Determining the Impact of Crawfish Imports on U.S. Domestic Prices

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Abstract

The study identifies the linkage between imports and the domestic price of crawfish. The results show a simultaneous increase in imports and domestic prices of crawfish while showing a negative relationship between domestic landings and price. Each model shows that there is a seasonality effect on the domestic price of crawfish. The study also shows that increases in the domestic supplies of shrimp, tilapia, and clams generated increases in the domestic crawfish price while increases in imported and domestic supplies of beef and imported supplies of pork decreased the domestic crawfish price.

Introduction

Expanded U.S. fish consumption is apt to result in increased imports of fishery products (Aquaculture Outlook, 2006). The importation of many fishery products increased significantly during the 1990s and into the early 21st century (National Marine Fisheries Service, 2005). Such an increase is expanding the market share of imported products in the U.S. fish market. Due to price differences between exporting countries and the U.S. market the imported fishery products would affect on the domestic price. In fact, in the original investigation of crawfish tail meat from China in 1997, the International Trade Commission found underselling by imports of crawfish tail meat to be significant, and concluded that the imports had suppressed prices for the domestic product to a significant degree. All price comparisons between imports and the domestic like product, in every market, showed underselling in excess of 20 percent (U.S. International Trade Commission, 2003).

Although crawfish enters the domestic market through a variety of different agents or market channels, the imported goods are consumed indiscriminately along with the domestically produced crawfish. Consequently, imported and domestically produced crawfish are considered homogenous for which price appears to be the strongest motivator in terms of influencing consumers' willingness to purchase the good (Tomeck and Robinson, 1990). The influence of price on consumers' decision is only heightened due to the fact that it is difficult to distinguish between domestic and imported goods.

Louisiana is a leading state in the production of crawfish. Even though other states such as Texas, California, and North Carolina produce crawfish, almost all domestic crawfish is produced in Louisiana. The crawfish industry in Louisiana has a long historical background. In the beginning of the Louisiana crawfish industry, most crawfish was supplied through natural harvest. Following the 1960s, farm-raised crawfish became a very common supply source. However, some farmers still catch crawfish in Atchafalaya River Swamp (U.S. International Trade Commission, 2003).

In 2004, total commercial crawfish production was 78 million pounds. Among this, 70 million pounds is farm-raised crawfish, representing 90% of total production. The remaining 8 million pounds is natural harvest. As shown in Table 1, 1,226 farmers produce crawfish under controlled water conditions which ensures quality of product, consisting of 118,250 acres. For the year 2004, gross farm value of crawfish was $46 million.

[Place Table 1 Approximately Here]

Crawfish aquaculture is an important component of integrated farming systems in which rice is the principal crop. To use natural and economic resources efficiently, double-crop crawfish in rice fields after rice has been harvested. In the last four decades, this dual-cropping approach has progressed from an incidental practice to a vital economic component of many rice farmers' operations. In fact, most crawfish in Louisiana are now being cultured in rice fields. The species of crawfish commercially important in Louisiana are the red swamp crawfish (*Procambarus clarki*) and the white river crawfish (*Procambarus zonangulus*) (Greg et al. 2003).

In the U.S. fish market, crawfish are sold for consumption in three forms: 1) whole live crawfish, 2) whole boiled crawfish, and 3) processed (peeled) tail meat. Tail meat, in turn can be sold fresh (chilled) or frozen. Whole crawfish and fresh tail meat do not keep more than a couple of weeks, so the U.S. market for whole crawfish and fresh tail meat is dominated by U.S. producers. Frozen tail meat, however, can keep for a year or more, and is the focus of Chinese imports. Historically, whenever local crawfish harvest exceeded what could be moved through market channels to restaurants and retail consumers, excess product found its way to processing plants to be peeled and sold as fresh or frozen tail meat. This marketing outlet served to moderate drastic price swing.

After the mid-1990s, however, these enterprises met a new face from low-priced imported crawfish tail meat, resulting in over all price instability not only for frozen tail meat but also for fresh tail meat and whole live and boiled crawfish. Imported crawfish prices were approximately half that of domestic crawfish prices. In particular, substantial volumes of low priced, imported Chinese crawfish tailmeat displaced sales of domestic crawfish tailmeat and since domestic producers were unable to meet those low prices, they responded by selling more fresh crawfish meat and more whole live crawfish in season. This caused material injury to the whole, live and fresh crawfish market in the U.S.

