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WHOLESALER MARKUP DECISIONS UNDER DEMAND UNCERTAINTY

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ABSTRACT---
We examine consistency with economic theory of markup decisions for a risk averse firm facing demand uncertainty. We derive testable comparative static results that describe the influence on the markup of expected demand, demand uncertainty, average variable costs and exogenous demand shifters. We test the model using data from the wholesale market for organic lettuce. Our results demonstrate that risk averse wholesalers raise markups as expected demand increases and reduce them as uncertainty increases, consistent with risk averse behavior. Wholesaler pricing decisions with respect to consumer-oriented demand shifters must be tailored to evolving market conditions. As marketing efforts promote organics and reduce demand uncertainty, wholesalers' ability to increase margins is improved.

-----KEY WORDS-----

risk aversion, marketing margins, comparative statics, organics

The theory of decision making under uncertainty has yielded a rich set of comparative static results on optimal firm and individual decisions for a multitude of situations. However, the practicality of implementing these decision models is questionable. Hey argued that the complexity of theoretically derived optimization rules precludes their use in the real world. Instead, firms use simple rules that are assumed to reflect the decision process modelled in theory. Whether the outcomes of these decisions are optimal in an expected utility framework has not been tested.

Nagle and Holden showed that markups, or contribution margins, may be used to evaluate the profitability of price adjustments by firms making strategic pricing decisions. We examine the consistency with economic theory of a rule of thumb in which a risk averse firm facing demand uncertainty sets its price using a fixed markup over the price paid to farmers. From an integrated model of the markup rule in the pricing decision, we derive a set of testable comparative static results to determine how the optimal markup is influenced by shifts in key parameters affecting the firm.

We test the model using data from the wholesale market for organic lettuce. Morgan and Barbour reported that organic wholesaling firms use markup pricing rules, with about 77 percent using the same or a lower markup for organic than for conventionally grown produce. In this market, wholesalers make repeated, low-valued bargains with farmers to purchase commodities, a bargaining arrangement that could lead to suboptimal rules of thumb (Rosenthal). Park and Lohr showed that in the organic lettuce market, demand factors are the main determinants of equilibrium price and quantity. Thus, organic wholesalers may be particularly vulnerable to consequences of suboptimal decision making in the face of demand uncertainty.

Reaction to changes in market factors that affect markups are based on the expected utility model of the risk averse wholesaling firm. Demand uncertainty has no effect on optimal markup for a risk neutral firm since price decisions are determined solely by elasticity of demand. By contrast, the risk averse wholesaler adjusts optimal markup in response to market conditions, yielding a set of testable implications. If the markup is consistent with optimal risk averse decision making, statistically significant relationships between the relevant factors and the markup should be observed. The impacts may be quantified by calculating the elasticities of these variables. Previous work on markup rules has neglected the joint impacts of demand uncertainty and risk aversion. Our objective is to test whether markups in the wholesale market for organic lettuce are consistent with optimal risk averse behavior under demand uncertainty. From these results, we can predict responses to anticipated changes in this evolving market.

Markup Rules and Optimal Marketing Decisions

The decision problem for a competitive wholesaler is to set an output price that maximizes the expected utility of profits. The wholesaler markets output, h, using a set of inputs, z, to process and distribute the produce. The price received by the wholesaler is denoted by p, the price paid by the wholesaler for the commodity is r, and the prices for processing and distributing inputs are represented by q. The wholesaling firm maximizes the expected utility of profit, $EU(\pi)$. Following Brorsen *et al*., the wholesaler is assumed

(1) $$EU[\pi] = EU\left[\{(1+\lambda)r - r\}h - q'z\right] \quad .$$

to charge a fixed percentage over the price paid to the supplier of the commodity. The markup rule is $p = (1 + \lambda)r$ where the markup λ is strictly positive. Substituting the markup rule directly into the wholesaler's profit equation gives

The demand for output marketed by the wholesaler is not known with certainty due to shifts in market demand. Nagle and Holden (p. 53) discussed implementation of profitable pricing decisions and suggested that "few, if any, managers actually know the demand curve for their product." Fraser (1995) explained that it is common in fresh produce markets for changes in demand conditions to affect both level of expected demand and uncertainty of demand. Quality perceptions affect salability. Organic produce is more susceptible to deterioration due to restrictions on post-harvest chemical treatments, resulting in greater shrinkage throughout the marketing chain (Morgan and Barbour; Jolly).

