A Technical Report to WSU Center for Sustaining Agriculture and Nature Resources

Organic Apple Price in Response to Crop Size Supplied to the Market

Holly Wang
Yuanlong Ge
School of Economic Sciences
Washington State University
(509)335-8521, wanghong@wsu.edu

A significant interest in organic tree fruit production has developed over the last 10 to 15 years. Total US sales of organic food and beverages were estimated at $9.0 to $9.5 billion for 2001, representing between one and two percent of total US food and beverage sales. Although the percentage is small, growth rates for organic products are 10 to 20 percent per year, well above growth rates for conventional food products (Greene and Kremen, 2003). Fresh fruits and vegetables are the largest category of organic food sales (Dimitri and Greene, 2002).

The state of Washington dominates commercial apple production in the US, accounting for well over 50 percent of total US production. Washington Apples have historically enjoyed national and international recognition (WASS, 2002). Washington is also the leading state in organic apple production, accounting for about 38% of total US organic apple acres. Although the organic acreage only accounts for a small percentage of all apple acreage, it is growing at a fast speed. However, it is observed that the organic price premium is decreasing currently, which brings a big concern on growers' profitability.

Certified Washington State organic apple acreage increased from well below 500 total acres in the late 1980s to 6,540 acres in 2001 with an additional 3,400 acres in the transition process. Washington is currently the leading state in organic apple production, accounting for about 38 percent of total US acres, and organic acres represent about four percent of the state's total apple acres (Greene and Kremen, 2003).

The driving power for growers to convert from conventional apple production into organic production was price premium that market provided to organic apples. However, the regular annual production cost for organic apples is also higher than conventional apples even without including the transition cost. Unfortunately, it is argued that the price premium is becoming smaller, which brings about the question whether the organic production can be profitable. As Parsons (2004) points out that organic producers should not expect to receive or sustain a premium price for the product unless they can produce a premium product and sell it in the right market. Furthermore, the perishable nature of fresh fruit makes the many small none-cooperating growers to have disadvantages in the market with a few large purchasers in terms of price negotiating.

As recognized in the literature that segmentation and better knowledge of the potential buyers are important to market the organic products (Gonzalez and Cobo, 2002; Granatstein and Kirby, 2002), it is identified that the processors of higher value product such as baby food may be able to offer reasonable prices to producers for processing grade apples. This brings out the question that whether selling more lower grade organic apples to processors instead of supplying

them to the fresh market is able to boost up the higher grade fruits while not losing money on the lower grade sales.

In this project, we estimate an inverse demand function to reveal the price response to quantity. This demand function includes multiple grade apples so that the cross grade effect can be evaluated. Specific objectives of this paper include, (1) estimating the percentage of low grades apples marketed in recent years; (2) studying the relationship between crop size of the lower grade apples and the price response of higher grade apples; and (3) predicting the price boosting in this year (or the future) by a reduction in lower grade supplies.

Data

Washington organic apple sales data are kept by alternative organizations such as WA Clearing House and Washington Organic Tree Fruit Growers Association. The most complete data is identified from the Wenatchee Valley Traffic Association. Weekly shipment data are recorded and facilitated to us from November 10, 2003 to September 19, 2005. The apples are from both Wenatchee and Yakima, two major apple production areas in Washington.

Although many varieties are recorded in the dataset, some of the new ones have few transactions and small quantities. We only analyze and report the five biggest varieties: Red Delicious, Golden Delicious, Fuji, Gala, and Granny Smith. There are totally 17, 908 entries, each of which represents the total packout transactions of one size-grade apples sold with a particular package type, for a particular variety, and from a particular storage during the week.

The criteria used to categorize organic apples in particular sizes and grades are the same as the conventional apples. The sizes in the dataset range from 30 to 198. The large size (80 and larger) accounts for 34.61% of total boxes, the middle size (88 to 125) accounts for 39.09% and the small size (138 and under) accounts for 26.30%. Grades appear in the data range from the lowest US#1, US Fancy (USF), US Extra Fancy (USXF), Washington Fancy (WAF), and Washington Extra Fancy #1 (WAXF#1) , #2 (WAXF#2), and Premium (WAXFP). Any grades lower than WAF are considered a low grade.

There are six different pack types: the most popular Tray Pack (TP) accounted for 59.94% of total boxes, Bag (BG) with 24.77%, the new and increasing Euro Pack (EU) of 11.71%, Cell Pack (CP) of 3.08%, Heavy Pack (HP) and Triwall (TW) each accounting for 0.37% and 0.13% respectively. Most of the quantities, 62.11% boxes, are from Controlled Atmosphere (CA) storage and the rest 37.89% from Regular (RG) cold storage.

Because the actual weight of each type of package is different, we convert all quantity units into a standard 42 pound box (thereafter referred to box). There are altogether 1,870,283 boxes of apples reported and the prices range from $5.40/box to $76.36/box with a weighted average of $21.59/box. (See Table A1 in Appendix for the conversion details.)

Over the two year period, the dominating variety is Gala, accounting for 29.88%, followed by Fuji, 20.43%, Red Delicious, 19.30% and Golden Delicious, 18.19%. The Granny Smith also accounts for 12.20% of the total quantity.

Analysis

The low grade apples are marketed as fresh for each of the varieties (Table 1). For the five varieties over the two years, about 3.34% of apples are in grade US Extra Fancy or lower. Fuji has the highest percentage, 8.77%, in the lower grades, followed by Granny Smith, 4.31%, and the other three varieties each has less than 2% in the lower category. Because the prices of these grades are lower, the sale revenues they bring to the industry only account for 2.59% of the total. They range from 6.86% for Fuji down to 0.78% for Red Delicious.

