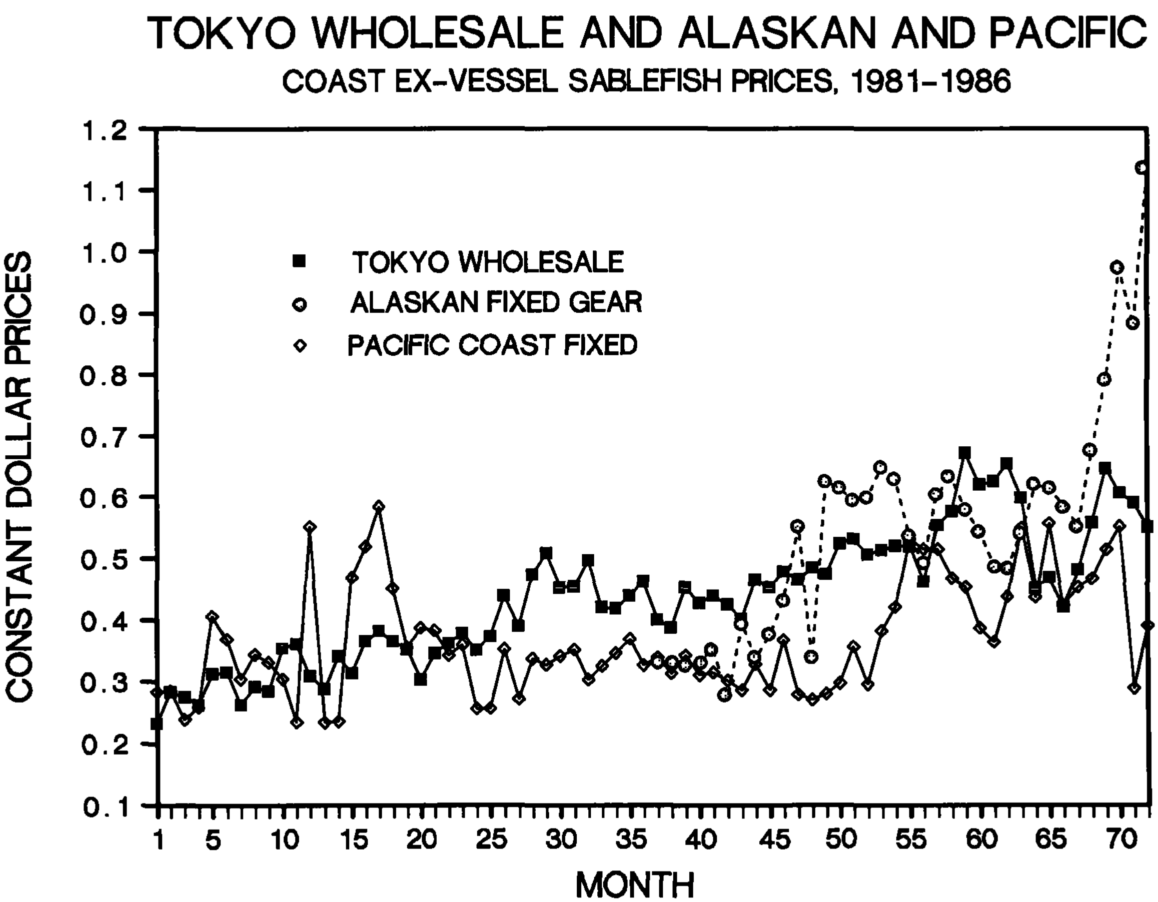

FIGURE 1.—Tokyo wholesale and Alaska and Pacific coast ex-vessel sablefish prices.