Uncertain market demand, h, is exogenous to the wholesaling firm and is a random variable with a given probability distribution where $h = \bar{h} + \omega\epsilon$. We specify expected demand as $\bar{h} = h(p,v)$, where $\bar{h}$ depends on price and a vector of exogenous demand shifters, v. Uncertainty is measured by the mean preserving spread, which is also a function of demand conditions. We specify this parameter as $\omega = \omega(v)$, and ϵ as a random variable with mean zero.

The specification of $\bar{h}$ and ω as functions of v permits us to examine specific factors that affect both expected demand and demand uncertainty. Since the wholesale market is derived from retailers and ultimately consumers, the influence of factors at levels closer to the consumer on the wholesale market is indirect. We must track the effect backward through the market chain and evaluate the joint effects. A factor that appears to have a large and unambiguous influence on consumer demand, such as a food safety scare, may be muted at the wholesale level because both expected demand and uncertainty are affected, perhaps in opposite directions and by unequal magnitudes.

The optimal markup, λ^*, is found by choosing λ to maximize equation (1), according to the first order condition

(2) $$\frac{\partial EU(\pi)}{\partial \lambda} = EU'\left(rh + \lambda r^2 h_1\right) = 0$$

where h_1 is the partial derivative with respect to the output price, p, the first argument of the demand function $h(p, v)$, and U' is the first derivative of the utility function.

To highlight the influence of uncertainty on a risk averse firm, equation (2) may be rewritten as

(3) $$r\bar{h} + \lambda r^2 h_1 + \frac{cov(U'h)}{EU'} = 0$$

where the covariance between marginal utility and demand is negative for the risk averse firm. For a risk neutral firm, the optimal markup depends only on the elasticity of demand, η_d, and from equation (2) is $\lambda^* = 1/(\eta_d - 1)$. The risk averse wholesaler facing demand uncertainty uses a lower markup than when demand is certain, since it considers the negative effect of the covariance term in setting λ^*. As Fraser (1985) noted, this implies that firms that are less risk averse tend to have higher markups.

Silberberg's primal-dual method may be used to derive a set of testable comparative static results from equation (2). The objective is to test whether pricing decisions using the markup rule are consistent with theoretically optimal behavior for a risk averse firm. We minimize the primal-dual convex Lagrangean function defined as the difference between the indirect and the direct expected utility functions. The indirect expected utility function is obtained when expected utility is maximized subject to the markup rule and contains only exogenous parameters as arguments.

The effects of shifts in the exogenous parameters, β, on the optimal markup decision are determined from the positive semi-definite, symmetric primal-dual matrix

(4)
$$\mathcal{L}^*_{\beta_i \beta_j} = \frac{\partial^2 EU(\pi)}{\partial \lambda \partial \beta_i} \frac{\partial \lambda^*}{\partial \beta_j} \quad .$$

The set of terms $\mathcal{L}^*_{\beta i \beta j}$ are positive. We use the properties of the primal-dual matrix under decreasing absolute risk aversion (DARA) to sign the comparative static results. We examine the effects on the optimal markup of changes in expected demand, $\bar{h}$, demand uncertainty, ω, average costs, q, and exogenous demand shifters, v, which enter both $\bar{h}$ and ω. The exogenous demand factors are market availability of competing products and an unexpected demand surge.