This study is motivated from these new circumstances and is intend to provide a practical means of determining the impact of a given import volume change on domestic price. In doing this, this study uses inverse demand functions because inverse demand theory provides a good economic foundation for analyzing quantity impact on price. Inverse demand function provides not only the own price flexibility but also cross price flexibilities and scale flexibility which provide information regarding the impact of quantity and income on price. This study will use three different inverse demand models, proceeding stepwise from simpler to more complicated formulations, permitting us to observe any gains from additional modeling sophistication.

To achieve this purpose, this study conducts as follows: in the next section theoretical framework of inverse demand is discussed, this discussion will provide a clear understanding of the concept of price and scale flexibilities. Thereafter, empirical analysis will be discussed to specify three different inverse demand models. In section four, the empirical results will be discussed in which this study will provide imports effects on domestic crawfish price estimated in the specified inverse demand models. In final section, conclusions will be provided.

Theoretical Framework

Gorman (1959) established a literature base for fish in demand analysis. Gorman proposed that the price of fish depends, in part, on its quantity consumed and income, and also on the shadow prices of basic characteristics shared by all types of fish. Houck (1965 and 1966) illustrated that price flexibility is a very useful measure of the effect a change in quantity supplied will have on the prices of agricultural products. Many agricultural production processes are of the nature that market supplies of related commodities are determined largely in advance of current prices.

Inverse demand theory has been applied in several instances to the aquaculture industry. Several previous studies (e.g. Katzner, 1970; Salvas-Bronsard et al., 1977; Laitinen and Theil, 1979; Anderson, 1980; and Barten and Bettendorf, 1989) suggest that the inverse demand function is preferred to the direct demand function when anticipating future trends of price and quantity for perishable fishery products. The biological nature of the production process results in many fishery products being produced annually or only at regular time intervals. Some of these products are perishable or semi-perishable, and cannot be stored for long periods. The products must be consumed within a certain period of time. Hence, the situation results in fixed supply and a given level of demand for a specific time period. In the short term, the level of production cannot be changed. For such goods, the causality is from quantity to price (i.e., a price-dependent demand equation describes the situation).

The theoretic price flexibility is often treated as the inverse of the price elasticity. It is the percentage change in price resulted from a particular change in quantity, other factors held constant. As Houck (1966) and Eales (1996) indicated, under certain parameter conditions the price flexibility (f) is equal to the reciprocal of the corresponding price elasticity. If demand is inelastic, then the absolute value of the indirect price flexibility coefficient is likely to be greater than one. A flexible price is consistent with an inelastic demand. In other words, a small change in quantity has a relatively large impact on price. If demand is elastic, then the absolute value of the indirect price flexibility coefficient is likely to be less than one. An inflexible price is consistent with an elastic demand.

In a statistical model, however, the direct price flexibilites[1] are derived from the inverse demand function in which price is a function of quantities of own and related goods and a shift variable in which indirect price flexibilities are acquired utilizing the direct demand function. In this case, quantity is a function of the prices of own and related goods as well as income. As Huang (1994 and 1996) indicated, the reciprocal of the flexibility (elasticity) is not always a good approximation of the elasticity (flexibility) since different variables are held constant in the two statistical equations.

Flexibility coefficients that are analogous to the concepts of price and income elasticity may also be defined (Tomek and Robinson, 1991). Typically, the price flexibility of income is expected to be positive for normal goods. However, the relationship among demand, supply,

[1] The concept of flexibilities was introduced in 1919 by H. L. Moore in his pioneering article “Empirical Laws of Demand and Supply and the Flexibility of Prices.” Moore drew attention to price flexibilities in order to (1) focus on price phenomena from the producers’ viewpoint and (2) provide analytic content to his cotton demand estimates.

price, and income must be investigated. In the traditional demand system, the income variable shifts the demand curve. If there is an increase in income, the demand curve will move to the right so that quantity demanded, for a normal good, will increase at the same price. An increase in quantity demanded will increase the price. Increase in price will increase the quantity supplied as well. If an increase in the quantity supplied is greater than the increase in quantity demanded resulting from increased income, then over-supply will occur, resulting in a price decrease. As a result, the sign of the price flexibility of income coefficient is ambiguous in the inverse demand system. It depends upon the relative impact of income on demand versus the impact of price on supply.

As Boyle, Gorman, and Pudney (1977) and Barten and Bettendorf (1989) indicated, the price of crawfish depends mainly on its quantity consumed and income and, in part, on the shadow prices of basic characteristics shared by all types of fishery products. Therefore, the models in this study are formulated to examine the relationship between domestic crawfish price and quantities supplied of not only own good but also other related goods. In so doing, this study seeks to quantify the magnitude of the impacts of imported crawfish on the domestic price.