Table 1. Quantities and Sales between November 2003 and September 2005

		Percent Weight				Percent by Sale	
	Quantity	Over all varieties	Low Grade	Small Size	Sale	Low Grade	Small Size
	(million pound)	(%)	(%)	(%)	(million $)	(%)	(%)
Red Delicious	15.16	19.30	1.12	30.95	6.70	0.78	28.95
Granny Smith	9.59	12.20	4.31	27.29	5.19	2.73	21.72
Golden Delicious	14.29	18.19	1.72	22.91	7.35	1.20	17.98
Gala	23.47	29.88	1.66	34.70	12.46	1.36	28.84
Fuji	16.05	20.43	8.77	12.07	8.68	6.86	9.75
Total	78.56	100	3.34	26.30	40.38	2.59	21.86

Because the apple prices are also determined by the size of the fruits, size is an important variable we will consider in our demand model. We aggregate the actual sizes into small, medium and large categories as mentioned above, and found the small fruits (Size 138 and below) account for a significant portion of the total crop (Table 1).

The inverse demand function approaches will be taken to conduct regression analysis using price as dependent variables and quantities and other impacting factors as independent variables (Cornes, 1992). Hedonic price functions are incorporated in this case to measure a wide variety of commodity characteristics such as size and grade, based on Lancaster's (1966) theory that consumers take commodity characteristics as the fundamental sources of utility.

The demand model takes the form:

$$P_{1t} = a_{10} + a_{11}DY_t + a_{12}DRG_t + a_{13}DRG_t * t + a_{14}DM_t + a_{15}DL_t + a_{16}DEU_t + a_{17}DBG_t + \sum_{j=1}^{n} b_{1j}Q_{jt} + \varepsilon_{1t}$$

$$\vdots$$

$$P_{nt} = a_{n0} + a_{n1}DY_t + a_{n2}DRG_t + a_{n3}DRG_t * t + a_{n4}DM_t + a_{n5}DL_t + a_{n6}DEU_t + a_{n7}DBG_t + \sum_{j=1}^{n} b_{nj}Q_{jt} + \varepsilon_{nt}$$

where P_{jt} and Q_{jt} denote the price and quantity of fresh apples for grade j at time t; j is from the highest grades to the lowest grades; and t is from 1 to 12 denoting the month in each crop year starting from September. [1] DY is the year dummy variable for 2004, DRG is the dummy variable for apples from regular storage. Because the prices for fruits from regular storage tend to drop as the time moves from harvest to winter, a time trend is also added as represented by DRG*t. There is no such evidence for fruits from the CA storage. DM and DL are size dummy variables for medium and large sizes respectively. DEU and DBG are package dummy variables for Euro Pack and Bag. Not all attributes are represented by a dummy variable because some of them are only observed in very few observations and little impact in the overall demand estimation.

The regression results are reported in the upper portion of Tables 2 to 6.[2] In the following, we only discuss those statistically significant coefficients, because the insignificant estimates mean they are not different to zeros and have no effect on the prices.

The above model has not captured the seasonal effect in general. It includes a linear trend for apples in regular storage, indicating that the quality of the fruits in those storage facilities decreases over time resulting in a decreasing in prices. However, consumers' seasonal consumption preference is excluded. Large supply of fresh apples in the fall, habitual consumption of apples in the fall and winter, and more competition from other available summer fruits including melons may have a seasonal effect of apple prices. We include additional five seasonal dummy variables to allow flexibility. They are bimonthly dummies, D1, D2, D3, D4, and D5 for Sep.-Oct., Nov.-Dec., Jan.-Feb., Mar.-Apr., and May-June respectively, leaving Jul.-Aug. as default. Each of the bimonthly dummy is included as itself as well as in combination with the DRG, so that the seasonality effect is allowed to be different for apples from the regular storage versus controlled atmosphere storage. The results are reported in the lower portion of Tables 2 to 6.

Fuji

For Fuji apple prices (Table 2), crop year 04/05 shows \$0.05 to \$0.12 lower than the year before for all grades, except for the Washington Extra Fancy #1 with similar prices in both crop years and the low grades (US Extra Fancy and lower) showing \$0.11 higher in 04/05. Medium sized apples have three and five cents price premium over the small sized apples in low grades and the WAXFP grade, and the large sized fruits have eight cents premium in WAXFP grade. The Euro Pack apples have a price premium over the regular Tray Pack apples of a few cents for WAXFP and WAXF#1, but more than a dollar for WAXF2 and WAF, while the Bagged apple prices are \$0.13 to \$0.24 lower than the Tray Pack.

The prices of each grade react to the quantity of own grade negatively, means there is an opposite relationship between the price and quantity of apples in each grade. Worth of mentioning, the quantity of low grades (all grades in the US category) does have a negative

Table 2. Organic Fuji Apple Price Responses to Quantity and Other Attributes

[1] All the quantity data in the regression are in standardized 42 pound boxes.
[2] The last two weeks of data in our dataset, September 6 to 19, 2005, are excluded from the regression analysis, because they are new crops in the crop year 05/06, while the analysis is for crop year 03/04 and 04/05 only.

