Christopher Ferguson and Hoy Carman\*

# Kiwifruit and the "Lemon" Problem: Do Minimum Quality Standards Work?

#### ABSTRACT

Mandatory minimum quality standards for size, grade, or maturity are a controversial provision included in many U. S. fruit and vegetable marketing order programs. These mandatory rules, which apply to all producers of the regulated fruit or vegetable, prevent the sale of any product that does not meet minimum specified standards. California kiwifruit growers approved a federal marketing order in 1985 with a provision establishing minimum quality standards in grade, size, and maturity that were first used for kiwifruit during the 1987-88 marketing year. This paper examines the effects of minimum maturity standards (MMS) on the average price differentials between kiwifruit from California and from New Zealand. The analysis of terminal market data found evidence of a "lemon" type problem for eight out of 20 cases for which data sets were available. Results are consistent with the proposition that minimum maturity standards corrected a lemon problem of asymmetric information on sweetness of California kiwifruit in the Boston, Los Angeles and Philadelphia terminal markets. The early season price premium that New Zealand fruit enjoyed over California fruit decreased significantly after the imposition of the minimum maturity standards.

# Introduction

<sup>\*</sup> Christopher Ferguson is Economist, American Express in Phoenix, Arizona and Hoy Carman is Professor,

Minimum quality standards for size, grade, or maturity are a controversial provision included in many U. S. fruit and vegetable marketing order programs. These mandatory rules, which apply to all producers of the regulated fruit or vegetable, prevent the sale of any product that does not meet minimum specified standards. A "poisoning-the-well" argument for minimum maturity regulations is often used - early shipments of immature fruit that look good but taste sour will depress demand for days or weeks to the detriment of both producers and consumers. This market failure, widely known as the "lemons" problem, arises because sellers have better information on quality than do the buyers. Akerlof (1970) demonstrated that the "lemons" problem is characterized by relatively low quality and prices as "bad" products drive out "good" products. Leland (1979) illustrated that the information provided by minimum quality standards can correct the "lemons" problem and increase total social benefits. Adopting Leland's reasoning, supporters of minimum maturity standards for fresh fruit argue that both producers and consumers benefit from the quality assurance offered by such standards. Some opponents of minimum maturity standards object to any interference with the operations of a free market. Others believe that such standards are unnecessary or that they may interfere with individual efforts to establish a high quality or brand reputation.

California kiwifruit growers approved a federal marketing order in 1985 that has a provision establishing minimum quality standards in grade, size, and maturity that were first used for kiwifruit during the 1987-88 marketing year. Kiwifruit maturity, which is not obvious from visual inspection, is measured with the soluble solids test (Brix level) for sweetness. The minimum maturity standard requires a Brix level of 6.5 percent at the time of inspection, which is done soon after picking. Since kiwifruit continue to convert starch into sugar after they are picked, they should reach a Brix level of at

Department of Agricultural & Resource Economics, University of California, Davis.

least 14 percent by the time they are consumed. If picked too early (at Brix levels less than 6.5 percent), kiwifruit may only reach a Brix level of 12 or 13 percent and never taste sweet.

#### Objectives

This paper examines the effects of minimum maturity standards (MMS) on the average price differentials between kiwifruit from California and from New Zealand. More specifically, it uses a series of statistical tests to determine if the minimum maturity standard corrected a lemon problem for California produced kiwifruit, and if so, the nature of the correction.

## Procedures

The test for market correction of a lemon problem is based on price differences of fruit from different origins within a single market. New season California produced kiwifruit typically competes with imports from New Zealand and Chile during the October - December period. New Zealand, which developed the market for kiwifruit with high quality standards, typically enjoyed a price premium for their fruit. The existence of the New Zealand price premium, in fact, helped stimulate California growers' interest in minimum quality standards. If a lemon problem existed prior to the use of minimum quality standards, we hypothesized that this premium would be reduced by minimum maturity standards for California fruit of the same size and grade.

The analytical model used is similar to the model that Sexton, Kling and Carman (1991) developed and used to test for periods of inefficient allocation, spatial price discrimination and product substitutability in markets linked by arbitrage in the U.S. celery industry. Daily data for major U.S. wholesale markets, that reported kiwifruit prices for comparable sizes, grades and packs, were analyzed to determine the effect of California minimum maturity standards on the price premiums enjoyed by New Zealand kiwifruit.