To achieve this objective, this study uses inverse demand equations to estimate direct price flexibilities. As a means of achieving this goal related to the direct price flexibility, it is important to understand the concept of the Antonelli matrix. The Antonelli equation refers to the effect of a change in quantity on the price of the good. Houck and Huang stated that there are fewer flexibility estimates than elasticity estimates because most economists are not familiar with the Antonelli matrix essential for performing flexibility analysis. Huang’s study states that when forecasting prices from an inverse demand model, flexibilities are more accurate. Also, price flexibility studies, using a direct method of flexibility estimation, would permit more accurate price forecasts to evaluate the effects of quantity changes on prices. This study approximates a conceptual inverse demand relationship of the following form:

(1) $$\ln p_i = \sum_j f_{ij} \ln q_j + \gamma_i \ln M \ ,$$

for all $i, j = 1,2,\ldots,n,$ where

(2) $$f_{ij} = \left(\frac{dp_i}{dq_j}\right)\left(\frac{q_j}{p_i}\right)$$

is the price flexibility of the i^{th} commodity with respect to a quantity change of the j^{th} commodity. If $i = j$, then f_{ij} is the own price flexibility, and if $i \neq j$, then f_{ij} is the cross price flexibility.

(3) $$\gamma_i = \left(\frac{dp_i}{dM}\right)\left(\frac{M}{p_i}\right)$$

Is the price flexibility of the i^{th} commodity with respect to income. We assume that f_{ij} is the usual type of inverse demand matrix in a general equilibrium model with own flexibility on the diagonal and cross flexibilities in the rest of the matrix. The flexibility matrix is constrained by the following conditions:

(4) *symmetry* $\left(f_{ij} / w_j + \gamma_i = f_{ji} / w_i + \gamma_i\right)$;

(5) *homogeneity* $\left(\sum_j f_{ij} + \gamma_i = 0\right)$; and

(6) *adding up condition* $\left(\sum_i w_i \gamma_i = 1\right)$.

The conceptual models are formulated to examine the effects of quantity on price.

Empirical Analysis

Since this study is mainly intended to estimate price flexibility as a tool to quantify the magnitude of impacts of imports of fish and red meats on domestic crawfish price, this study used a double logarithmic single equation model. A special property of the double logarithmic relationship is that if q_j rises by 1%, then p_i will rise by $\beta\%$. That is, β is the flexibility of p_i with respect to q_j in inverse demand equation. This functional form is commonly used when the study has interested in estimating on flexibility of some kind. In this study, the inverse demand equation of crawfish is estimated in logarithmic functional form using the Ordinary Least Squares method.

The model (1) estimated is as follows:

(6) $\ln p_{cr} = f\left(\ln q_m, \ln M\right)$

where p_{cr} is deflated domestic crawfish price, q_m is quantity of imported crawfish, and for theoretical consistence, $M = \sum_i p_i q_i$ is income or expenditure on the nine fishery products and three red meats. This model is intended to isolate the effects of the imported good and income on the domestic price. This model assumes that the imported good is an imperfect substitute for the domestically supplied good. Under this assumption, the model estimates the direct price flexibility.

The model (2) estimated is as follows:

(7) $\ln p_{cr} = f\left(\ln q_m, \ln q_{us}, \ln M\right)$

where q_{us} is domestically supplied quantity of crawfish. As in the previous model (1), this model assumes that the imported good is heterogenous with the domestic good. This model is intended to isolate the effects of not only imported goods but the domestically supplied good as well.

The model (3) estimated is as follows:

(8) $\ln p_{cr} = f\left(\ln q_m, \ln q_{us}, \ln s_m, \ln s_{us}, \ln M\right)$

where s_m is imported quantity of related goods, and s_{us} is domestically supplied quantity of related goods. This model is formulated to examine the effects of imported and domestically supplied own goods, imported and domestically supplied related goods, and income on domestic crawfish price.

Results and Discussion

Data

The models are estimated using data from January 1989 to December 2002 for domestic and imported crawfish, other fish, and three major meat products.[2] This study uses monthly rather than yearly data because of price endogeneity and quantity exogeneity. For example, in inverse demand system, quantities are naturally taken to be predetermined. However, fish imports can respond to price perturbations from previous months. For example, a strong U.S. crawfish price in January might affect imports in May or June of the same year, but will not result in an immediate response in the same month or affect imports during the following year. For this reason, it was determined that monthly data should be used in this analysis.