	WAXFP	WAXF#1	WAXF#2	WAF	USXF
No seasonality					
Constant	0.67***	0.67***	0.79***	0.77***	0.40***
DY(2004)	-0.051 ***	0.0087	-0.12***	-0.12*	0.11***
DRG	0.15***	0.19***	-0.11	0.14	0.25***
DRG*t	-0.050***	-0.052***	0.0058	-0.063	-0.057***
DM	0.051**	0.013	-0.018	-0.016	0.026**
DL	0.082***	0.014	N/A	N/A	N/A
DEU	0.042 ***	0.067***	1.04***	1.05***	N/A
DBG	-0.13***	-0.14***	-0.24***	N/A	-0.037
Q_{WAXFP}	-0.000021	-0.000024***	-0.000009	0.000018	-0.000022***
$Q_{WAXF\#1}$	-0.000033***	-0.000085***	0.000005	-0.000053***	0.000000
$Q_{WAXF\#2}$	0.000071***	0.000046**	-0.00020	0.00023**	0.000078***
Q_{WAF}	0.000089	0.00019***	-0.00010	-0.00056***	0.00034**
$Q_{LowGrade}$	-0.000027***	-0.000013	0.00015***	-0.000147	-0.000080*
Number of observations	717	603	88	51	235
R^2	0.53	0.46	0.64	0.86	0.50
With Seasonality					
Constant	0.63***	0.63***	0.60***	0.74***	0.50***
DY(2004)	-0.092***	-0.021	-0.31	-0.080	0.038
DM	0.036*	0.091***	-0.012	-0.013	0.021*
DL	0.062***	0.098***	N/A	N/A	N/A
DEU	0.041***	0.061***	1.42***	1.04***	N/A
DBG	-0.15***	-0.059*	-0.24***	N/A	-0.0090
D1	0.17**	-0.12	N/A	N/A	0.20***
D2	-0.0069	-0.064	0.19	N/A	N/A
D3	0.085	-0.037	0.41***	-0.20**	-0.059***
D4	0.16**	0.061	0.42***	0.016	0.00044
D5	0.072	-0.091	0.43***	-0.0018	N/A
DRG	0.046	0.73***	-0.051	-0.10**	-0.032*
D1*DRG	N/A	-0.42**	N/A	N/A	N/A
D2*DRG	N/A	-0.71***	N/A	N/A	N/A
D3*DRG	-0.11***	-0.78***	-0.041	N/A	N/A
D4*DRG	-0.31***	-1.06***	-0.10	N/A	-0.089**
Q_{WAXFP}	-0.000020	-0.000026***	0.000002	0.000015	-0.000020***
$Q_{WAXF\#1}$	-0.000040***	-0.000086***	-0.000023	-0.000059***	0.000000
$Q_{WAXF\#2}$	0.000090***	0.000065***	-0.00014	0.00030***	0.00012***
Q_{WAF}	0.000087	0.00020***	-0.00013	-0.00041**	0.00020
$Q_{LowGrade}$	-0.000036***	-0.000030***	0.00014**	0.000081	-0.000096**
Number of observations	717	603	88	51	235
R^2	0.57	0.61	0.72	0.90	0.58

Note, ***, ** and * mean statistically significant at 1%, 5% and 10%, respectively.

effect on WAXFP and WAXF1 prices, the two highest priced fruits. One percent increase in the total boxes of low grades apples causes 0.029 and 0.015ercent fall in WAXFP and WAXF1 prices, respectively.

We also observe that the prices of apples in Regular storage decrease about five cents each month since harvest, indicating the quality of the fruits decreases overtime without being kept in CA storage. This makes their prices to fall below the prices of apples from Controlled Atmosphere after four months of harvest.

When the seasonality effects are modeled and relaxing the linear time trend, the signs and magnitudes of the most coefficients remain similar. The quality decreasing issues for apples in regular storage are shown by the negative and increasing in size of the coefficients of combined seasonal and RG dummy variables. However, for apples in CA storage, prices actually increase over time caused by the fact that all the supply of fruits (organic or non-organic, apples or other fruits) reduces after early fall and prices go up. For example, the WAXF#2 seasonal dummy coefficients are 0.41, 0.42, and 0.43 for Jan.-Feb., Mar.-Apr., and May-June fruits from CA storage, indicating their prices increase one cent every two months after the New Year. The seasonal patterns of prices are shown in Figure 1 for grades WAXFP and WAXF#1.

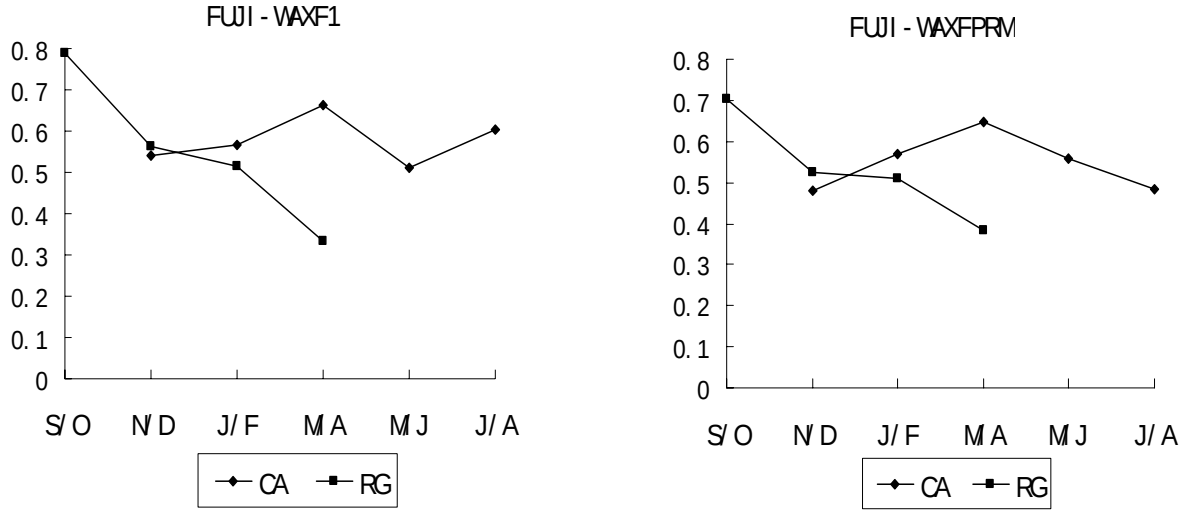

Figure 1. Fitted prices with seasonal effects for Fuji apples of two top grades.