Expected Demand

The effect of a shift in expected demand, $\bar{h}$, is

(5) $$\mathcal{L}^{*}_{\bar{h}\bar{h}} = \left[\, rEU' + rEU''\left(rh + \lambda r^{2} h_{1}\right) \right] \frac{\partial \lambda^{*}}{\partial \bar{h}} \quad .$$

The bracketed term is positive under DARA. Since $\mathcal{L}^{*}_{\bar{h}\bar{h}}$ must be positive, we can test whether the optimal markup is positively related to shifts in expected demand. Faced with increasing expected demand the risk averse wholesaler will raise the markup, increasing the profit margin if variable costs are constant or increasing at a slower rate.

In organic markets, sales have been expanding at a rate of 20 percent in each of the five years preceding 1994, with annual sales above $2 billion in 1994 (*Alternative Agriculture News*). In general, retailers and wholesalers report optimism about increasing expected demand (Armstrong, Bentley and White; Jolly; Estes, Herrera and Bender; Morgan and Barbour). If organic produce wholesalers respond as predicted, higher markups could lead to higher retail prices even as supply is increasing, consistent with the findings of Park and Lohr. This suggests that price premiums for organic produce may be sustained or even increased, if conventional price trends remain the same.

Demand Uncertainty

The result of a shift in demand uncertainty, measured by the mean-preserving spread, ω, is

(6) $$\left[\, rEU' \,(h - \bar{h}) + r\lambda EU''\,(rh + \lambda r^{2} h_{1})(h - \bar{h}) \right] \frac{\partial \lambda}{\partial}$$

Since the bracketed term is negative under DARA, the optimal markup is inversely related to the variance of demand. Wholesalers reduce markups by lowering price to maintain sales when reacting to unexpected demand shocks in the short run. Conversely, as demand becomes less variable, wholesaler confidence about consumer response to price changes improves and markups are increased.

While the trend is increasing demand, individual wholesalers encounter variability in demand, which restrains markups. In a 1990 survey of retailers and wholesalers with experience handling organic produce, Rosenblum and Haas found that three of 10 wholesalers responding reported decreased organic produce sales in the previous five years, while three reported an increase, and four reported no change. A 1990 survey of Kansas food outlets showed that of the 175 not offering organic products, the main reason was perceived low demand at their stores, even as 80 respondents stated demand overall is increasing (Armstrong, Bentley and White). In a 1994 survey of organic retailers and wholesalers in North Carolina, Estes, Herrera and Bender documented that uncertainty about profit margins due in part to variability in organic produce turnover rates is slowing retail expansion.

Improvements in marketing channels and consumer education are sometimes recommended to reduce this variability in demand. If successful, the comparative static result from equation (6) suggests that markups can increase, with potentially greater returns for wholesalers. As with increases in expected demand, the prospect for sustained organic price premiums is supported, assuming conventional price trends are unchanged.

Average Variable Costs

The effect on optimal markup of a change in variable costs, q, is

$$\mathfrak{L}^{*}_{qq} = -z \left[EU^{\prime\prime} \left(rh + \lambda r^{2} h_{1} \right) \right] \frac{\partial \lambda^{*}}{\partial q} \quad . \tag{7}$$

We know that the term in brackets is positive under DARA. From the requirement that $\mathfrak{L}^{*}_{qq}$ be positive, a testable implication is that incremental increases in average variable costs lead to decreases in the optimal markup. Risk-averse wholesalers do not automatically raise the markup to reflect higher marketing costs. As Fraser (1985) noted, this means firms allow short term decreases in the markup, in effect holding prices constant and accepting a variable profit margin.

Wholesalers may be willing to buffer retailers from wholesale cost increases, at least temporarily. In an evolving market, wholesalers may view maintaining market share as more important than maintaining profit margin as they establish client linkages to reduce future demand uncertainty. Park and Lohr showed that wholesaling costs have a significant negative effect on equilibrium price in wholesale markets for organic broccoli, carrots and lettuce, suggesting that cost increases are not passed on to retailers.