Pacific coast ex-vessel prices are also generally lower than the Alaska ex-vessel prices, perhaps reflecting a faster growth rate in market demand for Alaska's fish. An upward trend also exists for all prices. Because the Tokyo prices correspond to eastern dressed weight and correspond to a higher market level, the Tokyo prices can be generally expected to lie above the ex-vessel prices. Interestingly, this relationship only begins some time in 1983, perhaps reflecting the increasing importance of the Tokyo wholesale market as a clearinghouse for the increased imports from the United States and the sharp drop in Japanese harvests that began about this time (so that Tokyo prices now include additional transport, handling, and other market costs). Finally and most importantly, because no simple, direct, one-to-one relationship appears to exist between the Tokyo and U.S. prices, regression analysis can make an essential contribution to understanding the nature of the market integration.

To apply the Ravallion model, we specified the Tokyo wholesale market as the central market and the Pacific coast and Alaska ex-vessel fixed gear markets as the local markets.[5] The unrestricted model given by Equation (1) for six lagged periods ($J = 6$) was estimated by two-stage least squares. The autocorrelation and partial autocorrelation plots for the residuals were reasonably flat for both local markets, indicating the serial correlation does not present a problem. All statistical tests were F-tests for linear restrictions, which were all evaluated at a 5% level of significance. The results from these F-tests are reported in Table 1.

The importance of the local market characteristics was first examined. As indicated in Table 1, the null hypothesis that seasonal dummy variables for Alaska were not important was not rejected at 5%. Also, the linear trend variable was excluded because it did not contribute to the overall explanatory power of the Alaska model. The 1984 dummy variable was omitted from the Alaska model because 1984 was the first year that the Alaska's price series was used in the analysis. The seasonal dummy variables did not contribute in a statistically significant way to the unrestricted model for the Pacific coast, so that the quarterly dummy variables were not included in further regressions. The 1984 dummy variable and linear time trend did not contribute to the overall explanatory power of the unrestricted model for the Pacific coast when taken as a group (but not individually). The linear time trend for the Pacific coast was nonetheless retained in the model because of the clear upward trend in real prices exhibited by the data. The final version of the unrestricted model given in Equation (1) does not have any local market characteristics for Alaska, and only includes a linear time trend for the Pacific coast. The regression results for the final versions of the unrestricted model are reported in Table 2. These final versions of the unrestricted model were then used for the hypothesis tests on the form of market integration.

The next null hypothesis which was tested was that of long-run market integration for Alaska. As indicated in Table 1, it was not rejected at a 5% level of significance. In order to obtain more efficient estimates of the parameters and more powerful statistical tests for the short-run market integration hypothesis test for Alaska, the model was respecified with long-run integration imposed as in Equation (9) and all subsequent tests conducted against this restricted form. (The regression results are available from the authors upon request.) All three

TABLE 1.—Hypothesis tests for the integration of Japanese, Pacific coast, and Alaska sablefish markets. Distributions of F-test statistics given in parentheses of form (numerator degrees of freedom, denominator degrees of freedom).

	Local market	
Null hypothesis	Pacific coast	Alaska
No local seasonality	0.458* (4,47)	3.309 (4,17)
No local time trend and 1984 dummy	1.429* (2,51)	
No local time trend		0.034* (1,22)
Long-run integration	2.870* (1,52)	0.023* (1,23)
Short-run integration		4.230 (12,24)
Short-run integration (weak form)		4.012 (2,24)
Short-run integration (weakest form)		6.621 (1,24)
Market segmentation	0.826* (6,52)	

NOTES: The unrestricted model is Equation (1) for $J = 6$ estimated using two-stage least squares. The table gives F-tests of the linear restrictions on the model implied by each null hypothesis. Short-run integration tests conditional upon maintained hypothesis of long-run integration as given in Equation (9).

* indicates nonrejection of null hypothesis at 5% level of significance.

[5]Within-sample, bivariate direct Granger causality tests (see Squires 1986 for a discussion) were first applied to verify if Tokyo is indeed the source of price formulation in the U.S. markets, or whether prices are simultaneously determined between Tokyo and the local markets, or whether price linkages even exist at all. The null hypotheses that prices were first formed in either the Alaska or Pacific coast ex-vessel fixed gear markets were rejected at a 5% level of significance in both instances. The null hypothesis that sablefish prices first formed in the Tokyo wholesale market lead the Pacific coast ex-vessel fixed gear sablefish prices was also rejected, thereby suggesting market segmentation. The null hypothesis that Tokyo prices lead Alaska ex-vessel fixed gear prices was not rejected, indicating some form of sablefish market integration with price leadership most likely coming from Tokyo.

TABLE 2.—Parameter estimates of dynamic model of spatial price differentials for Alaska and Pacific coast fixed gear ex-vessel and Tokyo wholesale sablefish markets. [*t* − *j*] denotes current time period less *j* time periods. Standard deviations in parentheses.

Variable	Parameter estimates: Alaska	Parameter estimates: Pacific coast
Time trend		0.131E-4 (0.087E-5)
Ex-vessel price [t − 1]	0.565* (0.272)	0.300* (0.149)
Ex-vessel price [t − 2]	0.381 (0.225)	0.101 (0.157)
Ex-vessel price [t − 3]	0.237 (0.235)	0.130 (0.164)
Ex-vessel price [t − 4]	0.035 (0.227)	0.345 (0.169)
Ex-vessel price [t − 5]	−0.044 (0.253)	0.180 (0.163)
Ex-vessel price [t − 6]	−0.269 (0.240)	−0.154 (0.149)
Tokyo price current	−0.593 (0.673)	−0.268 (0.438)
Tokyo price [t − 1]	0.568 (0.698)	0.255 (0.440)
Tokyo price [t − 2]	0.249 (0.361)	0.080 (0.322)
Tokyo price [t − 3]	0.237 (0.381)	−0.406 (0.314)
Tokyo price]t − 4]	−1.090* (0.359)	0.258 (0.325)
Tokyo price [t − 5]	0.723 (0.422)	−0.037 (0.320)
Tokyo price [t − 6]	−0.055 (0.275)	0.288 (0.288)

NOTE: Two-stage least squares estimates of final version of unrestricted model given by Equation (1).

* denotes statistically significant at 5%.

forms of short-run market integration were rejected for Alaska at a 5% level of significance, as indicated in Table 1.

The null hypothesis of long-run market integration was not rejected for the Pacific coast at a 5% level of significance, as reported in Table 1. However, given that this nonrejection was only marginal, the evidence was only weak for long-run integration. The alternative null hypothesis of market segmentation for the Pacific coast was therefore tested and decisively not rejected; market segmentation is the most likely market relationship.[6]

To summarize, the Tokyo wholesale and Pacific coast ex-vessel fixed gear sablefish markets are likely to be segmented over the period 1981–86. Changes in the Tokyo wholesale market prices will have no effect, immediate or lagged, on the Pacific coast market. Instead, the local market price depends only upon its own lagged values and local market conditions. Pacific coast fixed gear ex-vessel sablefish markets operate independently of the Tokyo central wholesale market. Should the expansion of sablefish export markets be considered important, then the general lack of communication of prices and other market information should be targeted for improvement.

The Tokyo wholesale and Alaska fixed gear ex-vessel sablefish markets are well integrated by prices in the sense of a long-run tendency in the short-run adjustment process. Changes in Alaska ex-vessel sablefish prices can be attributed to changes in Tokyo wholesale prices and past spatial price differentials between the Tokyo and Alaska markets. Supply and demand conditions in the Tokyo central wholesale market are communicated effectively to the Alaska ex-vessel market and influence prices there irrespective of previous local conditions. In fact, previous local prices and localized market conditions contribute little to current Alaska ex-vessel prices. These two markets are well integrated by prices in this manner, although traders may fail to connect the two markets through commodity flows in the short run, particularly during the winter months.

