U.S. Demand for Source–Differentiated Shrimp: A Differential Approach

Keithly Jones, David J. Harvey, William Hahn, and Andrew Muhammad

Estimates of price and scale elasticities for U.S. consumed shrimp are derived using aggregate shrimp data differentiated by source country. Own-price elasticities for all countries had the expected negative signs, were statistically significant, and inelastic. The scale elasticities for all countries were positive and statistically significant at the 1% level with only the United States and Ecuador having scale elasticities of less than one. For the most part, the compensated demand effects showed that most of the cross-price effects were positive. Our results also suggest that despite the countervailing duties imposed by the United States, shrimp demand was fairly stable.

Key Words: CBS, conditional demand, countervailing duty, imports, scale elasticity, shrimp

JEL Classifications: C32, D12, Q13, Q22

This article addresses U.S. demand for source-differentiated shrimp. There is a large body of literature on demand for different seafood species (Asche 1996; Asche, Salvanes, and Steen; Burton; Eales, Durham, and Wessells; Keithly and Diagne; Park, Thurman, and Easley). There is also a large body of literature on trade policy and conflicts in the seafood market (Asche 1996, 1997, 2001; Asche, Bremnes, and Wessells; Kinnucan; Kinnucan and Myrland 2002, 2006). However, the lack of studies on an important species like shrimp is an odd exception, since, according to the National Oceanic and Atmospheric Administration (NOAA), shrimp accounted for more than a quarter of the United States per capita seafood consumption in 2005.

For the last decade (1996–2005), U.S. shrimp imports have increased nearly 11% per year on average and have gained a greater share of total U.S. supply. At the same time, shrimp prices saw a more than 75% decline (see Figure 1). In 1996, domestic shrimp production and shrimp imports were 21% and 79% of total U.S. supply, respectively. Currently, imports account for over 90% of total U.S. shrimp supply (NOAA). In addition to significantly increasing, U.S. shrimp imports have become more concentrated in a few supplying countries. In 2004, six shrimp exporting countries supplied more than 70% of total U.S. imports, which were in excess of 1 billion pounds. These countries included: Brazil, China, Ecuador, India, Thailand, and Vietnam. Other major exporters of shrimp to

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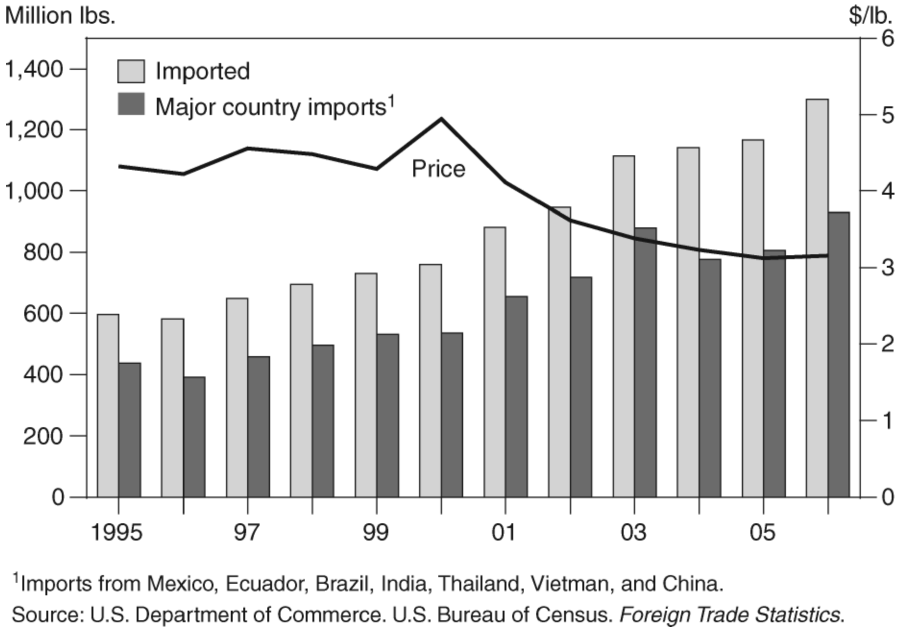

Figure 1. U.S. Shrimp Imports, 1995–2006

the United States included Mexico, Bangladesh, and Indonesia.

