Demand Characteristics for Imported Cod Products in Portugal: An Application of PCAIDS and Demand Growth Index Modelling

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Motivation

• Demand Fundamental structure of a market
• Important to understand Demand
• Learn a lot about a market by observing demand characteristics: Competition in the market; Investment possibilities
• Demand econometrics difficult because violation of conditional expectation rule
Purpose

• Portugal imports cod from many countries primarily in three forms; Frozen, Salted and Salted & Dried (Klippfisk)
• Consumption is primarily Salted & Dried
• Lots of attention on development of new fish markets for aquaculture and amazing growth in demand (Asche et al 2011)
• Cod in Portugal a traditional market
• Interest here is twofold
• First, measure Portuguese Import demand characteristics (own elasticities and cross price elasticities) for Imported Frozen, Salted and Salted & Dried cod
• Second, measure Shifts or Growth in demand for imported product.
Simple Demand Representation
Think about Elasticities and Demand growth
• Common to model using Almost Ideal Demand System (AIDS) modelling of Deaton and Muellbauer (1980).

• The AIDS model can incorporate the theoretical properties of the demand structure.

• To estimate a full AIDS model requires information on quantity, price and expenditure on all commodities within the market structure of interest.
PCAIDS

- Often data available only on quantity and price of select products
- Proportionally Calibrated Almost Ideal Demand System (PCAIDS) Epstein and Rubinfeld (2002)
- The PCAIDS model maintains many of the ideal features of the AIDS structure but when data are limited or incomplete, it is designed as a calibrated simulated model
- Coloma (2006) shows a regression procedure using incomplete data to provide an initial estimate for calibration of the PCAIDS model.
Demand Growth Index

• Measure growth in demand for imported product: Demand Growth Index Modelling
• The change in demand may be caused by changes in income or price of substitutes, or a change in preference for the product.
• Marsh (2003) shows a straightforward technique for measuring growth in market demand using an index approach.
Demand Growth Index

• The technique is a decomposition of a change in quantity demanded between the percentage change accounted by a price change (i.e., a movement) along the demand curve

• And the percentage change accounted by a shift in the demand curve.
Annual tonnes imports of frozen, salted & dried and salted cod

Cod: Frozen, Salted & Dried and Salted, 1990 - 2013

Source: EUROSTAT
PCAIDS

- In cases with limited data, Epstein and Rubinfeld (2002) suggest a simulation approach based on the assumption of ‘proportionally consistent market shares’ or PCAIDS model.

- What this means is that under a price change for one product, demand shifts towards other products in the market according to relative market shares.
PCAIDS has many of the ideal theoretical properties of the full AIDS model.

The PCAIDS assumption allows for an important relationship for the coefficients of the model

\[ a_{jj} = \frac{S_j \cdot (1-S_j)}{S_i \cdot (1-S_i)} \cdot a_{ii} \]

\[ a_{ij} = \frac{-S_i}{1-S_j} \cdot a_{jj} \]
In order to apply the PCAIDS model two conditions are required;

First, is the assumption of proportionally consistent market shares

Second, the availability of initial estimates of both $a_{ii}$ and $\eta$.

Coloma (2006) shows a regression procedure based on data for only a sub-component of the market to obtain initial estimates of the base parameters.
Share equations and Aggregate demand curve

\[
\frac{s_f \cdot (1-S_f)}{s_s} = c_f + a_{ff} \cdot \ln\left(\frac{P_f}{P_s}\right) + c_{fI} \cdot \ln (I) + \varepsilon_f
\]

\[
\frac{s_k \cdot (1-S_k)}{s_s} = c_k + a_{ff} \cdot \ln\left(\frac{P_k}{P_s}\right) + c_{fI} \cdot \ln (I) + \varepsilon_k
\]

\[
\ln Q_t = a + \eta \cdot \ln P_{avg} + c_{gdp} \ln I + \varepsilon_Q
\]
<table>
<thead>
<tr>
<th></th>
<th>Frozen</th>
<th>Salted &amp; Dried</th>
<th>Salted</th>
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<tbody>
<tr>
<td>Frozen</td>
<td>$a_{ff}$</td>
<td>$-S_k \cdot a_{ff}$</td>
<td>$-S_s \cdot a_{ff}$</td>
</tr>
<tr>
<td>Salted &amp; dried</td>
<td>$-S_k \cdot a_{ff}$</td>
<td>$S_k \cdot (1 - S_k) \cdot a_{ff}$</td>
<td>$S_s \cdot (1 - S_s) \cdot a_{ff}$</td>
</tr>
<tr>
<td>Salted</td>
<td>$-S_s \cdot a_{ff}$</td>
<td>$S_f \cdot (1 - S_f) \cdot a_{ff}$</td>
<td>$S_f \cdot (1 - S_f) \cdot a_{ff}$</td>
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Important for demand analysis is that the estimated $a_{ij}$ coefficients in the system (call it the ‘AIDS A’ matrix) have a correspondence to the demand elasticities that characterize the market structure.