The absence of any form of full short-run market integration for Alaska suggests that a price change in the Tokyo wholesale market is not immediately and fully passed on to the Alaska fixed gear ex-vessel market within one month. Given the important reduction in Alaska fishing during the winter months and the dispersed and often geographically isolated nature of harvesters, processors, and brokers, this result is not surprising. Yet, while the two markets are not fully linked by prices in the short run (one month), a weaker form of short-run market integration may still be taking place due to the economic forces causing Tokyo wholesale market price changes generally to be reflected in the Alaska fixed gear ex-vessel price level.

To examine one possible form of incomplete short-run integration by price between the Alaska and Tokyo markets, the modified Wolfram model was applied. This approach allows for asymmetric price responses in the Alaska fixed gear ex-vessel market and price transmission from the Tokyo central wholesale market over a time period longer than a

[6]The results of direct Granger causality tests discussed in footnote 3 further indicated no long-run net price leadership between the Tokyo wholesale and Pacific coast ex-vessel fixed gear markets, thereby reinforcing the conclusion of no market integration by price. Nonetheless, this relationship could have changed over 1987–89.

single month (here, six months). In this case, this modeling procedure is somewhat ad hoc in the sense that long-run market integration is not a maintained hypothesis, but nonetheless, the results provide good insight into the nature of short-run market integration.

After experimentation with first-, second-, and third-order polynomials with a six period lag length, we estimated Equation (10) with a second-order polynomial like that given in Equation (12).[7] Direct tests of asymmetric price responses are provided by F-tests on the polynomical lag coefficients (the d's of Equation (12)) corresponding to $(b_j'' - b_j')$ in Equation (10). The parameter estimates of Equation (10) with the second-order polynomial lag are reported in Table 3 and the F-test results are reported in Table 4. A Scheffe interval[8] is used to give a more cautious test by providing a larger critical value than that given by an F-test table due to the experimentation and pretesting used to determine the degree of polynomial.

The significance test results (at a 5% level of significance with a Scheffe interval) indicate symmetric price responses, that is, the response in the Alaska fixed gear ex-vessel market to rising Tokyo wholesale market prices does not differ from responses to declining prices. The results are robust to changes in the order of polynomial from first to second to third and to inclusion or exclusion of an intercept term in Equation (10). Because a first-order polynomial did not give sensible results, the peak Alaska response to a Tokyo price change is not immediate, and does not continuously decline throughout the price transmission period.

The distributed lag estimated under the maintained hypothesis of symmetrical price responses suggests that the peak price response in the Alaska fixed gear ex-vessel market occurs by the end of the third month after a price change in the Tokyo central wholesale market. Moreover, the impact of a Tokyo central wholesale market price change dies out after the fourth month.

TABLE 3.—Parameter estimates of asymmetric price linkages model. Standard errors in parentheses.

Variable	Parameter estimate
c_0	0.05761 (0.18720)
c_1	−0.01289 (0.16581)
c_2	−0.00136 (0.02676)
d_0	−0.00027* (0.00012)
d_1	0.00019 (0.00012)
d_2	−0.00003 (0.00002)

NOTE: Estimates of Equation (10) with second-order polynomial lag structure given in Equation (12). Variable abbreviations are c_i (parameters of polynomial lag for deviations from initial price) and d_i (parameters of polynomial lag for asymmetric price linkages).

* denotes statistically significant at 5%.

TABLE 4.—F-test for asymmetric price responses.

F-statistic	4.23090

F-test for overall significance of d_0, d_1, and d_2 for asymmetric price linkages.

CONCLUDING REMARKS

In this study, we examined the Tokyo central wholesale sablefish market and the Pacific coast and Alaska ex-vessel fixed gear sablefish markets for several forms of long-run and short-run market integration and segmentation over 1981–86.

