DYNAMIC ADJUSTMENT MODELS FOR ESTIMATING SHRIMP CONSUMPTION CHARACTERISTICS

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The authors analyze the factors affecting U.S. shrimp consumption. Two aspects seem to affect shrimp consumption: habit formation and inventory adjustment. They conclude that the long-run and short-run price elasticities are inelastic.

PROBLEM STATEMENT AND OBJECTIVE

In the past two decades, domestic consumption of shrimp has been steadily increasing (Table 1). Ending stocks for shrimp comprise between 10-20 percent of domestic consumption and has exhibited volatility over this time period.

Past experience with demand analyses for consumption goods has emphasized the importance of dynamic elements, particularly habit formation and inventory adjustment (Houthakker and Taylor; Houthakker, et al.; Sexauer; and Raunikar and Huang). This paper focuses on the nature of dynamic changes in monthly demand models for shrimp.

METHODOLOGY

The classical theory of consumer demand assumes that the individual consumer tries to maximize utility or satisfaction subject to a budget constraint determined by commodity prices and consumer income. Limitation of this type of analyses has been the emphasis on a static approach. Houthakker and Taylor suggest that consumers do not adjust instantaneously to price and income changes due to rigidities in consumer behavior and institutional restrictions.

As a basis for dynamic analyses, Houthakker and Taylor developed a model of consumer response influenced by past behavior, primarily habit formation and stock adjustment. There is no *a priori* basis for determining which of these two effects will predominate. The relative importance of these two dynamic elements is an empirical question and can vary across commodities (Raunikar and Huang).

In the Houthakker and Taylor model, past behavior is embodied in a state variable, comprised of both stocks or inventory held by consumers and habits formed by past consumption patterns. They tested their dynamic state adjustment model on sixty-five commodities. Their results indicate that generally habit formation had a greater effect on present consumption than stock adjustment.

TABLE 1. U.S. CONSUMPTION AND ENDING STOCKS FOR ALL SHRIMP

Year	Shrimp Consumption (million pounds)	Ending Stocks
1960	251.6	51.0
1965	313.4	38.2
1970	399.5	72.2
1975	416.5	47.4
1980	438.9	62.1

Source: Shellfish Market Review. U.S. Department of Commerce, (various issues).

Sexauer, however, pointed out that the Houthakker and Taylor model overlooked the time dimension. He contends that as the time interval analyzed decreases, the importance of stock adjustment increases relative to habit formation. The major reason is that as the time period shortens, consumer purchases become lumpy due to the high opportunity cost of shopping. His results suggest that habit formation predominates for annual data while stock adjustment is the stronger effect for quarterly and monthly data.

A study by Wohlgenant and Hahn evaluating monthly demands for beef, pork and chicken found beef and pork short-run price elasticities of demand to be more elastic than corresponding long-run elasticities. These results occur because households can vary their inventory as well as their consumption patterns. For chicken demand, they found inventory adjustment less dominant, resulting in price elasticities being more elastic in the long-run.

Another study by Raunikar and Haung obtained similar results. In the case of monthly and weekly consumption data, the demands for beef and veal, poultry and processed meats were more price elastic in the short-run than in the long-run. Their results imply that stock adjustment behavior predominates over habit formation.

Early demand research in shrimp and other shellfish utilized annual econometric models (Suttor and Aryan-Nejad; Doll 1971, 1972). These studies found price elasticities of demands to be -0.27 and -0.63 respectively. More recently, shrimp studies have concentrated on regional analyses, primarily the Gulf of Mexico (e.g., Prochaska and Cato; and Hopkins, et al.). The study by Hopkins, et al. estimated the own price elasticity of demand to be -0.27.

Following previous research (Houthakker and Taylor; Sexauer; and Raunikar and Huang), dynamic demand models for shrimp are estimated. Monthly data for the time period 1976-1981 are used for estimation. For the first shrimp equation, the functional form is specified as:

$$Q = f(P, Y, Q(-1), D) \qquad (1)$$

where

- Q = apparent shrimp consumption per capita for all shrimp, heads-off weight (pounds),
- P = retail shrimp price for 36-42 count, raw headless shrimp recorded in Baltimore, MD, deflated by CPI,
- Y = per capita personal income deflated by CPI,
- Q(-1) = per capita shrimp consumption lagged one month,
- CPI - Consumer Price Index for all goods less food (1967 = 100.0),
- D = 0/1 dummy variable to capture seasonality; 0 = months of November to April and 1 = months of May to October.

The coefficient for lagged consumption provides a measure of the effect of habit formation on current consumption. If the coefficient is zero, this indicates absence of inventory and habit effects. A positive lagged consumption coefficient implies habit formation is dominant and a negative coefficient suggests a predominant stock adjustment effect.

A second demand equation is estimated and compared to the results from equation (1). The modified equation, unlike equation (1), includes a change in stocks component to directly capture inventory adjustment.

$$Q = g(P, Y, Q(-1), \Delta S, D) \qquad (2)$$

where ΔS represents a change in shrimp stocks heads-off weight from period t-1 to period t and all other variables are as previously defined. Both equations (1) and (2) are estimated in double logarithmic form. This functional form yields estimated demand functions with constant price elasticities.

In equations (1) and (2), the price of shrimp is expected to be inversely related to per capita shrimp consumption. For normal goods, income is a positive shifter of the demand function. The dummy variable, D, is used to capture seasonal consumption patterns. Shrimp consumption is generally higher for the months of May to October and lower for the rest of the year. For equation (2), inventory adjustment would imply a positive coefficient on ΔS.