Retailers cite reliable supplies and acceptable price premiums over conventional produce as the main factors in expanding their demand from wholesalers (Jolly; Estes, Herrera and Bender; Morgan and Barbour; Armstrong, Bentley and White). Marketing costs, shrinkage and transportation costs cut into retailers' profit margins and put organics at a relative disadvantage to conventional produce (Estes, Herrera and Bender; Morgan and Barbour). Efforts by wholesalers to maintain supply flow while holding down wholesale cost transfers to retailers are likely to help market expansion.

Exogenous Demand Shifters

Consumer preference for fresh produce is driven by health concerns and greater awareness of pesticide risks. Demand for organic produce may be influenced by the availability of similar quality products as well as by consumer reaction to food safety issues. These effects on demand are captured in ν.

Following Leland's model of the price-setting firm, we assume that the demand function is separable in price and the vector of exogenous parameters, so that the cross-partial derivative is equal to zero. The effect of ν on the optimal markup is found from

(8) $$EU'(rh_2 + r\omega_1\epsilon) + \lambda EU''\left(rh + \lambda r^2 h_1\right)\left(rh_2 + r\omega_1\epsilon\right)$$

The sign of the bracketed term is indeterminate. The sign of equation (8) depends on the signs of h_2 and ω_1, the first partial derivatives with respect to ν. The exogenous demand factors alter both expected demand and demand variability. Since these effects may be of unequal magnitude, the net influence on optimal markup is unpredictable.

Consumers purchase organics in part because they are believed to be safer than conventionally grown produce (Estes, Herrera and Bender; Morgan and Barbour). Certification of treatments and residue testing give consumers more information about safety qualities of produce. To the extent that consumers understand the information they are given, their purchases will reflect quality preferences. Estes, Herrera and Bender showed that price differentials depend on consumer perceptions about quality distinctions, which may be inaccurate. Thus, it is not clear whether consumers view residue testing and organic certification as substitutes or complements. Estes, Herrera and Bender pointed out that as conventional growers reduce chemical use, through participation in integrated pest management, for example, consumers may become even more confused.

This has implications for both expected demand and demand variability. If noncertified produce is a substitute, expected demand for organics should decline unambiguously as more of the substitute becomes available. If it is a complement, as would be the case if noncertified purchases stimulate consumers to search for other reduced-chemical produce, then expected demand for organics should increase.

Variability in demand for organics should increase if nonorganics are perceived as substitutes, since niche markets for safe produce will be filled by either. Availability and price competition would be key determinants since retail demand for organics will be more elastic. Variability should decrease if nonorganics are complements, since their introduction into a market will enhance sales of organics and contribute to overall market expansion.

The optimal markup will expand if expected demand increases and demand variability decreases in response to greater availability of residue-tested produce. This result insures that the bracketed term in equation (8) is positive, so that $\mathcal{L}^*_{vv}$ positive as required by the primal-dual condition. If this result holds, then by emphasizing to consumers the distinction between organic and nonorganic produce and convincing them that organics are safer, wholesalers would facilitate opportunities to increase markups.

The Markup Rule for Organic Wholesalers

Although organic produce usually sells for a premium over conventionally grown produce, there is a limit to the differential that may be charged (Estes, Herrera and Bender). Organics do not necessarily command a higher profit margin than conventional produce, and may even retail at similar or lower prices. We test whether organic wholesalers are behaving optimally by using the same markup rule as conventional wholesalers, despite their greater demand uncertainty.

We specify and estimate an econometric model and evaluate relevant elasticities as explained for equations (5), (6), (7) and (8). We specify percentage price spread ($ORGSPRD_t$) between price paid, r, and price received, p, as function of $\bar{h}$, ω, q and v, as well as seasonality and weather. These latter two are exogenous to the wholesaler, but affect demand uncertainty through availability of the commodity.