We found that the Pacific coast fixed gear ex-vessel and Tokyo central wholesale sablefish markets are segmented, so that changes in the Tokyo market prices will have no effect, immediate or lagged, on the prices of the Pacific coast market. The Pacific coast market price instead depends only upon its own lagged values and local market conditions; the ex-vessel fixed gear markets operate independently of the Tokyo central wholesale market over 1981–86. Pacific coast fixed gear harvesters of sablefish are unlikely to be adjusting their sablefish harvesting patterns in response to changes in Tokyo central wholesale market price and demand conditions. While a limited quantity of Pacific coast

[7]A second-order polynomial gave the most sensible shape to the actual distributed lag recovered from the polynomial lag. Moreover, we followed a nested testing procedure for determining the polynomial degree for a given lag length J suggested by Judge et al. (1980). While these results marginally suggested a third-order polynomial, the actual distributed lag (the b's in Equation (10)) recovered from the polynomial lag (given by Equation (12)) indicated a more plausible shape for the second-order polynomial. In any case, the degree of polynomial did not affect the hypothesis test results for asymmetric pricing. Beginning and endpoint constraints were not used, and to be consistent with the Ravallion approach, an intercept term was not included (which would otherwise imply an unexplained constant relationship).

[8]An F-test of linear restrictions using the Scheffe interval adjusts the confidence region, so that the F-test statistic is significant only if it exceeds in magnitude $[(a - 1)F_b]^{1/2}$, where F is the b * 100% critical value for $F(a - 1, T - a)$, T is the number of observations, and a is the number of restrictions. See Snedecor and Cochran (1976, p. 271) for details.

sablefish harvested by fixed gears is exported to Japan so that these markets are integrated by commodity flow on at least a limited scale (but not by price), the low export volume suggests that the Pacific coast producers' export strategy has not aimed at capturing an important market share or establishing a dominant position in the Japanese market. Rather, relatively small-scale U.S. producers are more likely to be simply concentrating on maximizing their net returns in any given time period. Moreover, policy actions and shifting market conditions in one country are unlikely to affect the other.

The Tokyo central wholesale and Alaska fixed gear ex-vessel markets are well integrated by prices in the sense of a long-run tendency in the short-run adjustment process. That is, over a period longer than one month, changes in Alaska prices can be attributed to changes in Tokyo prices and past spatial price differentials between the two markets.

Tokyo and Alaska markets are not fully integrated in the short-run, so that a price change in the Tokyo market is not fully and immediately passed on to the Alaska market within one month. Yet, a form of short-run price integration exists. Alaska market responses to rising Tokyo prices do not differ from responses to declining prices, that is, price responses are symmetric. The peak price response in the Alaska market appears to occur by the end of the third month and the impact of a Tokyo price change appears to die out after the fourth month.

Policy actions or shifting market conditions in Japan will reverberate throughout the Alaska fixed gear ex-vessel sablefish market but not in the Pacific coast fixed gear ex-vessel sablefish market. Should the Alaska fleet continue to orient its harvesting activities toward supplying the Japanese export market, it must contend with the consequent increased vulnerability to any trade, import, and fishing policies implemented by Japan as well as changes in Japanese consumer tastes and preferences. For example, Japanese policy makers might feel that sablefish imports threaten the well-being of Japanese producers domestically culturing or harvesting fish. In this case, because Alaska ex-vessel markets respond to Japanese price changes, a tariff on imported sablefish from Alaska would reduce the price received by the Alaska producers within four months. In turn, changes in Alaska's harvesting patterns would follow sometime thereafter. Alternatively, a Japanese import quota on sablefish would directly restrict the commodity flow from Alaska but not indirectly as with a tariff, which signals through the price mechanism. In contrast, because Pacific coast harvesters do not respond to the information conveyed by Tokyo prices, a Japanese import tariff would be ineffective because it would not impact any commodity flow. Thus, import quotas would be the most effective Japanese policy option to insure that commodity flows are restricted.