The initial assumption is that fruits of different origin are perfect substitutes and prices are differentiated only by a stable premium, G, which may account for grade classification and differences in observable characteristics that yield information on taste. Note that G may vary by size, terminal market, time, and country of origin. The arbitrage condition is denoted by Equation 1. The fruit's origin is indexed by the superscript; d indicates the wholesale price of fruit produced domestically while o is the wholesale price of fruit produced in other countries. Size of fruit is differentiated by z, i is the terminal market, and t is the time period. If the arbitrage condition did not hold, profit opportunities would exist and prices of discounted fruit would be bid up so that the equality is restored.

$$P_{z,i,t}^{a} = P_{z,i,t}^{o} - G_{z,i,t}^{o} = \dots = P_{z,i,t}^{o} - G_{z,i,t}^{o}$$
(1)

By altering Equation 1, the impact of the minimum maturity standards is measurable if it leads to the correction of a lemon problem. For instance, prior to the marketing order's imposition of the minimum maturity standards at the commencement of the 1987-88 marketing year, domestic fruit may have featured premiums or discounts to imported fruit, depending on the degree of the lemon problem. The imposition of the minimum maturity standard ostensibly eliminated the asymmetric information problem by guaranteeing consumers that domestically produced fruit was of an adequate expected level of sweetness. Thus, if the minimum maturity standards were to correct problems due to asymmetric information, fruit of domestic origin would feature a rise in price relative to imported fruit.

Equation 2 captures this effect. D is a binary variable equal to 1 after the imposition of the minimum maturity standard.  $\alpha$  represents the (positive) impact on the price of domestically produced fruit caused by the minimum maturity standards.  $\alpha$  may vary depending on the terminal and the fruit size since the degree of the "lemons" problem may vary. Note that the assumption of perfect substitutability enables the relative volumes of fruit from different origins to be ignored; the premium will remain

constant over time even if imported fruit is in short supply relative to domestic fruit. Similarly, an important assumption is that observable quality differences between fruit of different origins are stable over time.

$$P_{z,i,t}^{d} = P_{z,i,t}^{o} + G_{z,i,t}^{o} + \boldsymbol{a}_{z,i}^{d} D = \dots = P_{z,i,t}^{o} + G_{z,i,t}^{o} + \boldsymbol{a}_{z,i}^{d} D.$$
(2)

The minimum maturity standards only affect the premium on early season fruit. Fruit picked later in the season will ripen to meet the minimum maturity standards regardless of the 6.5% standard. A comparison of imported and domestic fruit is only possible when the two are sold in direct competition, which occurs only near the beginning (Fall) and end (Spring) of the marketing years. Hence the binary variable is set to 1 only during the Fall after the imposition of the minimum maturity standards; the Spring premium (or discount) is assumed to be unchanged by the minimum maturity standards.

# Estimation

The *California Fruit Report* has daily kiwifruit price data which are differentiated by geographic origin and size. Prices are available from a number of wholesale terminals including Boston, Chicago, Cincinnati, Dallas, Detroit, Los Angeles, Miami, Montreal, New York, Philadelphia, Pittsburgh, San Francisco, and Seattle. Unfortunately, several factors limit testing of the model to selected terminals, origins, and sizes. First, Dallas, Miami, Montreal, and Seattle were either characterized by having fruit of different (and non-comparable) packaging, such as one layer flats from New Zealand and volume filled bags from California, or fruit of different origins were grouped together and priced identically. Hence these terminals could not be further examined. Second, the number of observations for imports is limited. While New Zealand sold fruit throughout the 1980's and early 1990's, Chile did not become an important factor until the 1990's. Italy, which is now the World's

largest kiwifruit producer, had only a few observations in the 1990's. Third, terminals may have featured both imported fruit and California fruit, but of different sizes (for example, trays with 36 pieces of fruit versus trays with 42 pieces of fruit). All else equal, larger fruit commands higher prices, so different sizes are not truly comparable. A fourth severely limiting factor is that comparable sizes may change over time. For example, in 1987, New Zealand and California may have both sold size 36 fruit in a given terminal, and in 1988, they may have both sold size 33 fruit in the same terminal. Unfortunately, the two sizes are not comparable, so these data cannot be used in estimating the model. Finally, while fruit of different origins had a large number of comparable prices in the 1990's, very few fruit were comparable in the early and mid-1980's, prior to the minimum maturity standards imposition, again restricting pre- and post-1987 premium comparisons.

Since both the low and high prices are reported for the week, the low premium and high premium were both examined. Following Spiller and Huang (1986, p. 137), Sexton, Kling and Carman (1991) chose to compare low prices, citing that low price seems to be that most affected by competition, that it avoids the issue of transaction versus list price, and that low price is usually quoted by independents who rarely discount . In the case of kiwifruit, however, high prices may be more accurate since they are the prices for the highest quality fruit. During the end of the season, when fruit of a given origin becomes soft and heavily discounted, high prices may be more reflective of comparable quality. Occasionally prices were reported for a given size spread, say the high and low weekly price of sizes 36-42 fruit. In this case, it was assumed that the high and low prices were representative of size 36 and size 42, but that intermediate sizes, such as 39 could not be fairly assumed to be priced, and hence would not be comparable to a size 39 fruit from a different origin.

Given the data limitations described above, we were able to estimate 20 separate regression equations for six different terminal markets using ordinary least squares methods. The sample period extends from the 1985 to the 1992 marketing years and estimation was performed using the Limdep software package. Only eight of the 20 regressions exhibited significant explanatory power and/or coefficients. Durbin-Watson statistics indicated the presence of autocorrelation so AR(1) regressions were also estimated. While we report the AR(1) regression results, the magnitude and significance of the coefficients is virtually identical for both models. The nonsignificant regressions that were dropped from further consideration included Chicago 36 low and high, Chicago 39 low and high, Cincinnati 39 low and high, Los Angeles 30 low, New York 33 low and high, New York 36 low and high, and Philadelphia 39 low. We conclude that there was no statistical evidence of a lemon problem for kiwifruit of the specified sizes in these markets. The eight cases that have evidence of a lemons problem were in the Boston, Los Angeles, and Philadelphia markets.

Table 1 presents the regression results for the Boston terminal market. The estimated coefficients are in the lower part of the table with t-statistics in parentheses; bold-font coefficients are statistically significant at the 95 percent confidence level. For the sizes and prices (high or low) listed, the results strongly support the hypothesis that the imposition of the maturity standard in 1987 led to a decrease in the premium of New Zealand fruit over that of California fruit. New Zealand kiwifruit had a significant and positive estimated premium over fruit from California prior to minimum maturity standards. The estimated  $\alpha$  coefficient in each case is significantly negative, suggesting that the minimum maturity standards led to a decrease in the premium. In the Boston market, the initial premiums for the low price observations were quite similar for both the 39 and

Terminal	Boston	Boston	Boston	Boston		
Size	39	39	36	36		
Price	Low	High	Low	High		
Observations	<u>192</u>	192	<u>136</u>	<u>136</u>		
pre-1987	43	43	17	17		
pre-1987 &						
Spring	80	80	45	45		
				•		
Parameter	Parameter Estimate and t-statistic					
Initial N. Z.	.87	1.06	.89	1.09		
Premium	(2.01)	(2.67)	(2.90)	(4.32)		
MMS Dummy	-1.79	-1.96	-2.00	-2.15		
	(-3.69)	(-4.57)	(-8.48)	(-9.47)		
Rho	.77	.79	.81	.75		
	(16.58)	(17.87)	(15.83)	(13.03)		

Table 1. Minimum Maturity Standards Regression Results For The BostonTerminal Market by Fruit Size and Price Bound, 1985-1992.

36 sizes, as were the initial premiums for the high price observations for both sizes, with high price observations having a larger premium. The decrease in premiums, as measured by the minimum maturity standards dummy was larger for the larger size 36 kiwifruit.

Regression results for the Philadelphia and Los Angeles markets are shown in Table 2. The results for the Philadelphia, high price, size 39 kiwifruit are consistent with the Boston results in Table 1, but the coefficients are not as large nor as significant. This can be at least partially explained by the small number of observations for the Philadelphia market, especially prior to 1987. The signs on the estimated coefficients for Los Angeles size 30 kiwifruit are the opposite expected, although the coefficient for initial New Zealand premium is not significantly different than zero. The number of observations for Los Angeles, while more than Philadelphia, is still comparatively small. In addition, the large size of comparable fruit in Los Angeles may be a factor. If size is correlated with maturity, size 30

fruit may not have exhibited a lemon problem prior to 1987; after the minimum maturity standards it is conceivable that the supply of larger fruit from Los Angeles rose relative to that from New Zealand as fruit was harvested later, thus

