Price Transmission Processes: An Empirical Analysis of the Apple Industry

by

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PRICE TRANSMISSION PROCESSES: AN EMPIRICAL ANALYSIS OF THE APPLE INDUSTRY

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In the United States, apples are an important commodity for both producers and consumers. Apples are grown in thirty-five states. They are valued commercially at over one billion dollars in revenue (USDA/ERS). During the last decade, apples were ranked second in U.S. consumption of non-citrus fruits, averaging 18.5 pounds per capita (Pearrow). Declining per capita apple consumption and movement away from traditional processed apple products have led to the introduction of new apple varieties and the adoption of new marketing strategies. Efficiency of price transmission processes influences producers' ability to remain viable in today's highly competitive markets. Moreover, the food marketing system transforms all farm commodities through packaging, processing and distribution before they reach the final consumers. Consequently, it is difficult to evaluate the relationship between changing prices at the grower and retail levels. Additionally, price lags and asymmetric price transmission processes contribute to the uncertainty of how price changes at one market level affect prices at other levels.

An economic model was developed to gain an understanding of the price flows in the apple industry. The price transmission processes of two apple products, fresh apples and processed apple juice, are analyzed and compared. Specific emphasis is placed on evaluating price lags and price asymmetry; two factors which complicate the flow of prices between market levels. Based on considerations of data availability and the acceptance of an additive underlying price structure, a markup model similar to that specified by Heien was chosen for this analysis. First, the traditional assumptions and the development of marketing margin theory is presented. The implications of choosing the markup model are then canvassed, and the generalized model is explained. Next, the data and estimation procedures are reviewed. A discussion of price lag structures and estimation follows. The hypothesis of price asymmetry is then introduced and the results of estimation analyzed. Finally, the conclusions of this analysis are presented.

BACKGROUND

Traditionally, the study of price spread relationships has been based on five assumptions: 1) perfect competition, 2) static equilibrium, 3) fixed proportions of inputs as factors of production, 4) constant supply of marketing inputs, 5) and immediate response of price changes from one level of the marketing system to the next level (Tomek and Robinson). These assumptions underlie the theory of joint demand which connects the markets for retail food, farm output and marketing services within the food distribution system. The theory relies on market based interactions at the retail level to determine the demand for retail food products and the demand for farm commodities as factors of production. The costs of marketing inputs are,

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however, determined by forces outside of retail demand. They are generally specified in terms of pricing rules. (Thomsen and Foote). George and King identified two pricing rules used to determine retail prices: an absolute markup and percentage markup. They hypothesized that these rules represented the true costs of marketing services in the food marketing system.

Gardner's research suggested that simple markup pricing rules, such as the absolute and percentage markups specified by George and King, do not provide an accurate depiction of price spreads. Instead, Gardner hypothesized that retail and farm prices move differently depending on whether changes occur in demand or supply. He developed a static equilibrium model of derived demands to explain how changes in retail food demand, farm product supply and prices of factor inputs affect margins. He assumed: 1) constant returns to scale 2) perfect competition and 3) an aggregate variable which represents all marketing activities. Gardner modeled the competitive food industry using two factors of production: 1) an agricultural commodity and 2) a marketing input. The marketing input was specified as an aggregate of transportation costs, processing costs and packaging costs.

Heien argued that the static equilibrium model formulated by Gardner does not provide an accurate representation of the food distribution system since inventory levels for agricultural markets are not continuously in balance. Due to the absence of a market wide auctioneer to drive the market clearing price (zero inventory) and the operational difficulty of restocking a zero level inventory, Heien hypothesized that managers rely on price changes at lower levels of the food distribution system to change retail prices. Using the conceptual framework specified by Gardner and including the wholesale level, Heien formulated a dynamic model based on a markup pricing rule, such that

$$r = a_1 w + a_2 z. \quad (1)$$

Hence, retail price, **r**, is related to markups, $\mathbf{a_1}$ and $\mathbf{a_2}$[1], over wholesale prices, **w**, and the prices of other inputs, **z**.

Heien proved his approach is economically and mathematically consistent in both short run and long run scenarios. In the short run, he used a Leontief production function which operates under the assumption that inputs of production are required in fixed amounts. Heien argued that in the short run firms operate with fixed technology and cannot adjust to changes in factor prices. In the long run, Heien conceded that substitution may occur and, therefore, he used a Constant Elasticity of Substitution production function. Empirically, tests of the markup model have led to stable solutions suggesting that the markup pricing rule proposed by Heien produces consistent results with constant returns to scale and fixed technology.

