Perennial Supply – Substitution in Bearing Acreage Decisions

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Introduction – Motivation
Perennial crops differ from annual crops in two significant ways.
1. Time from planting to full production can be several years (2-5 years).
2. Capital investment and durability of the crop – fruit tree life expectancies 15-25 years +/-.
Decisions to plant/remove fruit trees can have significant impact on future profitability of production system.
Decisions to plant/remove trees are made on incomplete information and expectations of:
Prices, Yields, Complements/substitutes.

Objective
Estimate substitution effects in bearing acreage for Washington State across tree fruit (apples, cherries, grapes, peaches, and pears).

Literature: Substitutes
French and Bressler (lemons 1962) and French and Matthews (asparagus 1971) – substitutes – but with too many choices?
Bateman (1965) cocoa and coffee in Ghana.
Kalaitzandonakes and Shonkwiler (1992) oranges and grapefruit.

Literature: Tree Fruit Dynamics
Plantings/removals (French, King and Minami 1985).
Reason for removals – weather, pests and diseases, marketing order controls.

Conceptual Model (cont.)
Total bearing acreage for a species is:
\[ A_{t,k} = \sum_{j=1}^{k} A_{t,j} - RM_{t,k} \]
where \( j \) is the upper age limit and \( j \) is the age at which trees bear marketable fruit.
New plantings are shown as:
\[ A_{t,k} = NP_{t,k} \]
Tree removals are a function of removals due to age and removals due to low production, pests, diseases, or marketing orders. Hence we have:
\[ RMT_{t,k} = \left( \sum_{j=1}^{k} RM_{t,j} \right) + RM_{t,k} \]
We calculate the change in bearing acreage as:
\[ \Delta A_{t,k} = NP_{t-1,k} - \sum_{j=1}^{k} RM_{t,j} \]
Optimizing a grower’s model, new plantings are a function of expected returns from a species and substitutes in production:
\[ NP_{t,k} = f(\pi_t, \pi_{1:t+k}, \pi_{1:t+k}) \]
Similarly for removals
\[ RMT_{t,k} = f(\pi_t, \pi_{1:t+k}, \pi_{1:t+k}, Z_{t,k}) \]
where \( Z \) captures removals due to non-economic factors.

Empirical Model
The econometric model is:
\[ \Delta A_{t,k} = f(P_{t-\delta,k}, \pi^{t-\delta,t}, k, \pi_{1:t+k}, \pi_{1:t+k}, Z_{t,k}) \]
where \( \delta \) is the lag length = 1, 2, 3, 4, 5, and \( k \) (and \( k_t \)) apples, sweet cherries, pears, peaches, grapes.
The model is estimated using GMM to account for endogeneity and contemporaneous correlations.

Data
All farm gate price, yield, and bearing acreage data from Washington State NASS.
Data covers the period 1960-2012
1960 chosen as new cherry marketing order begun in 1957.
Fruit prices deflated by fresh fruit PPI from BLS

Results
Individual Models

<table>
<thead>
<tr>
<th>Apples</th>
<th>Peach</th>
<th>Cherry</th>
<th>Grape</th>
<th>Pear</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>0.1325</td>
<td>-0.0657</td>
<td>0.0012</td>
<td>0.0032</td>
</tr>
<tr>
<td>Peach</td>
<td>0.1754</td>
<td>0.0051</td>
<td>0.0052</td>
<td>0.0046</td>
</tr>
<tr>
<td>Cherry</td>
<td>(0.0661)</td>
<td>(0.0208)</td>
<td>0.0782</td>
<td>0.0782</td>
</tr>
<tr>
<td>Grape</td>
<td>(0.0697)</td>
<td>(0.0518)</td>
<td>0.0724</td>
<td>0.0546</td>
</tr>
<tr>
<td>Pear</td>
<td>(0.1028)</td>
<td>(0.0228)</td>
<td>0.0426</td>
<td>0.0426</td>
</tr>
</tbody>
</table>

Own price elasticities measure effect on bearing acreage, cross price elasticities indicate some crops maybe complements, and this maybe reflective of a grower’s risk management strategy. Also growers are not land constrained in Washington. Results provide guidance to policy makers with respect to substitution effects after a pest or disease outbreak.

References