Several limitations were faced in obtaining relable monthly data for some fish products. For example, due to the lack of monthly domestic fish supply data, this study used domestic landings as a proxy to represent domestic supply. However, there are differences between domestic landings as reported by the National Marine Fisheries Service and domestic production. In addition, the domestic landings of some fish are reported in weight of meats while others are reported in live weight. These data limitations may be the cause of insignificance in several parameter estimations in the empirical models.

The data used in this study are obtained from the following sources: U.S. Import and Domestic Landings of Fishery Products provided by National Marine Fisheries Service; Livestock, Dairy and Poultry Situation and Outlook, Economic Research Service, USDA; and

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[2] The models do not include chicken imports, due to nonexistent imports of chicken in numerous sample periods.

the Disposable Personal Income used in the study was obtained from the U.S. Department of Commerce.

With respect to domestic crawfish price data, the study used monthly average crawfish prices obtained from New York's Fulton Fish Market (NYFFM). NYFFM, however, reports crawfish prices from March (or April) to September (or August) each year due to the seasonal nature of crawfish. As a result, this study uses synthetic prices for off-season product, which are obtained by adjusting the in-season prices based on the consumer price index.

Empirical Results

The results of the regression analyses for models 1, 2 and 3 are presented in Table 2. Each of the three models shows a positive and significant relationship between crawfish imports and the U.S. domestic crawfish price. Although the relationship does not exhibit the sign initially expected, it is likely that the causality is that of domestic prices driving imports rather than imports influencing the domestic price.

[Place Table 2 Approximately Here]

The sign for domestic crawfish landings is negative in both models 2 and 3, with a level of significance of 5% in the case of model 2 and 10% in the case of model 3. The negative sign is as expected, indicating that increases in domestic production have a negative impact on domestic prices.

All three models show a positive relationship between income and the domestic price of crawfish. Although only model one shows any level of significance (10%), the positive sign is consistent with the characteristics of a normal good.

The seasonality dummies exhibit very little in the way of significance. Although little can be inferred from these coefficients, the apparent trend of higher prices in the first part of the year with a drop-off in May or June is consistent with the decrease in consumption corresponding with the end of Lent.

With respect to the cross-commodity effects determined in model 3, beef and pork imports, and domestic beef production worked as the quantity of a substitute showing the expected negative sign at either the 5 or 10% level of significance. Contrary to expectations, domestic shrimp landings, domestic tilapia landings, and domestic clams landings proved to have a positive impact on domestic crawfish prices at the 1% level of significance. Even though this study could not exactly indicate the substitutability or complementarity as cross effect of the related goods used in this study due to limitation of single equation model, the results at least showed that there could be a complementary relationship between these products and crawfish price in some cases, or possibly from an income effect resulting from decreased shrimp, tilapia, or clams prices allowing for increased expenditures on crawfish. Furthermore, the study showed an interesting result related to cross effect. That is, cross effect of domestic supply of related goods showed all positive sign while most of imports of related goods showed negative sign even though the t-values are insignificant in $\alpha=0.1$. Based on this result, it can be explicitly shown that the negative effect of impost of fish and red meats on domestic crawfish price. So, further study using system equation model should be needed to estimate consistent cross effect between crawfish price and the related goods.

Conclusions

The Trade Adjustment Assistance Program allows the Secretary of Agriculture to compensate certain growers for economic damages incurred when imports have reduced domestic prices. The imported good must, even if lightly processed, be a close substitute for the domestic raw product. Compensation may be warranted if imports have brought domestic prices below 80% of the fiveyear, 1998-2002 average (United States Department of Labor: Employment and Training Agency, 2002).

Agricultural prices may decline for reasons unrelated to changes in import supply. For example, they may fall on account of changes in income, or in the availability of the commodity's substitutes. Thus, in order to distinguish between import effects and other effects on domestic prices, this study constructed econometric models to provide a practical means of determining the impact of a given import volume change on domestic prices; an account of the potentially perishable nature and seasonality of lightly processed commodities; the extent of substitutability between the domestic good, the imported good, and other related domestic and imported goods. In incorporating these features, this study progressed from simpler to more complex formulations, permitting observations of any gains from additional modeling sophistication.

This study indicated that imports of crawfish have increased along with an increase in the domestic price of crawfish. At the same time, domestic supply of crawfish has a negative relationship with the domestic price, implying that the high domestic price generated during the collapse in domestic production resulting from drought in 2000 and 2001 attracted imports of crawfish. Although each model shows a seasonal effect of the domestic price of crawfish, the results do not consistently show the seasonal effect of the domestic price of crawfish. This study also showed that increases in the domestic supplies of shrimp, tilapia, and clam resulted in an increase in the domestic crawfish price while increases in imported and domestic supplies of beef and imported supply of pork decreased domestic crawfish price.

These results provide insight into the question as to whether compensation to domestic producers was justified. One criterion for determining compensation is that economic damages be incurred as the result of imported product. According to this study, increased crawfish imports did not tend to depress domestic crawfish prices over the time period analyzed. Rather, the more plausible explanation is that domestic shortages strengthened domestic prices which, in turn, created market opportunities for foreign producers. Foreign product entered the U.S. market and served to stabilize the domestic price. However, as domestic product rebounded to its previous levels it was then combined with the expanded level of imports to create surplus conditions in the domestic market, causing downward pressure on domestic prices. It is also important to remember that relationships estimated over a twelve year period may not be the same as those experienced at any specific point in time.

A thorough understanding of the causality between imports and domestic prices, in addition to the events contributing to various price phenomena, is necessary to determine if imports have caused damage to the domestic industry. Estimation of flexibilities through the use of an inverse demand function provides a more accurate estimations of flexibilities than can be achieved through the inversion of elasticities obtained through a traditional demand function. Proper estimation of these flexibilities provides a better picture as to the impact of imports on domestic prices and their overall impact on the industry under consideration.

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Table 1. Louisiana Crawfish Production, 2004

	No. of Producers	Acres	Production (lb)	Gross Farm Value ($)
Farm-Raised	1226	118250	69,546,680	41,728,008
Wild-Caught	1481	-	8,267,173	4,808,939

Source: LSU AgCenter, 2005

Table 2. OLS Analysis of the U.S. Domestic Crawfish Price

Variable	Model (1)		Model (2)		Model (3)	
	Estimate	t-ratio	Estimate	t-ratio	Estimate	t-ratio
Incercept	-4.3030	-1.30	-0.2270	-0.06	3.1784	0.49
Crawfish imports	0.0246	3.82***	0.0235	3.71***	0.0260	2.69***
Crawfish domestic landings			-0.0222	-2.57***	-0.0215	-1.88*
Catfish imports					0.0045	0.35
Catfish domestic landings					0.0281	0.46
Shrimp imports					-0.0600	-0.68
Shrimp domestic landings					0.1363	1.96*
Tilapia fresh imports					0.0171	0.32
Tilapia frozen imports					-0.0097	-0.40
Tilapia canned imports					-0.0132	-0.43
Tilapia domestic landings					0.0281	2.33**
Trout imports					0.0089	0.25
Trout domestic landings					0.0022	0.12
Clam imports					0.1043	1.36
Clam domestic landings					0.2313	2.38**
Oyster imports					-0.0196	-0.44
Oyster domestic lands					0.0560	0.60
Mussel imports					0.0349	0.61
Mussel domestic landings					-0.0283	-1.48
Scallop imports					-0.0174	-0.34
Scallop domestic landings					0.0555	1.19
Chicken domestic prod.					0.4540	1.42
Beef imports					-0.2239	-2.07**
Beef domestic prod.					-0.6106	-1.78*
Pork imports					-0.2419	-1.71*
Pork domestic prod.					-0.4861	-1.38
income	0.3728	1.85*	0.1299	0.59	0.5017	0.81
January	-0.0310	-0.54	-0.0053	-0.09	0.1033	1.11
February	0.0320	0.55	0.0584	1.01	0.0429	0.44
March	0.0347	0.61	0.1079	1.71*	0.1961	1.78*
April	0.0351	0.61	0.1293	1.91*	0.0333	0.30
May	0.0606	1.03	0.1720	2.39**	-0.0760	-0.55
June	-0.0299	-0.53	0.0724	1.05	-0.1592	-1.04
July	-0.0230	-0.41	0.0454	0.74	-0.1278	-0.95
August	-0.0262	-0.46	-0.0135	-0.24	-0.1911	-1.50
September	-0.0146	-0.26	-0.0452	-0.80	-0.1772	-1.69
Ocober	-0.0133	-0.23	-0.0325	-0.57	-0.1403	-1.54
November	0.0178	0.32	-0.0002	-0.00	-0.0728	-0.98
SSE	3.9204		3.7693		2.6118	
DFE	166		165		132	
MSE	0.0236		0.0228		0.0197	
RMSE	0.1536		0.1511		0.1406	
SBC	-105.2965		-107.1788		-32.2769	
AIC	-149.9979		-155.0732		-151.4372	
R^2	0.1936		0.2247		0.4134	
Adj-R^2	0.1255		0.1530		0.2464	
Durbin-Watson	0.9720		1.0045		1.2655	

*, **, and *** signify statistical significance at the 10, 5, and 1 percent levels, respectively.