Terminal	Phil.	L. A.	L.A.	L.A.	
Size	39	30	mixed	mixed	
Price	High	High	Low	High	
Observations	<u>74</u>	<u>67</u>	<u>110</u>	<u>110</u>	
pre-1987	7	24	56	56	
pre-1987 & Spring					
	34	51	71	71	
Parameter	Parameter Estimate and t-statistic				
Initial N. Z.	.58	18	2.23	1.33	
Premium	(2.74)	(99)	(4.12)	(4.85)	
MMS Dummy	75	1.13	-1.70	-1.26	
	(-2.62)	(4.07)	(-3.59)	(-3.42)	
Rho	.19	.68	.75	.53	
	(1.63)	(7.60)	(11.94)	(6.58)	

Table 2. Minimum Maturity Standards Regression Results For The Philadelphia and<br/>Los Angeles Terminal Markets by Fruit Size and Price Bound, 1985-1992.

diminishing the premium during the latter time frame. Note that this explanation requires fruit of different origins to be imperfect substitutes.

The comparable size requirement was relaxed for Los Angeles in order to examine the effects of a larger number of observations prior to 1987. Weekly high and low prices are available from the Los Angeles wholesale market from 1982-1992 in the *Los Angeles Wholesale and Vegetable Report*. The only problem is that prices are reported for a spread of fruit sizes which changes periodically.

Hence the assumption must be made that the premium is relatively stable across sizes. As shown in the last two columns of Table 2, the results are similar to those found in Boston and Philadelphia. Again, the minimum maturity standards appears to have reduced the premium between New Zealand and California fruit, which is consistent with minimum maturity standards correcting a lemon problem.

The above results are based on the assumption that kiwifruit from different origins are perfect substitutes. We relaxed this assumption and estimated a switching regression model that allowed for imperfect substitution with periods during which the premium for domestic fruit could rise or fall. The results were very similar. The initial premium for New Zealand fruit over California fruit was significantly positive except for Boston 36 Low and the minimum maturity standards binary coefficient was significantly negative except for L.A. 30 Low.

Analytical results are consistent with the proposition that minimum maturity standards corrected a lemon problem of asymmetric information on sweetness of California kiwifruit in the Boston, Los Angeles and Philadelphia terminal markets. The early season price premium for New Zealand fruit over California fruit decreased significantly after the imposition of the minimum maturity standards. This result was consistent for each of the models employed. The interpretation is that the minimum maturity standards guaranteed a higher quality fruit to buyers, enabling them to pay a high quality price without the fear of paying high prices for low quality fruit. As expected, the benefits vary across geographic regions and fruit size as the size of the lemon problem varies, though a significantly reduced premium was consistently evident.

## Managerial Implications

Market imperfections caused by asymmetric information about quality between consumers and the upstream sectors of the marketing chain can reduce prices and profitability. Results of this study demonstrate the positive price impact of mandatory minimum maturity standards in the California kiwifruit industry. While similar price advantages are theoretically available for firm level quality programs, realization of higher prices is dependent on clear communication of product characteristics with customers. While brands can provide information that customers trust, brands recognized by fruit and vegetable consumers have been difficult to establish. Price premiums are available to innovative firms that find a way to communicate their "higher" quality standards to all of their customers.

Quality standards based on geographic origin have been successful marketing tools for both New Zealand and California kiwifruit. This strategy has obvious shortcomings, however, for multinational firms with global markets and sources. The New Zealand Kiwifruit Marketing Board has recently adopted the Zespri brand name for their product. If successful, the Zespri brand will permit such things as international sourcing of the "new" golden kiwifruit developed by the Board as part of a strategy to license production of the new product and establish year-around supplies of the brand to the market.

#### References

- Akerlof, George A., "The Market for 'Lemons': Quality Uncertainty and the Market Mechanisms," *Quarterly Journal of Economics* 84(1970):488-500.
- Leland, Hayne E., "Quacks, Lemons, and Licensing: A Theory of Minimum Quality Standards," *Journal of Political Economy* 87(1979):1328-46.
- Sexton, R. J., C. L. Kling, and H. F. Carman, "Market Integration, Efficiency of Arbitrage, and Imperfect Competition: Methodology and Application to U. S. Celery," *Amer. J. Agr. Econ.*, 73(1991):568-80.
- Spiller, P. T., and C. J. Huang, "On the Extent of the Market: Wholesale Gasoline in the Northeastern United States," *J. Indust. Econ.* 34 (1986): 131-45.

USDA, Agricultural Prices, various issues.

- USDA, Fruit and Vegetable Shipments, various issues.
- USDA/AMS, Federal-State Market News Service, California Fruit Report, daily issues.
- USDA/AMS, Federal-State Market News Service, Los Angeles Wholesale and Vegetable Report, daily issues.