Weekly organic quantity and price data from the Organic Market News and Information Service (OMNIS), published by the Committee for Sustainable Agriculture, were collected from September 19, 1985 through December 30, 1989 for romaine lettuce. This commodity was wholesaled in cartons of 24 heads, purchased from farmers certified through the California Certified Organic Farmers and sold to retailers throughout the U.S.

The estimated equation for the optimal markup is

(9)

$$RD_t = \beta_0 + \beta_1 WAGE_t + \beta_2 TRUCK_t + \beta_3 DEMDEXP_t$$
$$+ \beta_4 DEMDVAR_t + \alpha_1 SINE_t + \alpha_2 COSINE_t + \alpha_{3+k} W.$$

where ϵ_t is an i.i.d. random error term with mean zero and variance equal to σ_t^2. Variables for which we do not evaluate optimal markup behavior are designated with α_i. Average costs to the wholesaler, *q*, include $WAGE_t$, the labor cost to the wholesaler and $TRUCK_t$, shipping costs. Wages are measured as average hourly earnings of production workers in SIC 5148 (Fresh Fruits and Vegetables), extrapolated from U.S. Department of Labor monthly data. Per mile average variable and fixed trucking costs were extrapolated from U.S. Department of Agriculture monthly data. National averages were used because the wholesalers in California ship all over the U.S.

Expected demand is $DEMDEXP_t$, and uncertainty of demand, $DEMDVAR_t$. These are $\bar{h}$ and ω in the comparative static results. The exogenous demand shifters, *v*, are implicit in both. To make this vector explicit, so that elasticities may be calculated, expected demand is specified following the Just expectations model as

(10)

$$XP_t = \Big(\beta_5 Q_{t-1} + \beta_6 NUTRCLN_{t-1} + \beta_7 NUTRCLN2_{t-1} + \beta$$

where Q_{t-1} is the lagged quantity of organic lettuce sold. Output price is incorporated in the dependent variable from equation (9), $ORGSPRD_t$.

The availability of competing products is represented by linear and quadratic terms, $NUTRCLN_{t-1}$ and $NUTRCLN2_{t-1}$. Caswell and Johnson tracked the number of retail groceries participating in the NutriClean program to certify fresh fruits and vegetables as having "no detectable residues." For the time frame of this study, NutriClean-certified produce was the main alternative advertised by retailers and purchased by consumers. The NutriClean service was marketed only to retailers; wholesalers were not participants. Consumers use NutriClean and organic certifications as indicators of food safety to differentiate from noncertified produce.

Sensitivity to food safety issues is demonstrated by consumer response to news episodes that heighten awareness, here represented by $ALAR_t$. This dichotomous variable is equal to one for weeks following February 26, 1989, when a national television news show indicted the safety of Alar, a growth hormone used on varieties of red apples. The demand for organic produce along with organic apples soared in the months following this episode (DeVault). This spike in demand caught organic growers unaware, and resulted in severe price fluctuations. Since the event was completely unpredicted, we subscript the variable with *t* to indicate the current condition known to the grower in the period expectations were formed.

Demand uncertainty for organic produce, $DEMDVAR_t$, is defined as the squared difference between actual demand and expected demand in *t-1*. The exogenous variables that influence expected demand also affect demand uncertainty. Our specification permits measurement of these effects on the optimal markup, and allows us to test the implication that the coefficients on the exogenous demand shifters are equal for both expected demand and demand variability.

The model in equation (9) incorporates seasonality and weather elements as exogenous variables that alter availability of organic produce. Seasonality refers to cyclical, predictable changes in prices and quantities. Seasonal effects are captured by the weekly harmonic terms $SINE_t$ and $COSINE_t$. The term WXR_t is a vector of weekly cumulative cooling degree days (CDD) and heating degree days (HDD) for the two main production regions for organic lettuce, Bakersfield and Watsonville. The coefficient α is subscripted to reflect that four terms are included in the WXR vector, $BAKEHDD_t$, $BAKECDD_t$, $WATSHDD_t$ and $WATSCDD_t$.

We constructed the weather variables based on daily minimum and maximum temperature data from the National Oceanic and Atmospheric Administration. The variables representing the weekly cumulative degree days for specific weather stations were positive during months wholesalers said they bought from the corresponding production region and zero otherwise. Using this approach only weather data that affected the weekly availability were included.

Estimation Results and Model Interpretation

After substituting the specifications for mean and variance of demand into equation (9), we estimated the markup model using nonlinear least squares corrected for autocorrelation based on White's modified Durbin-Watson test. Parameter estimates are presented in table 1. We tested the equality restriction for the coefficients on exogenous demand shifters substituted into expected demand and demand variability by estimating restricted and unrestricted markup models and applying a likelihood ratio test. The χ^2_4 test statistic of 6.29 was smaller than the critical value of 9.49 for α=0.05. We failed to reject the equality restriction, confirming that the specification of the demand expectation and demand uncertainty measures was appropriate.

We compare coefficient estimates with the comparative static results in equations (5), (6), (7) and (8). These equations indicate the appropriate sign for the adjustment in the optimal markup due to changes in the relevant parameters. From the significant parameter estimates, we calculated elasticities that indicate the percentage change in markup expected as each parameter changes and interpret these elasticities. We derived coefficient estimates, t-statistics and confidence intervals for elasticities using a bootstrapping technique following Chalfant, Gray and White.

Expected demand has a significant positive effect on markup. Wholesalers respond to an increase in expected demand ($DEMDEXP_t$) by raising the markup, consistent with optimality as derived from equation (6). A one percent increase in expected demand results in a 0.07 percent markup increase. The magnitude of this elasticity suggests that organic wholesalers are cautious in responding to changes in expected demand, possibly due to weekly demand volatility. As wholesalers anticipate demand changes, their behavior can smooth market transition to a new price level, and in the long run, moderate farmer supply shifts.

The comparative static result predicts that wholesalers lower margins in response to increased demand uncertainty. This result is confirmed by the significant negative coefficient for $DEMDVAR_t$. Faced with greater demand uncertainty, wholesalers temporarily reduce profit margins to maintain sales and market share. A one percent increase in demand uncertainty reduces the markup by 0.009 percent. Wholesale pricing behavior is more responsive to shifts in expected demand than to changes in demand uncertainty, but is theoretically optimal with respect to both factors. Markup adjustments by organic wholesalers are consistent with the model of risk averse marketing decisions.

The coefficients on the cost variables, $WAGE_t$ and $TRUCK_t$, are positive, but only $TRUCK_t$ is statistically significant. These results are contrary to the sign predicted from equation (5). Marginal increases in the variable costs incurred in marketing organic lettuce are translated into higher markups by wholesalers. The elasticity for trucking costs is 3.017, indicating that a one percent increase in trucking costs results in a 3 percent increase in the marketing margin. The margin may be within acceptable levels for retailers, or wholesalers may be unaware of resistance to cost increases by retailers.

Expectation and variance of demand are influenced by produce sold in the previous period, as described by equation (10). The significant positive coefficient on Q_{-1} indicates that wholesaler expectations are based on observations of demand in the past. Wholesalers increase the markup by 0.11 percent when they observe a one percent increase in the previous week's quantity sold.

Since estimates for expected demand and variance are significant, and both are functions of retail demand factors, elasticities of the NutriClean and Alar variables were calculated. A one percent change in retailer participation in the Nutriclean program resulted in a 0.11 percent increase in markup, an elasticity estimate that was not significant. Reacting to the Alar episode, organic wholesalers slightly narrowed the markup to brake the price increase. The impact of the Alar scare on the markup for organic lettuce was small at -0.04 percent but was statistically significant. Although the estimated coefficients were not significant, the signs on $NUTRCLN_{t-1}$, $NUTRCLN2_{t-1}$ are consistent with consumer perceptions of complementary products. The negative sign on $ALAR_t$ suggests that spontaneous demand surges reduce the markup, indicating that wholesalers are not the source of dramatic price increases since their markups decline.

