The U.S. Shrimp Demand Market Analysis: A Product Differentiated Mixed Rotterdam Demand System

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Abstract
The Gulf of Mexico (GOM) is the primary producer of shrimp in the United States and annual production from this region has remained relatively constant over the past several decades. By comparison, U.S. shrimp imports have increased from about 400 million pounds annually during the early 1990s to more than 1 billion pounds in recent years. These imports arrive in a variety of product forms including shell-on, peeled, and miscellaneous. Using a Mixed-Rotterdam model, this study investigates the influence of changes in imports in total and by product form on the GOM dockside price as well as the influence of expenditures on imports and domestic product. Quarterly data covering 1991 through 2011 was employed. Overall, results conform to theoretical expectations.

Methodology and Data

Introduction

World Shrimp Market:
• World production of farmed shrimp (or aquaculture) has increased significantly during the past three decades. (Figure 1)
• The United States is the largest importer of warm-water shrimp and competes with Japan and the European Union for about 10% of world exports (Figure 2).

The U.S. Shrimp Market:
• Per-capita consumption was 4.2 pounds in 2011.
• The dockside value of the Gulf of Mexico shrimp production (which represents about 80% of the nation’s total) averaged $471 million annually between 2000 to 2011.
• Shrimp imports have been increasing since the 1990s (Figure 3).
• GOM shrimp landings have exhibited a slow-down trend during the same period (Figure 4).
• The defined prices of imported and GOM shrimp have declined since the 1990s with the decline being particularly pronounced after 2000 (Figure 5).

The primary objective of this study is to analyze the U.S. demand for shrimp by source (imports vs. domestic) and product type. Imports of shell-on shrimp are differentiated by size and classified as “large”, “medium”, and “small”. Specifically, this study:
1. Measures the effects of changes in U.S. shrimp expenditures on the quantity of imported product (by type), and the dockside GOM shrimp price.
2. Estimates own-price and cross-price effects for selected imported shrimp products;
3. Estimates the effects of GOM landings on the GOM dockside price.

Objectives

Domestic shrimp production is generally believed to be highly price inelastic in the short run (i.e. price dependent). A number of countervailing forces compete in the world shrimp export market and hence one can assume that the U.S. demand for imports is quantity dependent.

Neither an ordinary demand or an inverse demand system alone adequately models this complicated system of demand.

In 1965, Samuelson introduced the mixed demand system to more accurately model this type of system and since then the theory has been refined by a number of researchers (e.g., Barnett, Harris, Chen) to study various commodities.

A differential demand approach is a method that can satisfy all the properties which are required to drive a mixed demand system.

Results

Mixed Rotterdam demand Model under Preference Independence Utility Functions:

The terms \( \omega \) and \( \phi \) are budget share for good in commodity group a and budget share for good in commodity group b, respectively.

Mixed demand system properties:
- Adding up and Homogeneity Conditions:
- Symmetry Restrictions:

Table 1—Direct Demand Price Elasticities (Imported Shrimp Product equations, 1991–2011).

<table>
<thead>
<tr>
<th>Product Type</th>
<th>Price Elasticity</th>
<th>Own-Price Elasticity</th>
<th>Cross-Price Elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peeled</td>
<td>-0.83</td>
<td>-0.52</td>
<td>0.31</td>
</tr>
<tr>
<td>Shell-On</td>
<td>-0.68</td>
<td>-0.41</td>
<td>0.20</td>
</tr>
<tr>
<td>Miscellany</td>
<td>-0.70</td>
<td>-0.45</td>
<td>0.25</td>
</tr>
</tbody>
</table>

Table 2—Price Flexibility/Quantity Elasticities of GOM landings, 1991–2011.

<table>
<thead>
<tr>
<th>Source</th>
<th>Elasticity</th>
<th>Average</th>
<th>Variability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic Agent</td>
<td>-0.40</td>
<td>0.12</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

This table indicates that a 1% increase in GOM landings is associated with a 0.26% decline in GOM dockside price.

Further, the results indicate that the GOM demand for shrimp is relatively inelastic compared to the price elasticity as well as the quantity elasticity of supply elasticity.

Conclusions:
- Importable shrimp products account for a large marginal share of U.S. shrimp expenditures relative to GOM landings (i.e., domestic landings). (Table 1)
- Importable peeled shrimp exhibits the largest cross-price elasticity, implying that an increase in the peeled product causes a larger reduction in U.S. purchases from these product types relative to other types.
- Shell-on medium shrimp types has the largest own-price elasticity relative to all other products.
- GOM landings price sensitivity is less than any importable products.
- An increase in U.S. expenditures on the total shrimp category reduces in a reduction in share of imported shell-on small shrimp and domestic shrimp, and a proportionate increase for peeled, miscellaneous, and shell-on large shrimp products.
- The reduction in shell-on small and domestic shrimp expenditures is associated with a more proportionate increase in shell-on medium shrimp products, thus increasing the shell-on medium shrimp product’s market share.

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References: