Price Adjustments in Cherry Markets

R. Thomas Schotzko and Wesley W. Wilson

Buyers of cherries trade initially without inspection. Upon receipt, buyers sometimes seek to renegotiate the earlier agreements. Empirical results suggest that changing market conditions, fruit quality, and characteristics of the trading partners significantly affect the probability that a trade is renegotiated.

Sale and delivery of a highly perishable product, such as sweet cherries, is fraught with risk due to quality and price uncertainty. Quality of cherries is driven by weather conditions during the growing season as well as by handling during the harvest and shipment periods. Buyers of cherries purchase without inspection and without perfect knowledge of market conditions that will exist when they ultimately receive the cherries.[1] Further, because of transit times there is a lag from initial sale to receipt of the product, and during that lag prices can change dramatically (Tucker). Thus, at the time of initial sales, buyers and sellers have neither symmetric nor perfect information. Upon receipt of the cherries, buyers realize the quality and price risk. After realization, they can and often do attempt to renegotiate the initial terms of trade. The purpose of our research is to examine the determinants of renegotiation by buyers. We develop and estimate a model of renegotiation of initial terms of trade as a function of shipper and buyer characteristics, quality levels, and changes in the market price between the initial trade and receipt of the cherries.

In the markets we analyze, there is a history of buyers occasionally using quality levels to extract price adjustments from shippers. The cherry industry in Washington responded to these activities, first by having representatives in the market to observe the fruit as it arrived and then to provide information to the shipper when the receiver attempted to renegotiate price on the basis of unacceptable quality. As the representatives accumulated information (informally) on the quality of fruit on arrival, it became obvious that quality and price renegotiations were problematic. As a result, over the past several years the industry has been collecting data on fruit quality at receiving point. The ultimate purpose of this activity is to determine which types of defects were the most common. Given this information, presumably, efforts could be made to overcome the quality problems.

The availability of these data allow an opportunity to evaluate the determinants of renegotiation. Indeed, these data allow the effects of quality (overall and of specific quality attributes) as well as the effects of price changes on the probability of renegotiation to be identified.

In addition to quality and price changes, there is also a range of marketing strategies employed by receivers and shippers. Some receivers have clients who are very price conscious. These receivers may accept a lower quality product in exchange for a lower price, and that lower quality fruit has a greater potential to be below market standards on arrival. Under these conditions it seems reasonable to expect that some receivers may be more likely to attempt to renegotiate price after the fruit arrives. At the same time there are some shippers who tend to focus on the price market (as opposed to the quality market) and consequently ship a lower quality product. Ship-

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Schotzko is an Extension Economist in the Department of Agricultural Economics, Washington State University, Pullman, WA 99164, and Wilson is an Associate Professor in the Department of Economics, University of Oregon, Eugene, OR 97403-1285. The authors gratefully acknowledge research assistance from Melissa Harwood-Rom and editorial comments from David Hunger.

[1] Rosenman and Wilson (1991) examine cherry prices in this market where trades are made with asymmetric information. Their results suggest that sellers practices can signal asymmetric quality levels within the same grade. They find that Akerlof's (1970) lemon's problem does not obtain in this market because of a Spence (1983) type signaling mechanism. For related studies see Allen (1984), Bond (1982), Faulhaber (1989), and Gal-Or (1989).

pers who commonly serve the price conscious receiver ship a greater volume of fruit nearer the minimum-grade standards, and therefore, have a higher probability of having fruit arrive with below minimum-grade standards.

In evaluating these quality, price, and shipper/buyer characteristics, we first describe the price negotiation process in the next section. We then describe our empirical application to the cherry market and summarize our results.

Price Negotiation in Cherry Markets

At the time of initial sale, the buyer and seller negotiate price and terms of trade with asymmetric information. The seller brings information regarding industry volume, a perception of demand, past shipment history, knowledge of other price offers, and quality of the product to be shipped. The buyer brings information regarding other price offerings, product movement at retail, historical price patterns, current season price patterns, and expected volumes. While the information base of buyer and seller overlap, the quality of the information is not symmetric.

At the time of initial sale, the seller generally has a price floor beneath which positive returns are not earned. Packing costs generally determine the minimum price floor. Except when available supplies are extremely large, the seller also attempts to establish a price that at least covers production and harvest costs, in addition to packing costs. The buyer negotiates with the intent of providing the quality and quantity preferred by his customers given the established price. However, because of the susceptibility of cherries to packing and shipment damage, the buyer cannot be certain of fruit quality until it arrives at the receiving point. Thus, at the time of the sale, the buyer has knowledge of current market conditions and past history but does not have perfect information on quality.

When the cherries arrive at the destination, the buyer has updated information concerning both local and distant market conditions but also now has direct information on quality. When confronted with direct information on quality and updated information on market conditions the buyer may ask for a price adjustment -- seek to renegotiate prices. There are variety of factors including supply, demand, quality, behavioral, and interpersonal ones that may influence both the decision to ask for a price adjustment and the magnitude of the price adjustment (Waugh).

The seller must agree to a price adjustment. However, the seller's position is now considerably weaker than it was at the time of initial sale. The seller has three options that may be pursued. The first is to accept a lower price. The second is to ship the fruit to another buyer (most likely on consignment) who usually repackages the fruit and remits to the shipper only the residual revenue after covering repackaging costs. The third option is to dispose of the load at a waste disposal site. The second and third options seldom generate returns to the seller that match the returns associated with renegotiation. In short, the seller, no longer having direct information on quality and having limited alternatives to renegotiation, may agree to a price adjustment because of trust in the integrity of the buyer and because of the desire to make sales to this buyer at a later date (O'Rourke).

Empirical Framework

In a more formal framework, we model the likelihood of a given trade being renegotiated. Let $\delta_i = 1$ if a given trade is renegotiated and let $\delta_i = 0$ otherwise. The probability that a trade is renegotiated is taken to be a function of the change in market prices between the time of initial sales agreement and arrival at receiving point, the number of defects observed in the sample cherries (proxies for quality), and shipper and receiver dummy variables.

The change in market prices in the time interval between initial sale and final sale ($CMRKT_i$) is expected to have an influence on the likelihood that a trade is renegotiated. If prices in the marketplace are increasing, then receivers are expected to be less likely to initiate a price adjustment preferring the lower initial price quote. Price adjustments likely occur under these conditions only if fruit quality at arrival is significantly below initial expectations. On the other hand, if prices in the market are falling, the receiver has an incentive to seek a price adjustment.

Due to product attributes, (e.g., perishability) the receiver has a much stronger bargaining position once the product is received. The stronger bargaining position then reinforces the likelihood of renegotiation when prices are falling. Real or perceived quality problems during period of falling prices are more likely to result in renegotiation than during periods of rising prices.

Quality of the product, the number of defects in a lot, increases the probability of renegotiation. There are a wide variety of quality defects (quality variables) which may influence the decision to renegotiate a trade. These defects have been grouped into three categories. DEFOR includes those factors that likely occur in the orchard. Theses include healed cracks, russet, insect bites, limb rub, and pulled stems. DEFAFT, includes brown discoloration, decay, mold, fresh cracks, bruising, and pitting. These defects could occur in the orchard, but they may also occur after delivery to the warehouse or during transit. DEFOTH, consists of factors important to consumers even where no other defect exists. These include are stem color, fruit color, firmness, and deposits.

We include shipper (S_i) and receiver (R_i) dummy variables to account for unobserved characteristics of shippers and receivers. Such characteristics may reflect different strategies in the bargaining process, different handling/sorting/distribution techniques, different quality characteristics, etc. We add a time trend to account for other variables which may be correlated with time. Such variables include the turnover of competitors in the marketplace, and a rotating of market activity from southern Washington to northern Washington which may account for different quality distributions.

We report the results of several different models. In a general form, the model is a qualitative response model[2]

$$(1)\quad Prb(\delta_i = 1\ X_i\ \theta) = F(X_i) \quad I = 1, 2, \ldots, N$$

where: F() represents the normal cumulative distribution; $\delta_i = 1$ if the i^{th} trade is renegotiated and $\delta_i = 0$ otherwise; X_i represents the explanatory variables associated with the i^{th} trade defined above; and is a vector of coefficients to be estimated. N is the number of sales in the data set. The probit model given by (1) was estimated by using OLS to obtain starting values to form initial estimates of the likelihood. We then maximize the likelihood using the Newton method.

[2] See Amemiya (1985) for a complete discussion of quality response models.

Data

The data consist of information concerning individual sales of 178 cherry lots between packing houses in Washington and wholesalers in New York during the summer of 1987. The data were collected at both shipping and receiving points. Hebert Research Inc. collected the receiving point data, while shippers provided the shipping point data. The data include information on price, quality attributes, market conditions, and firms. The price variables include the initially agreed F.O.B. price and the actual price received.

The quality data were collected at receiving point. From each lot of cherries a random sample of 30 fruit was drawn. Each cherry was inspected for defects and the defects were recorded. All defects on each cherry were counted. For each lot the total number of each type of defect was encoded (i.e.; a defect variable ranges from 0 to 30).

Empirical Results

We examine a variety of specifications of the renegotiation model (Equation 1). The specifications differ according to treatments of trends, shipper-receiver dummy variables, and the quality variables. Table 1 provides a summary of results from four different specifications. Results with a trend variable are not reported. A strong multicollinear relationship between the trend variable and CMRKT, and the effect of CMRKT was negative and insignificant in all models estimated with a trend.

Model 1 in Table 1 is the basic model. This model performs reasonably well, correctly forecasting whether trades are renegotiated 80% of the time. The signs of all variables except

DEFOR are as expected. Using a one-tail test, DEFAFT is significant at the 10% level, DEFOTH is significant at the 5% level, while DEFOR is of the wrong sign.

While the DEFOR result is inconsistent with initial expectations, there is another, equally plausible, explanation for the negative signs. The defects included in DEFOR all occur in the orchard and are visible. Graders in the warehouse have the responsibility of removing these defective fruit. Since grade standards specifically cite the tolerances, it is in the shippers best interest to remove almost all, if not all, fruit with defects so that the cartons can be certified as U.S. No. 1's.

Table 1. Probability Estimates of Renegotiation[a]

	Models			
Variable	1	2	3	4
One	0.8948	1.12971**	-1.16988**	-1.21998*
	(1.151)	(1.679)	(1.754)	(3.422)
CMRKT	0.177916*	.160860**	0.165911**	0.142129*
	(1.660)	(1.559)	(1.626)	(1.845)
TOTALDEF			0.0083418**	
			(1.45)	
DEFOR	-0.007555	-0.028039		-0.0549103
	(0.962)	(0.825)		(2.122)
DEFAFT	0.022689**			0.039396*
	(1.292)			(2.777)
DEFOTH	0.012304*			0.0070986**
	(1.674)			(1.372)
DEFAFT1		0.013106*		
		(1.807)		
S4	-1.33878*	-1.3840*	-1.40267*	
	(2.615)	(2.731)	(2.80)	
S5	-7.09828	-7.11747	-7.3594	
	(0.018)	(0.018)	(0.019)	
S9	-0.78991	-0.752102	-0.809623	
	(1.375)	(1.403)	(1.531)	
R2	0.222214	0.187537	0.036427	
	(0.317)	(0.271)	(0.053)	
R3	-1.85339*	-1.90169*	-1.77767*	
	(4.198)	(4.365)	(4.328)	
R4	-5.77523	-5.82579	-5.87924	
	(0.014)	(0.014)	(0.014)	
R6	-0.601104	-0.667874	-0.676484	
	(0.910)	(1.023)	(1.041)	
R7	-6.08057	-6.07808	-6.02674	
	(0.008)	(0.008)	(0.008)	
R8	0.094362	0.067348	0.233806	
	(0.176)	(0.127)	(0.459)	
R9	-0.309494	-0.29784	-0.245927	
	(0.710)	(0.686)	(0.572)	
R11	-2.44620	-2.46535*	-2.47102*	
	(3.725)	(3.762)	(3.747)	
χ^2_{df}	95.57915_{15}	95.21714_{14}	94.0313_{13}	11.6234_{4}
% Correct	80	80	82	23
% Correct	80	80	81	89
% Correct (All)	80	80	81	65

[a] t-values are provided in ( ). A * and a ** indicate significance at the 5 and 10 percent levels, respectively. All intercept and dummy variable tests are two-sided tests while all others are one-sided tests.

When fruit delivered to the warehouse has a large number of defects, the warehouse has two options. The fruit can be diverted directly to processing. The other option is to remove as much defective fruit as possible from the lot and then offer it for sale on the fresh market. The probability of adjustment is inversely related to the firm's ability to eliminate defective fruit. There is, however, a defect level at which the shipper believes adjustments will be required. Under these conditions, the shipper asks for a relatively low price to avoid later problems. This reasoning suggests a relationship between DEFOR and the probability of adjustment. However, the lack of significance suggests that, at least during this particular harvest season, orchard defects were not a serious problem.

Since the shipper and receiver variables are binary, the coefficients for each firm are relative to the rejected firm. For example, the coefficient for shipper number 4 (S_4) indicates that the probability of price renegotiation is significantly less than the likelihood of price renegotiation for shipments by the deleted shipper. The receiver variables (R_i) are evaluated in an analogous manner. No *a priori* expectations were developed for these relationships. Nonetheless, our results suggest unobserved shipper and receiver characteristics are extremely important in explaining renegotiation.

Changing market conditions are reflected in the model by CMRKT. CMRKT is the difference between the F.O.B. price at the time of initial sale and the F.O.B. price at the time of arrival in New York (Normal transit time is 4-5 days.) The CMRKT coefficient in model 1 is significant at the 5% level and has the expected sign; the greater the decline in F.O.B. price between the time of shipment and the time of arrival, the greater the probability that a price adjustment occurs.

Models 2, 3, and 4 are variations of Model 1. In Model 2 and 3, we aggregate the different quality variables. In Model 2, we aggregate DEFAFT and DEFOTH into one variable, DEFAFT1. By aggregating DEFAFT and DEFOTH we have two quality measures. DEFOR relates directly to orchard defects while DEFAFT1 contains all other defects. DEFAFT1 has the expected sign and is significant at the 5% level, while DEFOR is not significant. In this model CMRKT remains significant at only the 10% level. The signs and levels of significance for all other variables remains unchanged. In Model 3, we aggregate all quality variables into a single measure. TOTALDEF includes all defects whether caused in the orchard or elsewhere. The TOTALDEF coefficient is significant at the 10% level. Only minor changes occur in the significance of the other coefficients and the chi-square value suggests slightly more statistical significance. The predictive ability of the equation is slightly better than models 1 and 2. The negative effects of DEFOR are buried in the total defect variable. In Model 4, we remove the shipper/receiver dummy variables to reinforce the importance of buyer and seller in the fresh produce business. Using the chi-square as a measure of impact, model 4's chi-square is significant at the 0.021 level while models 1-3 have chi-squares with significance levels in the order of 10^{-13}. The difference between model 4 and models 1, 2 and 3 are statistically significant and point to the importance of including shipper/receiver variables in the model.

From the results of all models, we find that there is strong evidence to suggest that variables representing changing market conditions, quality, and unobserved shipper/receiver characteristics are important in explaining the probability of renegotiation. To evaluate the numerical importance of each effect we plot probability schedules for three shipper/receiver pairs against CMRKT and TOTALDEF in Figures 1 and 2, respectively. In both figures we use the results from Model 3. In Figure 1, we plot the probability of renegotiation against CMRKT evaluated at the mean value of TOTALDEF, while in Figure 2, we plot the probability of renegotiation against TOTALDEF evaluated at the mean value of CMRKT.

The patterns in both Figure 1 and 2 are similar. Over the ranges of market price changes and total defects the probability of renegotiation increases steadily. The probability is higher for large price changes and for lots with a large number of defects than for small price changes and for lots with a small number of defects. But, perhaps more significantly, are the differences between

Figure 1

Renegotiation and Market Price Changes

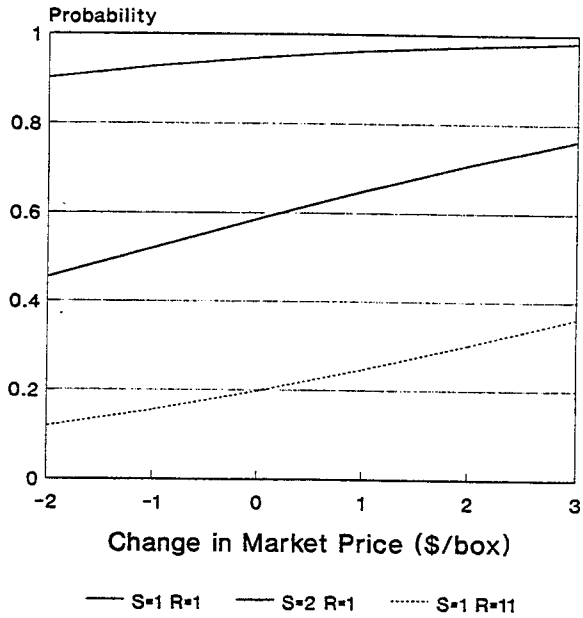
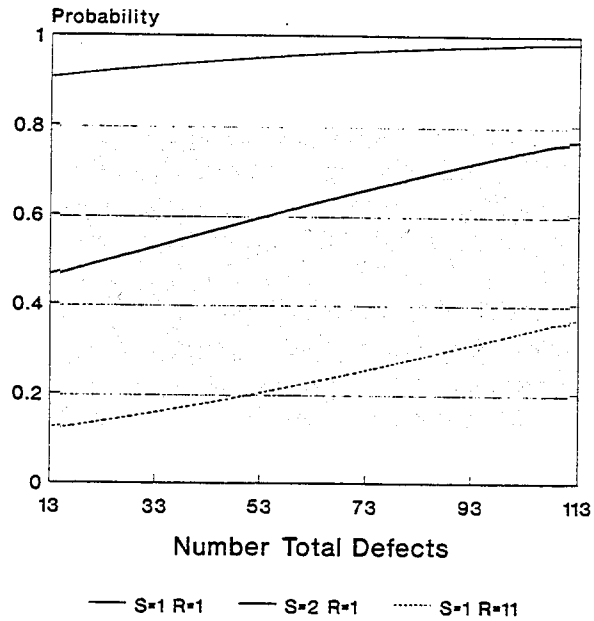


Figure 2

Renegotiation and Total Defects



the probability schedules for different shipper and receiver pairs. Re-negotiated trades between the shipper 1 and receiver 1 pair are very likely, regardless of changes in market conditions and the quality of the cherries. In contrast, trades between shipper 1 and receiver 11 are unlikely to be renegotiated, while trades between shipper 2 and receiver 1 are renegotiated only for large changes in market prices or for lots of cherries with a large number of defects.

Conclusions

The fresh produce market system is based on one-to-one negotiations and is heavily influenced by current market conditions, product quality, and knowledge of individual buyer and seller marketing strategies. We test these relationships, in this study, by using data from the fresh cherry market, a commodity that is highly susceptible to market changes, declining quality, as well as characteristics of the agents involved in the trade.

Changes in market conditions are changes in prices between shipping dates and arrival dates. We find that such changes do influence renegotiation even though initial price agreements are legally binding (assuming that the other conditions of the agreement are met). Nonetheless, our results suggest that shippers often acquiesce to the demands of buyers to renegotiate.

The level of defects also increases the probability of renegotiation. Buyers tend to react to the overall appearance of the product in the carton. We examine the effects of quality defects that occur in the orchard and are visible at grading time and those defects occurring later and find dichotomous results. This finding has implications for the industry. The lack of a significant positive coefficient for DEFOR is consistent with shippers revealing accurate time-of-sale quality information. Indeed, the negative coefficient of DEFOR may even suggest sellers may understate time-of-shipment quality levels. On the other hand, defects not observed at grading time, but manifesting themselves later, do increase the probability of a price adjustment. (Bruising and pitting often become obvious only after the fruit have been packed in cartons and shipped.) Identifying and minimizing the causes of these defect factors may

reduce the probability of adjustment by increasing the quality of the cherries on arrival.

An interesting aspect of the defect issue is implicit in these results, but discussed more fully in Harwood-Rom; that individual defects are not significant in isolation. This suggests that receivers are not concerned about individual defects, but, rather, how the fruit appears in the container. Eye-appeal is commonly understood to be very important in the sale of most fruits and vegetables.

Perhaps the most interesting results are the shipper and receiver variables. Firms within the fresh-produce industry operate within different market niches. Quality of product tends to be the differentiating factor, although service is also often used to differentiate one firm from another. The results of this study indicate that there are, in fact, significant differences between shippers and buyers. One explanation for this finding is that firms stressing quality tend to have less occasion to renegotiate price, and buyers wanting quality products tend to reject low quality shipments rather than renegotiate price. Indeed, over time these buyers tend to identify shippers who consistently deliver higher-quality product and purchase product only from those firms. At the other extreme are those buyers who use price as the primary criterion. These buyers might be expected to seize every opportunity to achieve a lower price.

In the final analysis, while price declines between shipment and arrival can impact actual price paid and while defects do influence buyer actions regarding renegotiation, the inclusion of shippers and receivers had the biggest impact on the ability of the model to predict renegotiation. Having quality product is important, but knowing or knowing about the buyer is at least as important in minimizing the prospects of renegotiation.

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