Fresh Vegetable Prices: Do Supermarkets Raise and Lower Them the Same Way?

This paper focuses on the transmission of prices from the wholesale to retail level for two selected fresh produce commodities: snap beans and sweet corn. The model distinguishes between adjustments to price increases versus decreases and allows for the estimation of different lag periods. Results suggest the retailer passes on increases to the same extent as decreases but transmits the increases faster.

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Retail level price changes are common occurrences. Vertical price relationships refer to price transmissions between products at various stages of the distribution system from producers to consumers. Two considerations in an examination of price increases and decreases are the speed with which they occur and the amounts of the increases versus decreases. The former pertains to the duration of the adjustment on the part of retailers to changes in costs. Do retailers lower prices as quickly as they raise them as suppliers lower and raise prices? If there is a difference, then there is asymmetry in the price adjustment process between the vertical components of the distribution system. The latter refers to whether retailers more than pass-on price increases, whereas price decreases are not completely transferred to consumers.

These issues have been studied by agricultural economists, who have developed analytical approaches to evaluate vertical price transmissions (Gardner, 1975; Hansmire and Willett, 1992; Holloway, 1991; Houck, 1977; Kinnucan and Forker, 1987; Pick, Karrenbrock, and Carman, 1990; Powers, 1994; Ward, 1982; Ward and Zep, 1981). The present paper applies the methodology to two food items that have not been studied previously. It also provides a consumer perspective on the results.

Food items are well suited for price transmission modeling. Many are homogeneous, and for some there are no brands (e.g. fresh produce). Present interest centers on an empirical description of price changes, as opposed to the development and testing of a theory of price transmissions. Whole fresh vegetables are essentially unaltered before they reach consumers. As a result, a price adjustment at the wholesale/broker level should have a more direct effect on retail prices, as opposed to more highly processed foods.

A major weakness of past studies of price movements in the vegetable industry has been the use of average monthly prices to assess how adjustments occur (with the exception of Powers, 1994, who used weekly observations). Weekly data are more consistent with the planning horizons of consumers and food retailers. With the introduction of retail scan data technology, weekly price data can be used to track prices.

A Vertical Price Linkage Model

The flow of product from the farm gate to the consumer can be visualized as a stream, so upstream and downstream relationships exist. By examining relationships between exchange points in the distribution stream, vertical price linkages can be estimated and used to evaluate how downstream prices move in relation to upstream changes. The direction of causality is from the wholesale/broker level to supermarkets based upon other research (Heien, 1980; Kinnucan and Forker, 1987; Pick, Karrenbrock, and Carman, 1990; Ward, 1982). Causality tests were not used due to this extant literature and to some inconclusive aspects of the tests (Pindyck and Rubinfeld, 1991; Zellner, 1988). Hansmire and Willett (1992) found rising wholesale prices of apples strongly affected retail prices but falling wholesale prices exhibited little influence. Ward and Zepp (1981) concluded that price lags seldom exceeded one to two months due to the perishable nature of fresh produce.

The approach taken here is based on Powers' (1994) analytical model. Firms are assumed to be competitive and fresh vegetables are provided by supermarkets combining the wholesale commodities with marketing inputs in fixed proportions. The former is supported by results such as Holloway (1991) and the latter by there being few possibilities for substituting inputs in the short run and the technology for distributing and marketing being fixed. Fees for cooling, packing, and selling produce are consistent with constant marginal cost (Powers, 1994). Given this setting the price relationship for the ith commodity is

$$R_i = a_{1,i}W_i + a_{2,i}M_i \qquad (1)$$

where: R = retail price; W = wholesale price; and M = marketing costs.

The number of units of the ith vegetable at the wholesale level needed to have one unit at the retail level is represented by $a_{1,i}$. Because fresh vegetables are perishable, $a_{1,i}>1$. It also represents the amount the retail price changes based on a one unit change in the wholesale price.

Houck (1977) proposed a way of introducing an asymmetric price adjustment process, shown as equation (2). $RP_{i,t}$ represents the change in the ith retail level price in period t from the respective base period retail level price, $R_{i,0}$. $SR_{i,k}$ ($SF_{i,k}$) is the ith price change whenever the current price is higher (lower) than the previous period's price. Similarly, rising and falling price changes can be obtained for transportation costs (TC).

$$RP_{i,t} = \sum_{j=0}^{r} \delta_{1,i,t-j} SR_{i,t-j} + \sum_{j=0}^{f} \delta_{2,i,t-j} SF_{i,t-j} + \delta_{3,i} TCR_{i,t} + \delta_{4,i} TCF_{i,t} + e_{i,t} \qquad (2)$$

where: $RP_{i,t} = R_{i,t} - R_{i,0}$;

$SR_{i,t} = \sum_{k=0}^{t} \Delta S_{i,k}$;

$\Delta s_{i,k} = S_{i,k} - S_{i,k-1}$, if $S_{i,k} > S_{i,k-1}$, 0 otherwise;

$SF_{i,t} = \sum_{k=0}^{t} \Delta S_{i,k}$;

$\Delta s_{i,k} = S_{i,k} - S_{i,k-1}$, if $S_{i,k} < S_{i,k-1}$, 0 otherwise;

$TCR_{i,t} = \sum_{k=0}^{t} \Delta TC_{i,k}$;

$\Delta TC_{i,k} = TC_{i,k} - TC_{i,k-1}$ if $TC_{i,k} < TC_{i,k-1}$, 0 otherwise;

$TCF_{i,t} = \sum_{k=0}^{t} \Delta TC_{i,k}$;

$\Delta TCF_{i,k} = TC_{i,k} - TC_{i,k-1}$ if $TC_{i,k} > TC_{i,k-1}$, 0 otherwise;

r = lag length for rising prices; and

f = lag length for falling prices.

