Perennial Supply – Substitution in Bearing Acreage Decisions

Peter R. Tozer,

Thomas L. Marsh, and

Xiaojiao Jiang.

School of Economic Sciences,
IMPACT Center,
Washington State University,
Pullman, WA. 99164.
Contact author: peter_tozer@wsu.edu

Selected Poster prepared for presentation at the Agricultural & Applied Economics Association's 2014 AAEA Annual Meeting, Minneapolis, MN, July 27-29, 2014.

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Peter R. Tozer, Thomas L. Marsh and Xiaojiao Jiang.
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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

Assume a grower optimizes their portfolio, intertemporally balancing tree planting (*NP*) and removal decisions (*RM*). Then Bearing Acreage (*A*) at time *t* for species *k* of age *j* is given as:

$$A_{t,k}^{j} = A_{t-1,k}^{j-1} - RM_{t,k}^{j}$$

Conceptual Model (cont.)

Total bearing acreage for a species is:

$$A_{t,k} = \sum_{j=j_\tau}^{J_k} A_{t,k}^{j}$$

where J_k is the upper age limit and j_τ is the age at which trees bear marketable fruit.

New plantings are shown as:

$$A_{t,k}^{0} = NP_{t,k}$$

Tree removals are a function of removals due to age and removals due to low production, pests, diseases, or marketing orders. Hence we have:

$$RMT_{t,k} = (\sum_{j=1}^{J_{k-1}} RM_{t,k}^{j}) + RM_{t,k}^{J_k}$$

We calculate the change in bearing acreage as:

$$\Delta A_{t,k} = NP_{t-j_\tau,k} - \sum_{j=j_\tau}^{J_k} RM_{t,k}^{j}$$

Optimizing a grower's model, new plantings are a function of expected returns from a species and substitutes in production:

$$NP_{t,k} = f(\pi_{t+i,k}^{*}, \pi_{t+i,k_A}^{*})$$

Similarly for removals

$$RMT_{t,k} = f(\pi_{t+i,k}^{*}, \pi_{t+i,k_A}^{*}, Z_{t,k})$$

where Z captures removals due to non-economic factors.

Empirical Model

The econometric model is:

$$\Delta A_{t,k} = f(P_{t-\delta,k}, y_{t-\delta,k}^{j}, P_{t-\delta,k_A}, y_{t-\delta,k_A}^{j} Z_{t,k})$$

where δ is the lag length = 1, 2, 3, 4, 5, and *k* (and k_A)= apples, sweet cherries, pears, peaches, grapes.

The model is estimated using GMM to account for endogeneity and contemporaneous correlations.

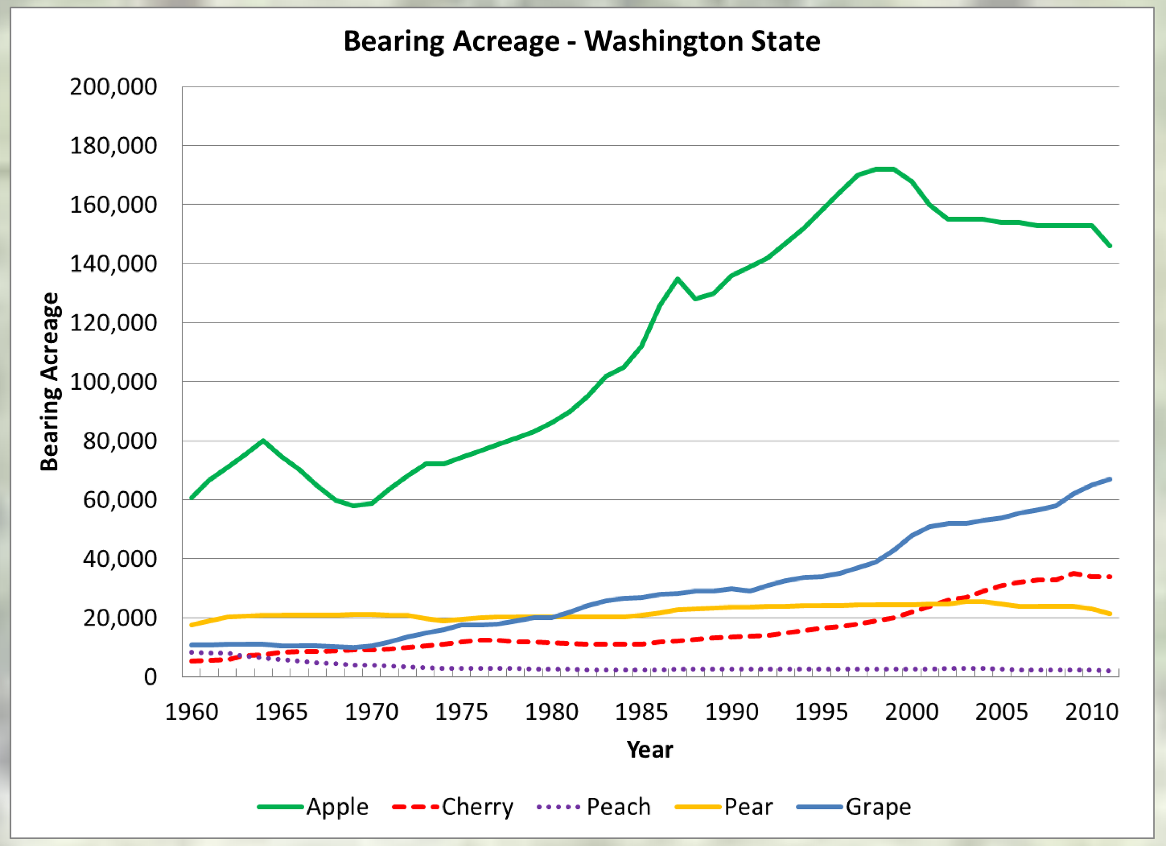
Data

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

All crops are functions of (1) lagged own price, yield, or revenue, (2) at least one substitute crop's lagged prices, yields or revenue, and (3) other variables, i.e time, or bearing acreages. (Lags 1 to 4 years).

Adjusted R^2 ranged from 0.68 to 0.88, D-W and Durbin h test indicate no autocorrelation, Sargan and Hausman tests for omitted variables and over-identification in all equations were not rejected.

Results

Individual Models

Apples - 9 variables - Apple yield and price, cherry bearing acres, grape revenue.

Cherries – 10 variables – Cherry price, apple bearing acres and price, grape price and wine percentage, peach price.

Grapes – 14 variables – Grape bearing acres, yield, price and wine processed grape price differential , apple bearing acres and revenue, cherry revenue.

Peaches – 11 variables - Peach bearing acres, price and yield, cherry, grape and pear price.

Pears – 12 variables – Pear bearing acres, yield and price, apple and cherry price.

Elasticities

Own and cross price elasticities, (R) indicates revenue elasticity.

Model	Apple	Peach	Cherry	Grape	Pear
Price					
Apple	0.1225		-0.0667	(R) -0.0012	-0.0032
Peach		0.1664	0.0011		
Cherry	(R) 0.0610	-0.0328	0.1382	(R) -0.073	0.0562
Grape	(R) -0.0067	-0.0518	0.0724	0.0563	
Pear	(R) -0.0208				0.0345

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.

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