\[
\eta_{ii} = -1 + \frac{a_{ii}}{S_i} + S_i + (\eta + 1)
\]

\[
\eta_{ij} = \frac{a_{ij}}{S_i} + S_j \cdot (\eta + 1)
\]
$\eta = -0.273 \ (0.08)$

<table>
<thead>
<tr>
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<th>Frozen</th>
<th>Salted &amp; Dried</th>
<th>Salted</th>
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</thead>
<tbody>
<tr>
<td>Frozen</td>
<td>-1.387$^{a)}$</td>
<td>0.356</td>
<td>0.515</td>
</tr>
<tr>
<td></td>
<td>(0.173)$^{b)}$</td>
<td>(0.039)</td>
<td>(0.058)</td>
</tr>
<tr>
<td>Salted &amp; Dried</td>
<td>0.356</td>
<td>-1.283</td>
<td>0.515</td>
</tr>
<tr>
<td></td>
<td>(0.039)</td>
<td>(0.157)</td>
<td>(0.058)</td>
</tr>
<tr>
<td>Salted</td>
<td>0.515</td>
<td>0.515</td>
<td>-1.079</td>
</tr>
<tr>
<td></td>
<td>(0.058)</td>
<td>(0.058)</td>
<td>(0.125)</td>
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$^{a)}$ Calculated at Mean  
$^{b)}$ Standard Error
Market Demand Index

- The index is straightforward in that it measures the difference between what the product price would be in the absence of any shift in demand i.e., the counterfactual price, and the actual resulting price.
- The index will measure demand shifts from one period to the other and observing the index overtime will provide a measure of changes in import demand.
Demand Growth Index

Graph showing the impact of price changes on demand with labels for $p^1$, $p^2$, $p^e$, and $D$, $D'$ on the graph axes.
There are four steps to building the index

Calculate the percentage change in Quantity
\[ \% \Delta Q_i = \frac{Q_{it} - Q_{it-1}}{Q_{it-1}} \]

Calculate the percentage change in price holding demand constant at the elasticity \( \eta_{ii} \)
\[ \% \Delta P_i = \frac{\% \Delta Q_i}{\eta_{ii}} \]

Calculate the counterfactual price not allowing a shift in demand (Entirely a supply side effect)
\[ P_{i}^{CF} = P_{it-1} + P_{it-1} \cdot \% \Delta P_i \]

Finally, calculate the demand index as the percent difference between actual price and the counterfactual price
\[ \frac{P_{it} - P_{i}^{cf}}{P_{i}^{cf}} = \text{Change in Demand Index} \]
• This value will represent the change in the index over time.
• A cumulative measure of demand growth relative to the base period is represented by the demand index overtime.
• For evaluation purposes the growth index is normalized to 100 for the base period, 2000.
## Summary Demand Growth Index, Select Periods

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<tbody>
<tr>
<td>Frozen</td>
<td>97.7</td>
<td>173.2</td>
<td>123.5</td>
<td>135</td>
</tr>
<tr>
<td>Salted</td>
<td>132.5</td>
<td>73.8</td>
<td>46.7</td>
<td>93.6</td>
</tr>
<tr>
<td>Salted &amp; Dried</td>
<td>79.5</td>
<td>67.7</td>
<td>75.8</td>
<td>73.9</td>
</tr>
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*a) Base period 2000*
Price Simulations

![Graph showing price simulations over time: Real Price (€/Kg.) on the y-axis and time periods from 2013m1 to 2015m1 on the x-axis. Three lines represent different price categories: Price Frozen (dotted), Price Salted & Dried (solid), and Price Salted (dashed).]
Demand Index: Frozen

![Demand Index Chart]

- **Index**
- **Index-Sim**

Month-wise demand growth index from January 2013 to December 2013.
Demand Index: Salted

Bar chart showing demand growth index for the months from January 2013 to December 2013. The chart includes two sets of data: Index and Index-Sim.
Conclusion

• Market Demand Characteristics Important
• PCAIDS is a useful technique with limited data to characterize the elasticity structure
• Measure elastic response in all three markets
• Measure substitute across products with salted and frozen strong substitutes
• Little measured growth for Salted & Dried
• Good demand growth for Frozen and early on for salted product
Price of Imported cod products

- Frozen
- Salted
- Klippfisk

Price/kg

Years:
- 1990m1
- 2015m1

Graph shows the price fluctuations of different types of cod products from 1990 to 2015.
Salted & Dried

Demand Growth Index