In response to the increase in shrimp imports and falling shrimp prices, the U.S. shrimp industry filed petitions requesting that the U.S. International Trade Commission (USITC) and the U.S. Department of Commerce (USDOC) investigate whether shrimp imports were being sold to the United States below fair market value, and to also determine if exporters were receiving government support deemed injurious to the U.S. shrimp industry. In 2005, the USITC unanimously found that the U.S. shrimp industry had been injured by illegal dumping on the part of the aforementioned exporters (Brazil, Ecuador, India, Thailand, Vietnam, and China) and that a countervailing duty could be imposed on specific warm water shrimp imports from the six countries (Long; Zwaniecki).

The question then is would the countervailing duties imposed by the United States have any significant impact on shrimp import demand? Thomas and Ulubasoglu found that trade policies resulted in structural breaks in import demand for some commodities due to the change in access to substitutes. Mwega also found that trade policies that are designed to increase export earnings are more likely to have a large impact on import volumes.

In this study, we estimate U.S. demand for domestic and imported shrimp differentiated by exporting country using a Netherlands Central Bureau Statistic (CBS) demand system model. Parameter estimates are used to obtain elasticities of demand. We also explore the stability of shrimp demand in light of the countervailing duties imposed on some imported shrimp. Specific objectives are the following: (1) to econometrically estimate U.S. demand for shrimp (domestic and imported) where imports are differentiated by country of origin; (2) to estimate demand elasticities from the estimated demand parameters; (3) to test for monthly seasonality and stability of demand from each country.

Background

In 2005 total U.S. landings of commercial shrimp were 261.1 million pounds and valued at $406.5 million. This was equivalent to 162.4 million pounds on a head-off weight basis. The Gulf States accounted for 88% of total landings that year while the South Atlantic and Pacific accounted for 7.4% and

4.4%, respectively. In 2004, U.S. production was 16% lower when compared to 2003. Since 2000, shrimp production had decreased 26%. During the last decade (1996–2005), U.S. commercial landings of shrimp (head-off basis) have averaged 190 million pounds. Above-average years included 2000 and 2001, where commercial landings were 218.5 and 201.0 million pounds, and below-average years included 1997 and 1998, where commercial landings were 179.0 and 173.3 million pounds, respectively. The year 2005 marked a record low for the decade. While U.S. shrimp production has declined by 56 million pounds since 2000, U.S. shrimp imports have increased to 467 million pounds. From 1996 to 2005, shrimp imports grew 107%. In 1996, U.S. shrimp imports were 720.9 million pounds, and in 2005, imports were 1.5 billion pounds. With the exception of 2005, imports have increased every year since 1996 (NOAA).

The increase in U.S. shrimp imports has been sustained by increases in United States per capita shrimp consumption. In 1980, per capita shrimp consumption was only 1.4 pounds. From 1990 to 1999, per capita consumption averaged 2.3 pounds, and in per capita consumption reached a record high of 4.2 in 2004. In 2005, per capita consumption was 4.1 pounds (NOAA). The rise in per capita consumption has made shrimp the top seafood product among U.S. consumers every year since 2001, surpassing can tuna and salmon, where per capita consumption in 2005 was 3.1 and 2.4 pounds, respectively (Johnson).

Under U.S. trade law, the administration of antidumping investigations is divided between the USDOC and USITC, where the USDOC determines whether imports subject to investigation have been sold in the United States at less than fair market value (Sharp and Zantow) and the USITC determines import injury to U.S. industries in antidumping, countervailing duty, and global safeguard investigations. If it is determined that exporters have injured U.S. producers, a countervailing duty is imposed on imports deemed by the USDOC as benefiting from subsidies generated by a foreign government or by a firm or person in that country (USITC). Based on the USITC determination, the U.S. Department of Commerce can issue a countervailing duty, which is enforced by the U.S. Customs Service. This is not necessarily imposed on all U.S. imports from a given country but on exporting companies as determined by USDOC to have benefited from different levels of government support (USDOC).

In December 2003, an association of U.S. shrimp farmers in eight southern states filed an antidumping complaint with the USITC against six countries that exported shrimp to the United States.[1] The petitioned charged that exports from Brazil, China, Ecuador, India, Thailand, and Vietnam were dumped onto the U.S. market causing material damage to the domestic shrimp industry (Baughman; Bhattarcharyya; Blauer). This was not the first petition filed by the U.S. shrimp industry claiming injury from imports. In 1971, the National Shrimp Congress filled a petition with the USITC for import relief. A petition was also filed in 1984. In both instances the USITC ruled that U.S. shrimp farmers were not unfairly injured by shrimp imports (Diop, Harrison, and Keithly).