Transportation costs have been included in other studies of vertical price transmission. However, they were not used here. This was based on the distribution system of the retailer supplying the scan data. Smaller chains and independents typically use third party suppliers, whereas this chain purchases fresh produce from brokers and wholesalers in various locations, including those used in the present study. Fresh produce transportation is part of the chain's distribution system, so transportation costs are fixed in the sense of no seasonal variation because warehouses, trucks, and drivers are part of the overhead. Furthermore, local growers do not deliver directly to this chain's outlets.

Within this framework, the sum of the $\delta_{1,i,t-j}$'s and $\delta_{2,i,t-j}$'s represent the price transmission process. Should the sums be equal to 1, then wholesale level prices are transmitted exactly to the retail level. The lengths of time required for the adjustments are reflected in r and f, and if they are equal, then the transmission speeds are the same.

Data

Snap beans and sweet corn were selected for study. Price data for wholesale markets were acquired from the Market News Service (U. S. Department of Agriculture, 1988-93) for four markets considered important to supermarkets operating in the local area where the scan data, described below, were generated. A reason for using four terminal markets is the chain purchases fresh produce throughout the country, and it is not clear which market has the greatest influence on local retail prices. Terminal market prices are also considered to reflect exchange prices among food distributors and brokers who are not located at the specific sites. Furthermore, the retailer could switch its buys among the locations depending on price differences.

Weekly retail prices were obtained from five supermarkets located in a metropolitan area in the Southeast that are part of the same multiregional chain. Prices are for seven day periods beginning Sunday and ending Saturday. Because vegetables are sold in different quantities at the retail and wholesale levels, the retail prices were adjusted to per carton values to reflect the prices charged for wholesale quantities (U. S. Department of Agriculture Statistical Bulletin 616). The scan data are accurate reflections of retail prices in

Table 1
Descriptive Statistics and Correlations

	Atlanta	Baltimore	Chicago	Cincinnati	Retail
Snap Beans					
Mean (dollars)	14.45	14.04	16.90	15.29	27.75
Range (dollars)	7.3-28	5-32.5	7.5-55.5	7.3-44.8	3.8-56.1
Coef. Var.	.30	.41	.41	.34	.25
Sweet Corn					
Mean (dollars)	9.82	10.24	11.66	11.09	18.78
Range (dollars)	5.5-18.3	4.3-20	3.5-22.5	3.5-27.5	5.7-73.5
Coef. Var.	.29	.31	.35	.35	.33
			Correlations		
Snap Beans					
Atlanta	1.00				
Baltimore	.84	1.00			
Chicago	.87	.84	1.00		
Cincinnati	.91	.89	.90	1.00	
Retail	.48	.40	.60	.54	1.00
Sweet Corn					
Atlanta	1.00				
Baltimore	.88	1.00			
Chicago	.86	.88	1.00		
Cincinnati	.91	.91	.93	1.00	
Retail	.53	.52	.50	.53	1.00

the area because the chain controls the largest market share in that location.

Some descriptive statistics and price correlations between the wholesale and retail levels are provided in Table 1. Baltimore had the lowest mean snap bean wholesale price. Atlanta had the lowest mean sweet corn price. Mean retail prices ranged from $4 to $56 per bushel carton for snap beans and from $6 to $74 for sweet corn. Mean retail prices were $27.75 and $18.78, respectively. Coefficients of variation indicated high relative variability in snap bean wholesale prices vis-a-vis the supermarket, whereas those for sweet corn suggest more comparable variability of prices among the markets.

Price correlations are always higher between the wholesale markets than between the wholesale and retail levels. This was expected. Information spreads quickly among participants in wholesale markets. Also, several additional factors affect retail prices, such as competition and labor costs. The retail-wholesale correlations also suggest that the retailer may purchase snap beans and sweet corn in a particular market depending on its price relative to the other locations.

Initial estimates of equation (2) were obtained using Powers' methodology which entailed setting r and f at seven weeks. The last lag was deleted if its p-value was greater than .20, and the equation was re-estimated. Lags were increased if the p value was less than .20. These iterations continued until the longest significant lag period was found. Results were inconsistent with other fresh produce studies cited above. More specifically, the duration of the adjustments seemed very long for highly perishable products (e.g., eight weeks or more) or the amount of the transmission was several orders of magnitude (e.g., five times the wholesale increase or decrease).