Gala

For Gala apples (table 3), almost no WAF grade apples are marketed during the years. Crop year 04/05 prices only show a $0.04 lower than the year before for all WAXFP, and no price difference between the two years for all other grades. Medium sized apples have seven to 20 cents price premium over the small sized apples, and the large sized fruits have ten to 25 cents premium. This means the Gala price is more sensitive to fruit size than Fuji prices.

Table 3. Organic Gala Apple Price Responses to Quantity and Other Attributes

	WAXFP	WAXF#1	WAXF#2	USXF
No seasonality				
Constant	0.53***	0.55***	0.57***	0.24*
DY(2004)	-0.04***	-0.02	-0.03	-0.0016
DRG	-0.05***	-0.05***	-0.11	-0.064
DRG*t	0.01***	0.0043	0.025	0.0065
DM	0.085***	0.078***	0.04	0.20*
DL	0.19***	0.13***	0.10***	0.25**
DEU	0.098***	0.085***	0.27***	N/A
DBG	-0.10***	-0.027	0.19**	0.21
Q_{WAXFP}	0.000001	-0.000011***	-0.000019**	-0.000001
$Q_{WAXF\#1}$	-0.000009***	-0.000011	0.000002	-0.000003
$Q_{WAXF\#2}$	0.00012***	0.000067***	0.000016	0.00013 ***
$Q_{LowGrade}$	0.000065*	0.000025	0.00012**	-0.00013
R^2	0.50	0.31	0.47	0.19
With Seasonality				
Constant	0.75 ***	0.70***	0.56***	0.54***
DY(2004)	-0.08***	-0.12***	-0.20**	-0.13**
DM	0.07***	0.062***	0.037	-0.032
DL	0.17***	0.12***	0.10***	N/A
DEU	0.09***	0.083***	0.28***	N/A
DBG	-0.12***	-0.04**	0.30***	-0.04
D1	-0.24***	-0.17**	-0.03	-0.10**
D2	-0.25***	-0.16***	N/A	-0.098*
D3	-0.22***	-0.09	0.21***	-0.036
D4	-0.11*	-0.00086	0.26***	0.076
D5	-0.046	0.075	0.12	0.15**
DRG	-0.07	-0.0042	0.073*	0.07
D1*DRG	0.11	0.095	N/A	N/A
D2*DRG	0.11	0.0059	N/A	N/A
D3*DRG	0.078	-0.078	-0.19**	-0.069
D4*DRG	N/A	N/A	N/A	-0.27**
Q_{WAXFP}	0.000005	-0.000006***	-0.000025**	0.000003
$Q_{WAXF\#1}$	-0.000002	-0.000006	0.000002	0.000008
$Q_{WAXF\#2}$	0.0001***	0.00008***	0.000000	0.00012***
$Q_{LowGrade}$	0.000033	0.000028	0.00012**	-0.000098
R^2	0.59	0.47	0.59	0.39
Number of observations	688	658	118	108

Note, ***, ** and * mean statistically significant at 1%, 5% and 10%, respectively.

The Euro Pack apples have a price premium over the regular Tray Pack apples of 10 to 27 cents, while the Bagged apple prices are $0.10 lower than the Tray Pack for WAXFP. Surprisingly, the Bagged apple prices are $0.19higher than Tray Pack for WAXF#2.

On the price response to quantities marketed, there is no clear pattern observed that lower grade quantities would affect higher grade prices.

There is no evidence for a negative time effect on prices of apples in Regular storage from either the linear trend model or the seasonality model. The seasonal dummy coefficients also indicate the prices for fruits from Controlled Atmosphere storage drop immediately after harvest and then rise overtime, while the seasonality effect on the Regular stored fruits is not statistically significant. This is because no shipment was made after February for fruits from Regular storage (Figure 2). Within the four months period, the regularly stored fruits do not show a clear price fall.

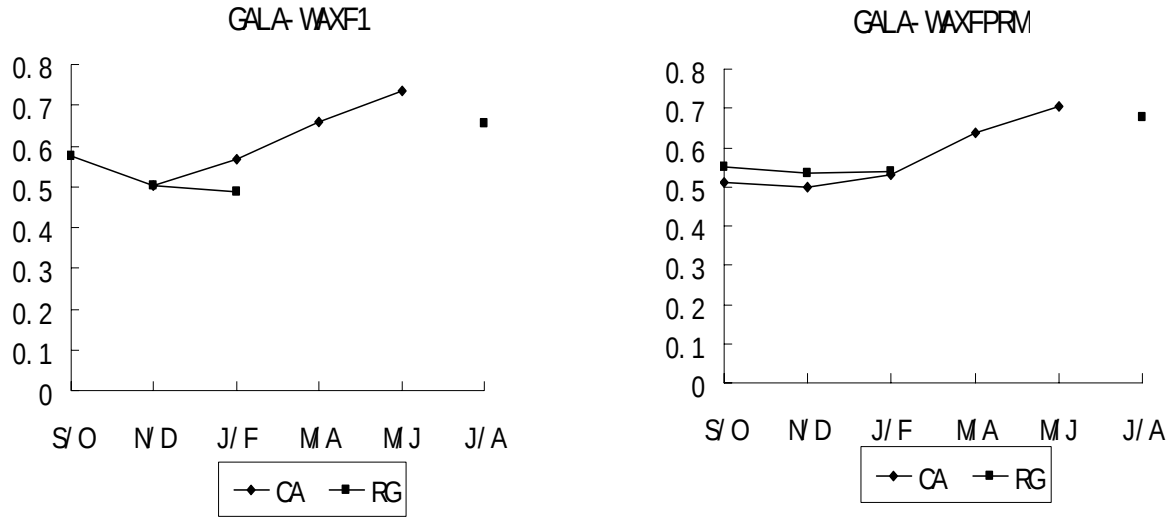

Figure 2. Fitted prices with seasonal effects for Gala apples of two top grades.