In the most recent petition filed, the primary points of contention were that the six named countries accounted for 74% of all shrimp imports and that imports from these countries increased from 466 million pounds in 2000 to 650 million pounds in 2002. They also charged that import prices in the targeted countries dropped 28% in the three years prior to the petition and that U.S. dockside prices fell from $6.08 to $3.30 per pound during that same period. Lastly, petitioners charged that higher tariff rates and sanitary requirements in other large importing countries made the U.S. market a dumping ground for shrimp exports that were rejected in markets such as the European Union (Bhattarcharyya).

In January 2005, the USITC ruled in favor of the U.S. shrimp industry, indicating that

[1] The association of shrimp farmers in the South is often referred to as the Southern Shrimp Alliance or the Ad Hoc Shrimp Trade Action Committee.

Table 1. Antidumping Duties for Frozen Warm Water Shrimp Products

Countries	Highest Company Margin	Lowest Company Margin	Margins for All Companies without Specific Margins	Trade-Weighted Margins[a]
People's Republic of China	82.27%	0.07%	112.81%	49.09
Vietnam	25.76%	4.30%	25.76%	16.01
Brazil	67.80%	4.97%	7.05%	36.91
Ecuador	4.42%	1.97%	3.58%	7.30
India	15.36%	2.48%	10.17%	14.20
Thailand	6.82%	5.29%	5.95%	6.39

Source: International Trade Administration (ITA), U.S. Department of Commerce.
[a] Bhattarcharyya, B. "The Indian Shrimp Industry Organizes to Fight the Threat of Anti-Dumping Action." WTO, Managing the Challenges of WTO Participation: Case Study—Case Study 17. Geneva, Switzerland. Internet site: 192.91.247.23/English/res_e/booksp_e/casestudies_e/case17_e.htm (Accessed 4/23/07).

there was reasonable indication that the industry was materially injured by shrimp imports sold below market value. In a unanimous decision the USITC ruled that noncanned, mostly frozen shrimp and prawn imports from all six countries had hurt or threatened the U.S. shrimp industry (Long; Zwanicki;). The USITC ruling led to the imposition of antidumping duties where margins ranged from 0 to a high of 112.8%. The trade weighted duties for each country were 36.91% for Brazil, 49.09% for China, 7.30% for Ecuador, 14.20% for India, 6.39% for Thailand, and 16.01% for Vietnam (Bhattarcharyya).

Company-specific duties, highest and lowest margins, and overall margins for each exporter are presented in Table 1. Duties were imposed on selected warm-water shrimp and prawns, whether frozen, wild caught (ocean harvested), or farm-raised (produced by aquaculture); head-on or head-off; shell-on or peeled; tail-on or tail-off; de-veined, cooked, or raw; or otherwise processed in frozen form. Frozen warm-water shrimp and prawn products included in the scope of the countervails, regardless of definitions in the Harmonized Tariff Schedule of the United States (HTSUS), are products that are processed from warm-water shrimp, frozen, and sold in any count size (Fact sheet—International Trade Administration [ITA], Department of Commerce).

Data

The data consist of U.S shrimp production and prices and U.S. shrimp import data from eight importing countries for sixteen 10-digit HS codes. Six of these countries had antidumping duties imposed. Mexico and the rest of the world (ROW) had no antidumping duties applied. Brazil, though one of the countries levied with antidumping duties, was included with the ROW for two reasons. First, there were no reported imports from Brazil for several months during the study period. Second, its share of imports by the United States was very small for the reported months. Though the countervailing duties varied among companies within the affected countries, data were not available for each company's imports. As such, import data for each of the Harmonized System (HS) codes was aggregated to a monthly total for each country and analysis of the countervailing duty impact was based on the countrywide rate of duty, rather than by company. Table 2 shows the descriptive statistics on U.S. consumption of shrimp by source country, 1995 to 2005.

The sixteen 10-digit HS codes could be divided into three broad categories—frozen, semiprocessed (brine, dry, and salted), and processed (prepared frozen, breaded, and canned). Frozen shrimp and prawn averaged 78% of all shrimp imported between 2000 and 2006, but for the period of study frozen shrimp

Table 2. Descriptive Statistics on U.S. Consumption of Shrimp by Source Country, January 1995 to December 2005

	Mean	Median	Minimum	Maximum	Coefficient of Variation
Mexico					
Quantity (1,000 lbs)	5625.60	3757.45	102.35	21889.02	72.62
Price ($ per lb)	5.28	5.07	3.47	8.39	0.89
Value (000 USD)	29281.70	18507.95	719.36	128496.90	166.69
Ecuador					
Quantity (1,000 lbs)	7746.13	7295.02	2325.66	15317.67	58.85
Price ($ per lb)	3.62	3.76	2.42	5.06	0.79
Value (000 USD)	28408.95	25562.78	9656.13	65290.89	121.89
ROW					
Quantity (1,000 lbs)	19918.75	19091.97	9901.51	40769.04	83.32
Price ($ per lb)	3.71	3.74	2.38	4.90	0.76
Value (000 USD)	72270.86	67987.85	38310.74	142453.38	151.44
India					
Quantity (1,000 lbs)	5301.71	4566.01	1898.09	14704.80	51.20
Price ($ per lb)	3.40	3.43	1.97	5.02	0.80
Value (000 USD)	18845.51	15051.21	5239.31	55198.60	107.59
Thailand					
Quantity (1,000 lbs)	19702.97	17127.44	6895.14	51077.52	91.85
Price ($ per lb)	4.69	4.85	2.61	6.32	1.00
Value (000 USD)	88875.41	82859.08	21947.11	187709.96	183.64
Vietnam					
Quantity (1,000 lbs)	3824.06	1809.88	41.19	15544.94	64.41
Price ($ per lb)	5.65	5.46	2.66	8.84	1.04
Value (000 USD)	19612.53	11321.23	233.83	73955.82	139.39
China					
Quantity (1,000 lbs)	5349.73	2719.33	224.70	25336.39	79.82
Price ($ per lb)	2.46	2.37	1.48	4.50	0.72
Value (000 USD)	13599.92	7355.85	401.91	64532.35	126.51
United States					
Quantity (1,000 lbs)	28781.63	30417.46	3159.51	89502.92	129.78
Price ($ per lb)	1.78	1.81	0.87	2.78	0.64
Value (000 USD)	48542.91	51486.84	6900.40	202629.90	170.37

imports have been steadily declining, from as much as 93% in 1990 to 71% in 2006 with most of the decline occurring in peeled shrimp. The frozen shrimp and prawn with shell-on of all count size ranged from 70–75% of the total frozen shrimp imported between 2000 and 2006 while peeled shrimp made up 25–30% of the total frozen shrimp imported. Semiprocessed shrimp, which consists of dry, salted, or brined shrimp, made up 1% of shrimp imports in 2006 and has steadily declined from around 3% in 1990. Processed shrimp (prepared frozen, breaded, and canned) has seen the largest increase in the imports over the study period.

Monthly import quantities and expenditures from each country were obtained from the U.S. Department of Agriculture, Foreign Agricultural Service, and Foreign Agricultural Trade Statistics. All expenditures are on a free on board (FOB) basis, excluding transportation costs, insurance and custom duties, making import prices fairly representative of the wholesale U.S. domestic price. Using expenditures and quantities, per-unit values ($/lb) for each country were calculated.

Demand-Model structure

In this paper, the CBS demand system derived by Keller and Van Driel is used to estimate shrimp demand parameters. The CBS model combines the nonlinear expenditure effects of the Almost Ideal Demand System (AIDS) (Deaton and Muellbauer 1980b) and the price effect of the Rotterdam model (Barton; Theil). The Rotterdam model meets negativity conditions on the Slutsky matrix required for a downward sloping demand curve if its price coefficients are negative, semidefinite. The CBS demand system starts with a set of partial-differential equations:

$$w_i \cdot \left[\partial \ln(q_i) - \sum_j w_j \partial \ln(q_j)\right] = \sum_j c_{i,j} \partial \ln(p_j) + b_i \left[\partial \ln(x) - \sum_j w_j \partial \ln(p_j)\right] \quad (1)$$

ln(.) is the natural–logarithm operator; *qi* and *pi* are the quantity and price of the i^{th} good; x is the total group expenditure; and w_i is the budget share for the i^{th} good, defined as:

$$w_i = \frac{p_i q_i}{x}$$

The terms $c_{i,j}$ and b_i are coefficients. In order for the system of equations to be consistent with optimization theory, the following restrictions on the coefficients must hold:

$$(2) \quad \sum_i c_{i,j} = \sum_j c_{i,j} = \sum_i b_i = 0,$$

$$(3) \quad c_{ij} = c_{ji}, \forall i, j$$

Equations (2) and (3) ensure that the CBS model is homogenous of degree 0, consistent with the budget constraint, and meets Slutsky symmetry conditions. The matrix of compensated price effects $\mathbf{C} = (c_{i,j})$ must also be negative semidefinite (n.s.d), suggesting that trace $[\mathbf{C}] \leq 0$. The n.s.d condition implies that own-price effects should be negative or at least nonpositive. Given the constraints (2) and the requirement that the own-price terms have to be negative, some or all of the cross-price terms should be positive.

Demand elasticities are derived from model coefficients and the budget shares:

$$(4) \quad \varepsilon_{i,j} = \frac{ci,\, j - b_i w_j - w_i w_j}{w_i} \quad \text{(price elasticities)}$$

$$(5) \quad \varepsilon_{i,x} = 1 + \frac{b_i}{w_i} \quad \text{(expenditure elasticities)}$$

The CBS demand system is based on consumer demand theory; however, we use wholesale demand. Given the analytic parallel between consumer demand and derived demand, use of the CBS model in a derived demand context is simply a matter of interpretation. The CBS model, like other differential demand systems, starts with a set of differential-in-logarithms equations. The budget constraint in log-differential form is expressed as:

$$(6) \quad \partial \ln(x) = \sum_i w_i \partial \ln(p_i) + \sum_i w_i \partial \ln(q_i)$$

From Equation (6), we define the Divisia price (P) and quantity (Q) indices respectively as:

$$(7) \quad \partial P = \sum_i w_i \partial \ln(p_i)$$

$$(8)\quad \partial Q = \sum_i w_i \partial \ln(q_i)$$

We rearrange Equation (6), and substitute in Equations (7) and (8) to get the following:

$$(9)\quad \begin{aligned} &\partial \ln(x) - \sum_i w_i \partial \ln(p_i) = \\ &\sum_i w_i \partial \ln(q_i) = \partial \ln(x) - \partial P = \partial Q \end{aligned}$$

Equation (1) is re-specified as:

$$(10)\quad w_i \cdot [\partial \ln(q_i) - \partial Q] = \sum_j c_{i,j} \partial \ln(p_j) + b_i \partial Q$$

In a production context, the Divisia can be thought of as a measure of total shrimp or real shrimp expenditures. Equation (10) implies that the change in demand for a country's shrimp is driven by the changes in all countries' prices and the overall size of the industry. In a derived demand context, b_i is referred to as a scale coefficient rather than an expenditure coefficient.

As typical of differential models, continuous log are approximated with finite log changes. Our specification also includes dynamic adjustment, seasonality, and taste or technology shifts, following Anderson and Blundell's approach for adding dynamic adjustments to demand systems. Their approach makes it relatively easy to recover the long run or full-adjustment structure of demand. We test various hypotheses about dynamic adjustment in shrimp demand. The most restricted model without dynamic adjustment is written as:

$$(11)\quad \begin{aligned} &(\theta_t * w_{i,t} + (1 - \theta_t) w_{i,t-1}) \cdot [\Delta \ln(q_{i,t}) - \Delta Q_t] \\ &= \sum_j c_{i,j} \Delta \ln(p_{j,t}) + b_i \Delta Q_t + u_{i,t} \end{aligned}$$

Equation (11) includes a random error term, $u_{i,t}$. The t subscript refers to the time in months. The term θ_t is a time-varying weight. We derived θ_t by making the following three equations consistent:

$$(12)\quad \begin{aligned} \Delta Q_t = &\sum [\theta_t * w_{i,t} + (1 - \theta_t) w_{i,t-1}] \\ &* [\ln(q_{i,t}) - \ln(q_{i,t-1})] \end{aligned}$$

$$(13)\quad \begin{aligned} \Delta P_t = &\sum [\theta_t * w_{i,t} + (1 - \theta_t) w_{i,t-1}] \\ &* [\ln(p_{i,t}) - \ln(p_{i,t-1})] \end{aligned}$$

$$(14)\quad \ln(x_t) - \ln(x_{t-1}) = \Delta Q_t + \Delta P_t$$

Here, the "differenced" budget constraint becomes consistent with the differential budget constraint. The more common approach in this case is to fix the θ_t to ½.

Because of the way it is constructed, the endogenous variables of the CBS demand system sum to 0 in every time period, which makes the error terms sum to 0 as well. In order to estimate the system, we have to drop an equation. The estimates will be invariant to the equation dropped; we happened to drop the equation for U.S. shrimp.