U.S. Alaska sablefish policies should be formulated with an eye on the market integration of the fixed gear fleet with the Tokyo market. U.S. policy intentions could be either amplified or dampened, depending upon the situation, creating unintended and perhaps even surprising consequences. For example, U.S. concern over depleting the Alaska's sablefish resource could lead to trip quotas and even contentious gear allocation issues. Yet, if Tokyo prices dramatically rise because of a subsequent restricted Alaska export flow, Alaska harvesters will receive strong market signals to increase sablefish harvests, thereby generating further pressure on the sablefish resource and aggrevating the issues of discards and gear conflicts.[9] Alternatively, if U.S. limitations on sablefish harvests are coupled with say a shift in Japanese consumers' tastes and preferences away from sablefish, leading to a pronounced decline in relative sablefish prices, Alaska producers might respond to these price signals by cutting sablefish production back below the harvest guidelines—thereby obviating the very need of these restrictions. In contrast, if the price linkages present from 1981 to 1986 continue, U.S. Pacific coast sablefish regulations can be formulated without regard to the possible effects upon U.S. production of trends and shifts in the Japanese market or Japanese government policies.

Finally, another form of vulnerability facing U.S. harvesters involves a trade parameter under less direct policy control: changes in the currency exchange rate between Japan and the United States. All prices used in this analysis are converted to U.S. dollars so that fluctuations in the exchange rate will tend to move prices of a traded good in opposite directions within the producing and consuming countries. Price movements observed in the United States and Japan from 1985 to 1987 illustrate the effect of a rapid 40% reduction in the exchange rate. As one indication of increased Japanese purchasing power, real Tokyo wholesale prices for sablefish fell

[9]The price of Pacific coast sablefish are also likely to bid up under this scenario. Through provision of price incentives, the Japanese will encourage methods of harvest, dress, and storage which provide a product suited to their markets (as long as the Japanese hold such a commanding price position in the market).

by 30% during this period. At the same time, real ex-vessel prices for Alaska's longline and pot catch (nearly all of which is exported) rose by 15%, placing them at record highs. Thus the falling exchange rate sent favorable price messages to both U.S. fishers and Japanese consumers, i.e., suppliers were encouraged to provide more fish for export, while Japanese wholesalers were encouraged to buy greater quantities. It is prudent to realize, however, that a reversal in the recent exchange rate decline would tend to produce the opposite effect, sending unfavorable signals to both groups. In such a case, the rising price of the dollar would tend to lower Japanese offers for U.S. sablefish, and, in turn, lower the willingness of American producers to export, if not harvest. The more expensive dollar and reduced supplies would mean higher Japanese domestic sablefish prices, which would reduce their demand for sablefish imports.

ACKNOWLEDGMENTS

We are grateful to Dan Huppert, David Whitmarsh, and two anonymous reviewers for helpful comments. Conversations with Robert Alverson, Clint Atkinson, Pierre Marchand, and Lou Quirollo are gratefully acknowledged.

LITERATURE CITED

HASTIE, J.
1988. An economic analysis of markets for Pacific sablefish. Natl. Mar. Fish. Serv., Seattle.

HEYTENS, P. J.
1986. Testing market integration. Food Res. Inst. Stud. 30: 25–41.

JUDGE, G. G., W. E. GRIFFITHS, R. C. HILL, AND T. C. LEE.
1980. The theory and practice of econometrics. John Wiley & Sons, N.Y.

RAVALLION, M.
1986. Testing market integration. Am. J. Agric. Econ. 68: 102–109.

SNEDECOR, G., AND W. COCHRAN.
1976. Statistical methods. 6th ed. Iowa State Univ. Press, Ames, 593 p.

SQUIRES, D.
1986. Ex-vessel price linkages in the New England fishing industry. Fish. Bull., U.S. 84:437–442.

TIMMER, C. P.
1974. A model of rice marketing margins in Indonesia. Food Res. Int. Stud. 13:145–167.

WARD, W. W.
1982. Asymmetry in retail, wholesale, and shipping point pricing for fresh vegetables. Am. J. Agric. Econ. 64:205–212.

WOLFRAM, R.
1971. Positivisitic measures of aggregate supply elasticities: Some new approaches - some critical notes. Am. J. Agric. Econ. 53:356–359.

YOUNG, T.
1980. Modeling asymmetric consumer responses, with an example. J. Agric. Econ. 31:175–186.