Golden Delicious

Golden Delicious prices behave similar to Fuji (Table 4). Crop year 04/05 shows $0.07 lower than the year before for Washington Extra Fancy Premium. Medium sized apples have 17 cents price premium over the small sized apples for WAXFP grade, and the large sized fruits have 18 cents premium for that grade. The Euro Pack apples have a price premium over the regular Tray Pack apples of a few cents for all grades with shipments, while the Bagged apple prices are eight cents lower than the Tray Pack for WAXF#1.

The quantity of low grades does have a negative effect on WAXFP price, the highest prices fruits. One percent increase in the total boxes of low grades apples causes 0.021 percent fall in WAXFP prices.

We also observe that the prices of apples in Regular storage decrease about three cents each month since harvest for WAXFP and one cent for WAXF#1, indicating the quality of the fruits decreases overtime without being kept in CA storage.

Table 4. Organic Golden Delicious Apple Price Responses to Quantity and Other Attributes

	WAXFP	WAXF#1	WAXF#2	USXF
Constant	0.46***	0.53***	0.66***	0.48***
DY(2004)	-0.073***	-0.012	-0.015	-0.0064
DRG	0.062***	0.057**	-0.11	-0.15**
DRG*t	-0.034***	-0.014**	-0.003	0.012
DM	0.17*	-0.0008	N/A	-0.03
DL	0.18**	N/A	0.0038	N/A
DEU	0.027**	0.065**	0.094***	N/A
DBG	0.0069	-0.087***	N/A	N/A
Q_{WAXFP}	-0.000002	-0.000014***	-0.000016*	-0.00003***
$Q_{WAXF\#1}$	-0.000041***	-0.000065	-0.000028	-0.00003
$Q_{WAXF\#2}$	0.000093***	0.00015***	0.000097	0.00015**
$Q_{LowGrade}$	-0.00013***	-0.000061	0.000084	0.00016
R^2	0.36	0.24	0.23	0.37
With Seasonality				
Constant	0.42***	0.61***	0.46***	0.51***
DY(2004)	-0.058***	-0.043	-0.032	-0.0077
DM	0.20**	-0.0024	0.0085	-0.027
DL	0.22**	N/A	N/A	N/A
DEU	0.03***	0.052*	0.12***	N/A
DBG	0.04	-0.092***	N/A	N/A
D1	-0.12*	0.011	0.052	-0.10
D2	-0.17**	-0.12**	N/A	-0.11
D3	-0.026	-0.063	0.19**	-0.069
D4	0.042	0.022	0.36***	-0.17*
D5	-0.0096	-0.086*	0.19*	-0.099
DRG	0.12*	0.01	0.083	-0.10
D2*DRG	N/A	0.043	N/A	N/A
D3*DRG	-0.20***	-0.0081	-0.17	0.043
D4*DRG	-0.49***	-0.24***	N/A	N/A
Q_{WAXFP}	-0.000002	-0.000015***	-0.000009	-0.00002
$Q_{WAXF\#1}$	-0.000054***	-0.0001***	-0.00011***	0.000004
$Q_{WAXF\#2}$	0.000087***	0.00014***	0.000020	0.00016**
$Q_{LowGrade}$	-0.00014***	-0.000031	0.00013	0.00022
R^2	0.39	0.33	0.40	0.40
Number of observations	752	419	134	77

Note, ***, ** and * mean statistically significant at 1%, 5% and 10%, respectively.

When the seasonality effects are modeled and relaxing the linear time trend, the signs and magnitudes of the most coefficients remain similar. The seasonal pattern of prices looks similar to that of Fuji apples (Figure3). For example, the WAXF#2 seasonal dummy coefficients are 0.19, 0.36 and 0.19 for Jan.-Feb., Mar.-Apr., and May-June fruits from CA storage, indicating their prices increase overtime except for the last two months of the season. The seasonal patterns of prices are shown in Figure 3 for grades WAXFP and WAXF#1.