One of the attractive features of the CBS demand system is that it is linear in its parameters. The equality restrictions of demand theory are also linear in the parameters. (The negative, semidefinite restrictions are nonlinear inequalities.) We could specify equation (11) in a more conventional, linear regression format as:

$$(15)\quad \begin{aligned} y_{i,t} &= Z_t B_i + u_{i,t} \\ y_{i,t} &= (\theta_t * w_{i,t} + (1 - \theta_t) w_{i,t-1}) \\ &\quad \cdot [\Delta \ln(q_{i,t}) - \Delta Q_t] \\ Z_t &= [\ldots \Delta \ln(p_{i,t}), \ldots, \Delta Q_t] \\ B_i &= [\ldots c_{i,j} \ldots b_i]' \end{aligned}$$

Our most general dynamic model includes current and lagged (one period) endogenous and exogenous and is written as:

$$(16)\quad \begin{aligned} \Delta y_{i,t} = &\Delta Z_t B_{i,s} + \alpha^* \lfloor Z_{t-1} B_{i,l} - y_{i,t-1} \rfloor \\ &+ u_{i,t} \end{aligned}$$

In Equation (16) the change in the endogenous variable is related to the change in the exogenous and the lagged exogenous and endogenous variables. The vector $B_{i,s}$ is the short-run response to price and scale changes, $B_{i,l}$ is the long-run response and α is a positive adjustment parameter. Both sets of B vectors are required to be consistent with the imposed equality and inequality restrictions. Equation (16) shows the most general adjustment model. General lags are placed on the exogenous variables while restricted lags are placed on the endogenous variables. We also experimented with restricted lags on the exogenous variables, imposing the following relationship between the two sets of "B" vectors:

$$(17) \quad B_{i,s} = \gamma^* B_{i,l}$$

In Equation (17), γ is a positive parameter. If we make γ equal to 1, then our "dynamic adjustment" model is actually a model with first-order autoregression, and the short-run and long-run elasticities of demand are the same.

CBS models are often estimated with an intercept. The intercept is generally justified as a taste-shift term; a non–0 intercept produces demand changes unrelated to changes in prices, expenditures, and/or scale. (In our derived-demand case, an intercept could measure some combination of taste and technology shifts.) We are using monthly data; we use 12 monthly dummies in each equation rather than an intercept.

The monthly dummies' coefficients must also be consistent with the budget constraint; this means that all the January coefficients have to sum to 0, and all of February's, and so on. We looked at three different hypotheses regarding the seasonal effects. It might be the case that there is no seasonality in derived shrimp demand. If so, we could have used an intercept rather than a set of monthly dummies. We compared models with only an intercept to one with a full set of dummies. As noted above, the monthly dummies represent taste/technology shifters. Shrimp demand might change month to month, but still be stable on an annual basis. If each shrimp source's monthly dummies sum to 0, (January plus February . . .) then demand is stable on a year-to-year basis. We can combine the no-seasonality and stable-annual-demand models by estimating a model without either intercepts or dummies.

Empirical Results and Discussion

Since the dynamic versions of the model are nonlinear and the negativity conditions are nonlinear, inequality restrictions, the model was estimated using nonlinear maximum likelihood estimation. Sixteen versions of the model were estimated; each combination of the four dynamic and the four monthly dummy/intercept hypotheses. Table 3 shows the hypothesis tests based on the likelihood ratio test. Demand dynamics are consistent with an autoregressive process; the autoregression is statistically significant. Shrimp demand has a statistically significant seasonal pattern, but is stable on an annual basis.

Estimated conditional price and share demand coefficients are reported in Table 4. For the most part, the compensated" demand effects, the "C_{ij}" coefficients, showed that most of the cross-price "C_{ij}" terms are positive. Using these estimates and average budget shares for the sample period, own- and cross-price elasticities and scale/expenditure elasticities were generated. These estimates are presented in Table 5. The standard errors in parenthesis were generated using 1,000 bootstrap iterations. Green, Roke, and Hahn show that the bootstrap covariances are more accurate measures of the small sample covariances than the more conventional approaches (e.g., the Rao approach) that use asymptotic approximations.

The conditional own-price elasticities represent both the substitution and the income effect of price changes. These elasticities are conditional on total expenditure on shrimp. The own-price elasticities for all countries had the expected negative signs and were statistically significant and inelastic (less than -1), implying that it is possible for these countries to increase revenue by lowering quantities supplied. This also implies that an increase in these countries' shrimp prices would result in a less than proportionate decrease in the quantity of shrimp demanded from them by the United States. The least inelastic was Thailand, -0.825. A 1% increase in the Thailand shrimp price will result in a decrease in their quantity of shrimp demanded by only 0.825%.