Powers noted that results are sensitive to the initial values. Consequently, mean values for each wholesale market were used instead of the more arbitrary observed initial price. An interpretation is that a retailer is reacting more to price changes relative to an average price, as opposed to the value at the start of the time series.

Estimates of equation (2) are presented in

Table 2
Estimated Sums of the δs and Overall Fits.

	Snap Beans			Sweet Corn		
	Increases	Decreases	R^2	Increases	Decreases	R^2
Atlanta	1.99[a]	1.78[a]	.13	2.45[a]	1.41[a]	.12
Baltimore	1.04[a]	.89[a]	.09	3.43[a]	2.47[a]	.18
Chicago	2.14[a]	1.70[a]	.31	2.92	1.83	.18
Cincinnati	1.64[a]	1.58[a]	.11	3.18[a]	2.09[a]	.18

[a]Denotes a pair of sums for a city are not significantly different at the .01 level.

Table 2. Durbin-Watson statistics are not reported due to the lag structure of the price changes. Although the R^2 values are low, the F statistics (not reported) were significant. These results are not surprising because other factors enter into the chain's pricing decisions, such as competitive environment, other costs, and outlet supplies coming from all four markets over the time period.

Notice that for each wholesale market for the two commodities, the sum of the δs is greater than one with only one exception. The exception is for Baltimore snap beans price decreases. Aside from price decreases in Baltimore, the sums of the δs are greater than one, suggesting the chain more than transmits wholesale changes. All the sums of the δs estimates for price increases are greater than those for decreases. However, except for Chicago sweet corn prices, the cumulative effects of the increases versus the decreases are not significantly different. This suggests that for the chain's outlets in this geographic area there does not appear to be asymmetry in price adjustments.

Examination of significant estimated adjustment lag periods, displayed in Table 3, provide additional insight into the pricing behavior. In six of the eight instances, the retailer used the following week (one week lag) to begin passing on price increases, but in four linkage situations, the decreases began in the second, third, or fourth week. Furthermore, price increases seem to be completed sooner than price decreases. This suggests that, although there may be no evidence of differences in the amounts of the adjustments with respect to increases versus decreases, the chain may be somewhat slower in passing the decreases along to consumers.

Summary

This paper has illustrated the use of nonreversible functions to analyze retail food pricing behavior based on wholesale price changes. The model allows for comparisons of the amount of price increases and decreases that are transmitted from the wholesale to the retail level and the duration of the adjustment period. Scan data from a supermarket chain for snap beans and sweet corn and their corresponding wholesale level prices from four terminal markets were used to estimate the price transmission equation. Results suggest that 1)the retailer more than passed on price increases and decreases, 2) there was no pattern of significant differences in the amounts transmitted in response to price increases and decreases, 3) there did appear to be a slower adjustment process to price decreases as opposed to price increases, and 4) retailers may be following a strategy of increasing or decreasing the retail price relative to an average level, which may reflect a decision to let unit profits vary from week to week when the wholesale price is moving within a certain price range.

Table 3
Significant Lag Periods for Increasing and Decreasing Prices.

	Snap Beans		Sweet Corn	
	Increases	Decreases	Increases	Decreases
Atlanta	1,2,3,4	1,2,3,5	2,4	4,5
Baltimore	1,2	3,4,5	1,2,3,4	1,2,5
Chicago	1,2,3,5	2,3,4,5	1,2,3,4	2,4,5
Cincinnati	2,3,4,5	1,2,3,5	1,2,3,4	1,3,5

References

Gardner, B. L. (1975). The farm-retail price spread in a competitive food industry. American Journal of Agricultural Economics. 57, 399-409.

Hansmire, M. R. & L. S. Willett (1992). Price transmission processes: An empirical analysis of the apple industry. Cornell University.

Heien, D. M. (1980). Markup pricing in a dynamic model of the food industry. American Journal of Agricultural Economics. 62, 10-18.

Holloway. G. J. (1991). The farm-retail price spread in an imperfectly competitive food industry. American Journal of Agricultural Economics. 37, 979-989.

Houck, J. P. (1977). An approach to specifying and estimating nonreversible functions. American Journal of Agricultural Economics. 59, 570-572.

Kinnucan, H. W. & O. D. Forker (1987). Asymmetry in farm-retail price transmission for major dairy products. American Journal of Agricultural Economics. 69, 285-292.

Pick, D. H., J. Karrenbrock & H. F. Carman (1990). Price asymmetry and marketing margin behavior: an example for California-Arizona citrus. Agribusiness: An International Journal. 6, 75-84.

Pindyck, R. S. & D. L. Rubinfeld (1991). Econometric models and economic forecasts. New York: McGraw Hill.

Powers, N. J. (1994). Vertical pricing relationships for lettuce. USDA Technical Bulletin 1836.

U. S. Department of Agriculture, Agricultural Marketing Service. Fresh fruit and vegetable shipments. Selected issues.

Ward, R. W. (1982). Asymmetry in retail, wholesale, and shipping point pricing for fresh vegetables. American Journal of Agricultural Economics. 64, 205-212.

Endnotes

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