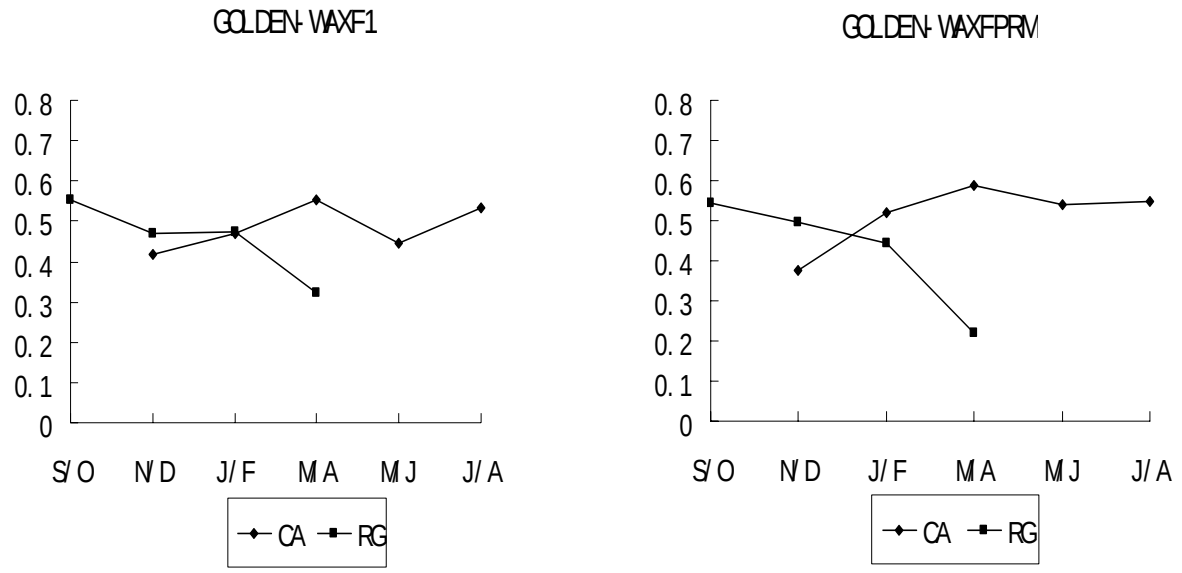

Figure 3. Fitted prices with seasonal effects for Golden Delicious apples of two top grades.

Granny Smith

Similar to the previously discussed varieties, Granny Smith apples (Table 5), the crop year 04/05 price shows $0.03 to $0.08 lower than the year before for Washington Extra Fancy Premium and US Extra Fancy. There were almost no apples marketed in the WAXF#2 grade during the two years. There were also no large sized Granny Smith apples. The medium sized apples have no price differences with small apples basically.

The Euro Pack apples have a price premium over the regular Tray Pack apples of three and 18 cents for WAXFP and WAXF#1, while the Bagged apple prices are $0.23 and $0.10 lower than the Tray Pack for the two grades correspondingly.

The quantity of low grades does have a negative effect on WAXFP price, the highest prices fruits. One percent increase in the total boxes of low grades apples causes 0.015 percent fall in WAXFP prices.

There is no significant effect of storage time for either the linear time model or the seasonality model (Figure 4). Regular stored fruits were marketed only up to winter time.

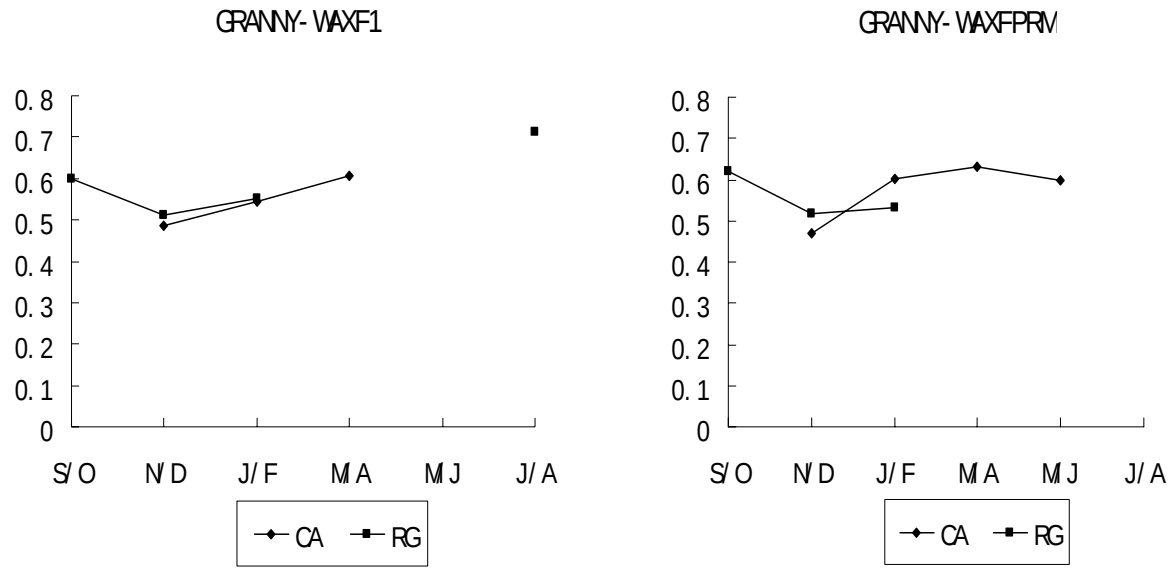

Figure 4. Fitted prices with seasonal effects for Granny Smith apples of two top grades.

Table 5. Organic Granny Smith Apple Price Responses to Quantity and Other Attributes

	WAXFP	WAXF#1	USXF
Constant	0.67***	0.57***	0.48***
DY(2004)	-0.03*	0.023	-0.08**
DRG	-0.042**	0.02	0.03
DRG*t	-0.0024	-0.0059	-0.016
DM	-0.014	0.016	0.029
DEU	0.03**	0.18***	N/A
DBG	-0.23***	-0.099***	0.079
Q_{WAXFP}	0.000006	-0.000009***	-0.000022***
$Q_{WAXF\#1}$	0.000013	-0.00004	0.000004
$Q_{LowGrade}$	-0.00005**	-0.000014	-0.000056
R^2	0.43	0.24	0.22
With Seasonality			
Constant	0.88***	0.50***	0.50***
DY(2004)	-0.068***	-0.026	-0.10***
DM	-0.02**	0.013	0.03
DEU	0.037***	0.17***	N/A
DBG	-0.22***	-0.10***	0.094
D1	-0.23***	-0.11	0.0044
D2	-0.31**	0.049	-0.048
D3	-0.18	0.11	N/A
D4	-0.15	0.17**	-0.12*
D5	-0.19	N/A	N/A
DRG	0.064	0.28***	-0.0027

D2*DRG	-0.018	-0.25**	N/A
D3*DRG	-0.13	-0.27***	-0.038
D4*DRG	N/A	-0.48***	-0.076
Q_{WAXFP}	0.000009	-0.000013***	-0.000021***
$Q_{WAXF\#1}$	0.000008	-0.000046	0.000015
$Q_{LowGrade}$	-0.000036*	0.000024	-0.000076
R^2	0.52	0.35	0.26
Number of observations	507	346	114

Note, ***, ** and * mean statistically significant at 1%, 5% and 10%, respectively.