Table 3. Hypothesis tests for the CBS Model

Twice the Likelihoods

Dynamics	Degrees of Freedom for Restriction	Dummy Constraint: No Shifts 84	No Seasonal 77	Stable Annual with Seasonal 7	General
No dynamics	28	2,268.693	2,270.028	2,749.954	2,752.360
AR1	27	2,271.390	2,272.907	2,770.152	2,773.415
Restricted X lag	26	2,298.909	2,300.283	2,772.682	2,775.888
General dynamics		2,346.030	2,347.434	2,808.042	2,811.237

Significance Levels of Test versus Most General Model, Based on Chi-Square

Dynamics	Dummy Constraint: No Shifts	No Seasonal	Stable Annual with Seasonal	General
No dynamics	0.0%	0.0%	0.4%	0.1%
Ar1	0.0%	0.0%	18.8%	8.1%
restricted X lag	0.0%	0.0%	23.3%	10.4%
general dynamics	0.0%	0.0%	86.6%	

Significance Levels of Tests Comparing Stable Annual & AR1 Model with More General Models

Dynamics	Dummy Constraints: Stable Annual with Seasonal	General
Ar1		86.0%
restricted X lag	11.2%	67.7%
general dynamics	8.0%	18.8%

The most inelastic was the ROW. A 1% increase in the ROW shrimp price will result in a decrease in their quantity of shrimp demanded by only 0.242%. The paucity of studies on shrimp import demand limited the ability to compare results.

The scale elasticity measures the degree by which the amount of shrimp demanded from

Table 4. Estimated Price and Scale coefficients for the CBS Model, with Dynamic Adjustments Replaced with AR1

	Mexico	Ecuador	ROW	India	Thailand	Vietnam	China	United States	Scale (Share of Total Demand)
Mexico	−0.0273	0.0061	−0.0091	−0.0009	0.0127	0.0003	0.0027	0.0155	0.0433
Ecuador	0.0061	−0.0470	0.0212	0.0031	0.0294	−0.0077	−0.0100	0.0049	−0.0268
ROW	−0.0091	0.0212	−0.0405	0.0251	0.0035	0.0134	0.0028	−0.0164	−0.1633
India	−0.0009	0.0031	0.0251	−0.0291	0.0081	−0.0108	0.0018	0.0026	0.0440
Thailand	0.0127	0.0294	0.0035	0.0081	−0.1322	0.0119	0.0067	0.0598	0.0711
Vietnam	0.0003	−0.0077	0.0134	−0.0108	0.0119	−0.0066	0.0009	−0.0014	0.0339
China	0.0027	−0.0100	0.0028	0.0018	0.0067	0.0009	−0.0075	0.0026	0.0116
United States	0.0155	0.0049	−0.0164	0.0026	0.0598	−0.0014	0.0026	−0.0676	−0.0137

Table 5. Estimated Price and Scale Elasticities for the CBS Model, with Monthly Seasonality but Stable Year-to-Year Demand and AR1

	Mexico	Ecuador	ROW	India	Thailand	Vietnam	China	United States	Scale (Share of total demand)
Mexico	−0.463(0.024)**	−0.077(0.031)*	−0.488(0.027)**	−0.086(0.017)**	−0.294(0.031)**	−0.052(0.024)	−0.032(0.005)**	−0.040(0.022)	1.532(0.022)**
Ecuador	0.004(0.025)	−0.554(0.034)**	0.045(0.033)	−0.019(0.013)	0.099(0.040)*	−0.142(0.040)*	−0.114(0.014)**	−0.057(0.011)**	0.736(0.026)**
ROW	−0.072(0.008)**	0.065(0.014)**	−0.242(0.018)**	0.089(0.010)**	−0.073(0.025)*	0.049(0.011)**	−0.003(0.013)	−0.115(0.012)**	0.301(0.006)**
India	−0.141(0.019)**	−0.137(0.030)**	0.017(0.032)	−0.602(0.018)**	−0.343(0.031)**	−0.295(0.025)**	−0.029(0.049)	−0.210(0.034)**	1.740(0.074)**
Thailand	−0.065(0.007)**	−0.017(0.012)	−0.284(0.025)**	−0.044(0.009)**	−0.825(0.017)**	−0.025(0.011)	−0.024(0.003)**	0.031(0.006)**	1.253(0.009)**
Vietnam	−0.084(0.039)	−0.350(0.071)**	−0.098(0.051)	−0.301(0.026)**	−0.222(0.059)**	−0.244(0.044)**	−0.032(0.035)	−0.269(0.023)**	1.599(0.026)**
China	−0.053(0.010)**	−0.374(0.039)**	−0.252(0.084)*	−0.020(0.073)	−0.195(0.024)**	−0.032(0.051)	−0.262(0.039)**	−0.126(0.049)*	1.314(0.018)**
United States	0.030(0.013)	−0.057(0.008)**	−0.324(0.023)**	−0.035(0.009)**	0.156(0.017)**	−0.064(0.009)**	−0.017(0.013)	−0.593(0.011)**	0.904(0.019)**

[a] SEs generated from 1,000 bootstrap iterations are in parentheses.
* Significance level of 0.05.
** Significance level of 0.01.