Conclusions

We test whether markup pricing in the wholesale organic lettuce market is consistent with decision making by the risk averse competitive firm facing demand uncertainty. The organic market is subject to more demand uncertainty than the market for conventionally grown lettuce, making this issue particularly relevant as organic sales continue yearly expansion. Of concern to many in the industry is what profit margins will be as demand shifts occur.

Wholesaler behavior with respect to expected demand and demand uncertainty is consistent with theoretical comparative static results. Wholesalers raise markups as expected demand increases and reduce them as uncertainty increases. Although the expected demand is trending upward, individual firms face substantial variability in demand. If variability in demand can be reduced, it is likely that wholesalers will be able to obtain higher profit margins even as supply from farmers expands by increasing markups.

Wholesaler behavior with respect to variable trucking and wage costs is not consistent with theory. Our results show that as trucking costs increase, wholesalers raise the markup. Worker wage costs did not exhibit a significant relationship with markups. While existing retailers may accept a small cost pass through, several surveys have demonstrated that resistance to cost increases is a formidable barrier to organic market expansion.

We examine empirical markup behavior with respect to the exogenous demand shifters - availability of other certified produce and demand shocks dues to spontaneous consumer reactions. The results suggest that wholesalers perceive that consumers may be treating organic and NutriClean-certified produce as complements. As NutriClean products became more available, organic markups increased indicating confidence on the part of wholesalers that consumers would not react adversely. Consumer concern is apparently sufficient that any produce perceived to have a food safety advantage over conventional produce is being purchased. Although retailers during the time frame of this research distinguished between the two goods, most of the time the same fruit or vegetable was not offered in both NutriClean and organic form. It may be this physical separation that is responsible for the markup result.

In response to consumer demand shocks such as the Alar incident generated, wholesalers reduce their markups. The effect on demand uncertainty outweighed the effect on expected demand, and the markup declined. The dramatically higher prices charged by retailers were not due to wholesalers' pricing behavior. The wholesale margin declined, indicating that farm price for raw product increased more than wholesale price. Industry sources indicate that the short-term supply of organic produce was exhausted and prices soared at all levels of the marketing chain.

Wholesaler pricing decisions with regard to consumer-oriented demand shifters must be tailored to evolving market conditions. Theoretical results do not predict what markup behavior is optimal in the face of alternative safe food products. The burgeoning market for safe produce includes certification for "green," "IPM," "pesticide-free," as well as organic. Efforts to reduce consumer confusion and promote advantages of organics may pay off for wholesalers. The National Organic Foods Production Act is expected to improve product uniformity and aid in consumer education. To the extent that this effort reduces demand uncertainty, wholesalers' ability to raise margins is improved.

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Table 1. Parameter Estimates for the Markup Model Under Uncertainty

CONSTANT	-1.471* (-3.059)
$WAGE_t$	0.722 (1.488)
$TRUCK_t$	1.025* (1.664)
$DEMDEXP_t$	0.088* (4.043)
$DEMDVAR_t$	-0.003* (-2.621)
$QUANT_{t-1}$	0.456* (2.044)
$ALAR_t$	-0.181 (-1.041)
$NUTRCLN_{t-1}$	-0.491 (-0.628)
$NUTRCLN2_{t-1}$	0.466 (0.664)
$SINE_t$	-0.0002 (-0.301)
$COSINE_t$	0.008* (4.545)
$BAKEHDD_t$	-0.021* (-4.428)
$BAKECDD_t$	0.002 (0.970)
$WATSHDD_t$	0.020* (2.689)
$WATSCDD_t$	0.002 (1.241)

Note: Asterisk indicates significance at the $\alpha = 0.10$ level.