Red Delicious

Red Delicious is one of the largest varieties in our dataset (Table 6). The 04/05 crop year observes a five cents lower price than its 03/04 counterpart for WAXFP grade, but not other grades. Medium and large sized apples are sold about six and ten cents more expensive in WAXFP and WAXF#1 grades, respectively, than the small sized fruits. Euro Pack is sold three to 16 cents per pound more than Tray Pack.

The quantity of low grade apples sold to the market does not affect the price of higher grade apples.

There is a clear time effect on the price of fruits from Regular storage (Figure 5). The price drops about three cents every month since harvest. However, apples from Controlled Atmosphere storage don't have that problem.

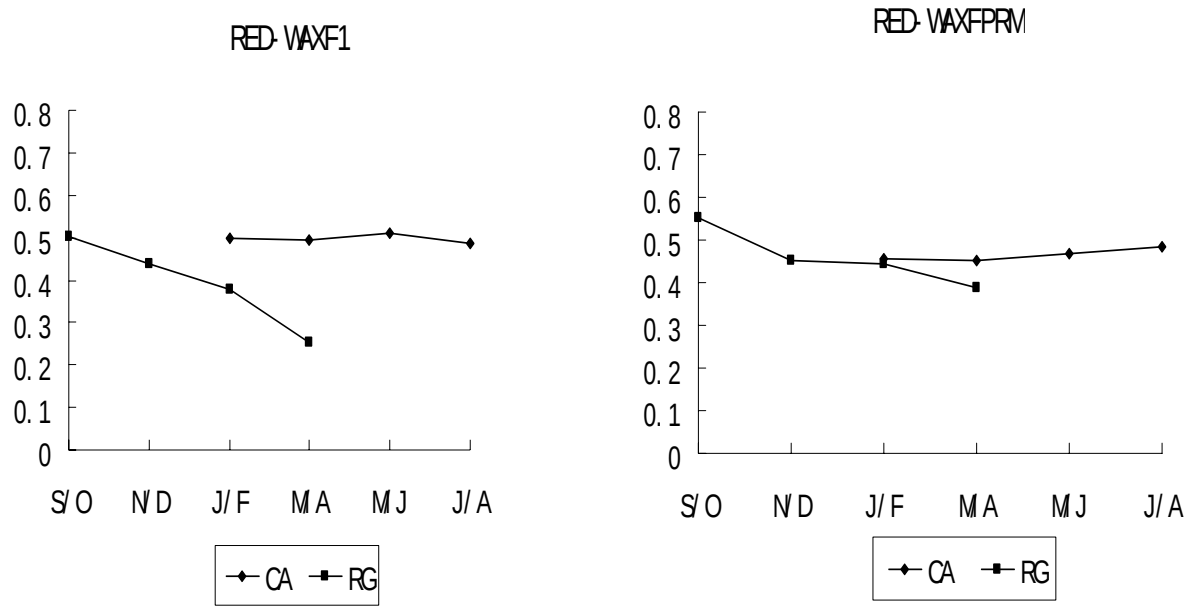

Figure 5 Fitted prices with seasonal effects for Red Delicious apples of two top grades.

Table 6. Organic Red Delicious Apple Price Responses to Quantity and Other Attributes

	WAXFP	WAXF#1	USXF
Constant	0.43***	0.45***	0.37**
DY(2004)	-0.049***	0.005	0.025
DRG	0.10***	0.059***	0.12
DRG*t	-0.025***	-0.033***	-0.035*
DM	0.068**	0.11***	0.024
DL	0.057*	0.096**	0.016
DEU	0.079***	0.16***	0.34***
DBG	0.0082	0.092**	0.08
Q_{WAXFP}	-0.00004***	-0.000034***	-0.000022*
$Q_{WAXF\#1}$	0.000030***	0.000011	-0.000016
$Q_{LowGrade}$	-0.000054	-0.00005	-0.00024
R^2	0.24	0.50	0.25
With Seasonality			
Constant	0.49***	0.45***	0.34*
DY(2004)	-0.073***	0.0056	0.079
DM	0.055	0.11***	0.016
DL	0.043	0.097**	0.0088
DEU	0.08***	0.16***	0.31**
DBG	-0.0044	0.092**	0.035
D1	0.0059	-0.093*	-0.09
D2	-0.11	-0.13***	-0.069
D3	-0.028	0.0098	0.12
D4	-0.033**	0.007	0.067
D5	-0.014	0.024	0.041
DRG	0.082	0.079*	0.15
D1*DRG	-0.02	0.029	N/A
D2*DRG	N/A	N/A	N/A
D3*DRG	-0.092	-0.20***	-0.35
D4*DRG	-0.14*	-0.32***	N/A
Q_{WAXFP}	-0.000037***	-0.000037***	-0.000031*
$Q_{WAXF\#1}$	0.00003***	0.000006	-0.00003
$Q_{LowGrade}$	-0.000058	-0.000057	-0.00034
R^2	0.25	0.53	0.28
Number of observations	762	492	53

Impact of marketing low grade apple on the industry profitability

The aforementioned 0.029 and 0.015 price elasticities for WAXFP and WAXF1 Fuji suggests that if low grade apples in crop year 04/05 reduce by 1% which is 250 boxes for the

entire crop year, the prices of WAXFP and WAXF1 will increase by $0.00015/lb, and $0.000071/lb. This trade-off converts to a reduction in low grade apple sale of $4109.32 (assuming not selling as cull but just disposing them), and a sale increase of WAXFP and WAXF1 of $1067.20 and $245.88, respectively. For Fuji apples, market less low grade apples will not make the whole industry more profitable.