RESULTS AND CONCLUSIONS

Table 2 shows the estimated results for monthly shrimp consumption. Specification of both equations is similar except for the exclusion of a stock variable in one of the equations. With the exception of income, all other variables have coefficient signs consistent with a priori expectations. The negative, but statistically insignificant, coefficient for income probably stems from shrimp being primarily consumed in restaurants than in the household.

Since the demand equations are in double logarithmic form, the coefficients represent short-run elasticities. The coefficient on lagged shrimp consumption (LNSHCON (-1)) provides a measure of the effect of previous consumption levels on present consumption. The partial adjustment coefficient is defined as one minus the coefficient on lagged consumption.[1] The long-run price elasticity is derived by dividing the short-run elasticity by the partial adjustment coefficient:

$$\eta^{LR} = \frac{\eta^{SR}}{\lambda} \qquad (3)$$

where η^{LR} denotes long-run elasticity, η^{SR} is the short-run elasticity and λ is the partial adjustment coefficient.

The estimated short-run price elasticities for both equations are -0.20 and -0.21. The corresponding long-run price elasticities are calculated as approximately -0.25. Since the long-run price elasticity is relatively more elastic than the short-run elasticity, this implies that predominance of the habit effect. Also, the insignificant stocks coefficient (LNSTCK) in the second equation confirms the absence of a statistically significant inventory effect.

The monthly demand for shrimp is price inelastic implying that changes in shrimp price have little impact on demand. The estimated monthly short-run price elasticity was more inelastic than previous studies' estimated annual price elasticities. This is consistent with consumption adjustment being relatively more responsive to price changes as the length of the time period increases.

The results also show the habit effect to be predominant over the inventory effect. Although Sexauer's study would suggest the opposite result for monthly demands, shrimp is a commodity not primarily consumed in the home where inventory adjustment can be important.

IMPLICATIONS

The highly inelastic short-run and long-run shrimp demand, negative, but statistically insiginficant income coefficient, statistically significant seasonal consumption pattern and shrimp being consumed primarily away-from-home

TABLE 2. MONTHLY SHRIMP DEMAND RESULTS, 1976-1981[1,2]

Dependent Variable	Intercept	LNP	LN Q(-1)	LNY	LND[4]	LNΔS	$\bar{R}^2$[5]	F-Stat.[6]
LNQ	-0.85024 (-0.90)[3]	-0.20112 (-2.03)	0.18799 (2.25)	-0.56133 (-0.72)	0.37880 (8.63)		0.69	40.74
LNQ	-0.89325 (-0.94)	-0.21390 (-2.11)	0.16280 (1.77)	-0.56681 (-0.72)	0.38503 (8.55)	0.016167 (0.67)	0.69	32.09

[1] Equations estimated by Ordinary Least Squares. The prefix "LN" denotes natural logarithm taken for that variable.

[2] For the double logarithmic form, the individual coefficients represent elasticities.

[3] Figures in parentheses are t-statistics. The critical t-value at the 5% level is 2.00.

[4] Ln(e) = 1.0 and LN(1) = 0.0.

[5] Coefficient of determination adjusted for degrees of freedom.

[6] The critical F-value at the 5% level is 3.70.

suggest that shrimp is a commodity which is insensitive to the usual economic characteristics such as price and income. Instead, current shrimp consumption is strongly dependent on past shrimp consumption levels. This attribute may be consistent with commodities primarily consumed away-from-home.

APPENDIX A: DATA SOURCES

Shrimp consumption, prices and ending stock data are found in: Shellfish Market Review, Division of the National Marine Fisheries Service, U.S. Department of Commerce, (various issues).

Data for disposable personal income and the CPI for all goods less food are found in: Survey of Current Business, Bureau of Economic Analysis, U.S. Department of Commerce, (various issues).

Population data have been provided by the Population Division, Bureau of Census, U.S. Department of Commerce in an unpublished version of revised data for the 1980 census.

FOOTNOTES

[1]As an example, assume the following consumption model:

$$Q_t^* = \beta_o + \beta_1 P_t + \beta_2 Y_t \qquad (4)$$

where Q_t^* is the desired per capita consumption of good X in period t, P_t is the retail price of good X in the period t and Y_t is per capita personal disposable income in period t.

Because consumption of good X does not fully respond to changes in price and income instantaneously, the partial adjustment towards Q_t^* occurs and is represented as:

$$Q_t - Q_{t-1} = \lambda (Q_t^* - Q_{t-1}) \quad 0 < \lambda < 1 \qquad (5)$$

where Q_t and Q_{t-1} are the actual consumption levels of good x in period t and t-1 and λ is the partial adjustment coefficient. If $\lambda=1$ then $Q_t^* = Q_t$ or the desired response would be completed in one time period. Substituting the value of Q_t^* in equation (5) into equation (4) produces the following:

$$Q_t = \alpha_o + \alpha_1 P_t + \alpha_2 Y_t + \alpha_3 Q_{t-1} \qquad (6)$$

where $\alpha_i = \lambda \beta_i$ for i = 0, 1, 2 and $\alpha_3 = 1 - \lambda$.

So $\lambda = 1 - \alpha_3$ or one minus the estimated coefficient on lagged consumption.

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