Table 6. Estimated Monthly Dummies with Seasonality but Stable Year-to-Year Demand and AR1

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Mexico	−0.0123	−0.0284	−0.0056	−0.0081	−0.0374	−0.0227	0.0000	0.0146	0.0837	0.0652	−0.0138	−0.0352
Ecuador	0.0105	0.0202	0.0416	0.0047	−0.0285	−0.0133	−0.0138	−0.0194	−0.0134	−0.0033	−0.0086	0.0233
ROW	−0.0274	0.0056	0.0028	0.0085	0.0273	0.0104	0.0324	−0.0047	−0.0214	−0.0225	−0.0135	0.0025
India	0.0353	0.0054	0.0074	−0.0183	−0.0270	−0.0056	0.0143	0.0024	−0.0140	−0.0221	−0.0002	0.0224
Thailand	0.0200	0.0020	−0.0163	−0.0106	−0.0647	0.0207	0.0095	−0.0184	0.0103	−0.0081	0.0567	−0.0013
Vietnam	0.0209	0.0003	−0.0041	−0.0038	−0.0090	0.0120	0.0025	−0.0051	−0.0029	−0.0154	0.0026	0.0020
China	0.0056	−0.0048	−0.0146	0.0036	−0.0050	−0.0033	0.0107	0.0066	0.0020	−0.0083	0.0105	−0.0029
United States	−0.0526	−0.0003	−0.0112	0.0241	0.1442	0.0018	−0.0555	0.0239	−0.0443	0.0144	−0.0337	−0.0108

the United States and importing countries change when U.S. overall shrimp demand changes; this scale elasticity is also the elasticity of total wholesale shrimp expenditure. Scale elasticities for all countries were positive and statistically significant at the 1% level. The estimated scale elasticity for Mexico, India, Thailand, Vietnam, and China were greater than one. India had the largest scale elasticity of demand of 1.740, which implies that a 1% increase in overall U.S. shrimp demand would increase Indian shrimp import demand by 1.740%. Ecuador and the United States had scale elasticities of less than 1, though positive suggesting that a 1% increase in total U.S. shrimp demand would result in a less than 1% increase in shrimp demand from these countries.

As noted above, the elasticities in Table 5 are conditional on total shrimp expenditure. These cross-price elasticities account for both the substitution effects and expenditure effects of price changes. In a CBS specification, the "pure" substitution effects are determined by $C_{i,j}$ terms. Most of these cross-price terms are positive. However, the cross-price elasticities were very low, with 0.086 being the largest in absolute value. For the most part, signs on the cross elasticities were negative. This demonstrates that the expenditure effects of price declines tend to outweigh the pure substitution effects. For example, China's cross elasticity were negative with all other countries. A few cross elasticities were positive; for example, a 1% increase in the price of U.S. shrimp would result in a statistically significant but small increase in imports in shrimp from Thailand of 0.031%.

Stability of Demand

The premise associated with the antidumping procedure is that it has a measurable impact on import behavior and that dumping margins have a negative impact on dumped imports with stronger reactions for larger margins. The expectation, then, is that countervailing duties will destabilize the demand for shrimp imported from countries affected by the antidumping duties. The results shown in Table 6 demonstrate that although a high degree of monthly seasonality existed shrimp import demand form all of the countries, the overall demand was fairly stable.

Conclusions

The aim of the paper was threefold. First, we empirically estimated the total U.S. demand for shrimp and the conditional import demand for shrimp consumed in the United States with an econometric model. From this we calculated conditional import demand elasticities from estimated demand parameters. Finally, we tested for seasonality and stability of shrimp import demand in the face of a countervailing duty imposed on imports from certain countries.

The own-price elasticities for all countries had the expected negative signs, were statistically significant, and inelastic. The scale elasticities for all countries were positive and statistically significant at the 1% level with only the United States and Ecuador having scale elasticities of less than 1. For the most part, cross elasticities were negative, implying that shrimp demand exhibited a complementary relationship between countries. In a few cases, cross elasticities were positive, suggesting a substitute relationship.

Our results from this study suggest that despite the countervailing duties imposed by the United States on six major shrimp exporting countries, shrimp demand from these countries was fairly stable although there was a high degree of monthly seasonality. The monthly seasonality was expected since production for most countries is seasonal.

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