For Golden Delicious, if low grade apples marketed in crop year 04/05 reduce by 1% which is 42 boxes, the price of WAXFP will increase by $0.000096/lb. This trade-off will make the whole industry more profitable because the reduction in low grade apple sales of $564.37 is less than the increase of WAXFP sale of $662.94. The total sales gain of for this variety will then be $9,857 if the entire low grade apples are removed from the market.

For Granny Smith, if low grade apples marketed in crop year 04/05 reduce by 1% which is 45 boxes, the price of WAXFP will increase by $0.00008/lb. This trade-off will not make the whole industry more profitable because the reduction in low grade apple sales of $500.14 is more than the increase of WAXFP sale of $389.56.

The impact of the low grade crop size on the price of other grades is not statistically significant for Red Delicious and Gala.

Summary

In this analysis, we use the sales data from November 10, 2003 to September 19, 2005, organized by the Wenatchee Valley Traffic Association, the most complete dataset available for WA apples. The apples are from both Wenatchee and Yakima, and the five biggest varieties, Red Delicious, Golden Delicious, Fuji, Gala, and Granny Smith, are analyzed, while the other varieties do not have enough data for the analysis.

During this period, the low grade apples (US Extra Fancy or lower) sold to market account for about 3.3% in volume and 2.6% in value. The crops sizes have a negative impact on prices generally. Especially, the crop size of the lower grade apples can have a negative impact on the price of higher grade apples for all varieties except Gala and Red Delicious, for which the impact is insignificant. However, based on the market elasticities, only Golden Delicious will benefit from a higher sales value if the lower grade apples are removed from the market, assuming zero cull values for these fruits. The sales gain will be less than $10,000 over all.

BIBLIOGRAPHY

Cornes, R. *Duality and Modern Economics*, Cambridge University Press, New York, 1992.

Dimitri, C. and C. Greene. *Recent Growth Patterns in the U.S. Organic Food Market*. Washington, D.C., U.S. Department of Agriculture, Economic Research Service, AIB 777, September 2002.

Elliot, S. L., and J. D. Mumford. "Organic, Integrated and Conventional Apple Production: Why Not Consider the Middle Ground?" *Crop Protection*, 21(5) (2002):427-429.

Glover, J. D., J. P. Reganold, and P. K. Andrews. "Systematic Method for Rating Soil Quality of Conventional, Organic, and Integrated Apple Orchards in Washington State." *Agriculture, ecosystems & environment*, 80(1/2) (2000): 29-45.

Gonzalez Ruiz; Cobo Quesada. Organic Production in Spain: the Marketing Strategies Key Factor for the Success. *Distribucion y Consumo*, Abril-Mayo, (2000):39-54.

Granatstein, D. and E. Kirby. *Current Trends in Organic Tree Fruit Production*. Wenatchee, WA, Center for Sustaining Agriculture and Natural Resources, CSANR Report No. 4, May 2002.

Greene, C. and A. Kremen. *US Organic Farming in 2000-2001: Adoption of Certified Systems*. Washington, DC, US Department of Agriculture, Economic Research Service, AIB No. 780, February 2003.

Lancaster, K. "A New Approach to Consumer Theory." *Journal of Political Economy* 74 (1966): 132-157.

Parsons, W. "Organic fruit and vegetable production: Do farmers get a premium price?" *VISTA on the Agri-Food Industry and the Farm Community*, Canada. February, 2004.

Reganold, J. P., J. D. Glover, P. Andrews, and H. R. Hinman. "Sustainability of three apple production systems," *Nature*, 410(19 April 2001):926-30.

Sylvander, B., A. Le Floc'h-Wadel. "Consumer Demand and Production of Organics in the EU." *AgBioForum*, 3(2-3) (2000): 97-106.

Tzouvelekas, V., C. J. Pantzios, and C. Fotopoulos. "Empirical Evidence of Technical Efficiency Levels in Greek Organic and Conventional Farms." *Agricultural Economics Review*, 3(2) (2002): 49-60.

WASS. *2002 Washington Agricultural Statistics*, Washington Agricultural Statistics Service, Olympia, WA, 2002

Table A1. Apple Size Conversion

Tray pack		Euro Pack			Cell Pack	Heavy Pack	Bag Diameter Inch		Triwall		Grouping
Standard	2 Layer	1 Layer	2 Layer	3 Layer					One Bin	Half Bin	
42LB	21LB	12LB	27LB	40LB	40LB	46LB	3LB	5LB	600LB	300 LB	
36	36	36	25	40	36	36					Large
48	48	48	35	52		48					Large
56	56	56	40	60		56					Large
64	64	64	45	68	60	64					Large
72	72	72	50	75	S80	72					Large
80	80	80	55	83	80	80					Large
88	88	88	60	90		88	3	3	3	3	Medium
100	100	100	70	105	96	100					Medium
113	113	113	78	117		113					Medium
125	125	125	84	126	120	125	2.75	2.75	2.75	2.75	Medium
138	138	138	90	135		138					Small
150	150	150	100	150		150	2.5	2.5	2.5	2.5	Small
163	163	163	108	162		163					Small
175	175	175	122	183		175					Small
198	198	198	134	201		198	2.25	2.25	2.25		Small
216	216	216	140	210		216					Small