Wohlgenant found fault with the theoretical consistency of the previous studies because they assumed fixed proportions between factors of production and did not allow for accurate estimates of demand relationships and linkages between farm and retail prices. He criticized the traditional assumption of fixed proportions between marketing services and farm product to

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[1] a_1 and a_2 are specified exogenously based on past prices.

As mentioned previously, the markup model can only measure changes in price flows when shifts occur in either retail demand or farm supply, but not both. The issue of shifts in retail demand and supply has caused some problems for the apple industry during the past decade. A large apple crop in 1987 followed by the alar incident in 1989 caused shifts in both supply and retail demand. Kinnucan and Forker point out that "the existence of large inventories is expected to neutralize the effect of demand shifts because stocks and not prices would be affected." This reasoning is applicable to the apple industry as both regular and controlled atmosphere storage are utilized throughout the marketing season.

The apple marketing system is characterized by the grower price and three price spreads; 1) the grower-shipping point price spread, 2) the shipping point-wholesale price spread and 3) the wholesale-retail price spread. It is believed that the transfer of prices between these levels comprises the retail value of apples (Pearrow). From this framework, two basic equations were developed to test for price lags and price symmetry in the apple industry. For the fresh apple market, each of the equations was adapted for the retail, wholesale, and shipping point market levels by choosing the appropriate price variables and a variable to represent marketing costs. Data availability, however, limited the analysis of the apple juice market to only the grower-shipping point price spread.

Generalized equations for each market level are based on the formulation that the price at a higher market level is a function of markups over the prices of farm commodities and marketing service inputs at lower market levels. More specifically, retail prices are viewed as a function of wholesale prices and an index of retail earnings expressed as

$$\text{(2)} \quad \textit{RETAIL PRICE} = f_2(\textit{WHOLESALE PRICE}, \textit{RET}, \mu_2).$$

RET was chosen as a proxy variable to represent the costs store managers incur in retailing apples.

Wholesale prices are a function of shipping point prices and a storage variable (**STOR**) representing apple movements between shipping points and wholesale levels expressed as

$$\text{(3)} \quad \textit{WHOLESALE PRICE} = f_3(\textit{SHIPPING POINT PRICE}, \textit{STOR}, \mu_3).$$

Shipping point prices are specified as a function of the grower price and the interest rate (**IR_1**), a proxy variable representing the opportunity cost growers forego by placing their apples in storage, as seen by

$$\text{(4)} \quad \textit{SHIPPING POINT PRICE} = f_4(\textit{GROWER PRICE}, \textit{IR}_1, \mu_4).$$

Finally, the shipping point price for apple juice is specified as a function of farm prices and the interest rate (**IR**$_2$), chosen to represent the opportunity costs of holding processing equipment as seen by

$$(5)\quad \textit{SHIPPING POINT JUICE PRICE} = f_5(\textit{GROWER PRICE}, \; IR_2, \; \mu_5).$$

DATA AND ESTIMATION PROCEDURES

Prices used in this study are for New York red delicious apples at the wholesale and shipping point levels in forty-two pound carton tray packs. Retail and grower prices represent the prices, in cents per pound, received on all fresh apples in the United States. Fresh apple prices came from the Agricultural Marketing Service, the USDA and the Bureau of Labor Statistics. Shipping point prices for apple juice in twelve thirty-two ounce containers were found in the Food Institute Report. Data for variables representing marketing inputs (**RET, IR, STOR**) are from The Survey of Current Business and Cold Storage Report. The price series are not deflated because the purpose of this analysis was to examine the behavior of nominal prices and not relative prices. Furthermore, different deflators are required for each market level making comparison between levels impossible.

Monthly prices from 1980 through 1990 were analyzed. Originally, all equations for lag length and asymmetry were estimated in **SAS** using ordinary least squares (**OLS**) but consistently low Durbin-Watson statistics required the use of the autoregression correction procedure. Only the results of the autoregression procedure, **FGLS**, are reported in subsequent tables.

PRICE LAG STRUCTURES AND ESTIMATION

Neither theory nor knowledge of the apple industry provide information for choosing a lag structure and for determining lag length. Because a polynomial lag structure is often used (Lutrell) in studying price transmission processes and it "provides a more flexible method for reduced parameterization" (Johnston), a low order polynomial lag structure was chosen a priori. Although this structure is theoretically appealing, both the degree of the polynomial and the length of the lag must be chosen a priori (Kmenta). Three sets of equations covering the grower-shipping point, shipping point-wholesale and wholesale-retail market levels were generated from the general specification of polynomial lags and the markup model. Due to counter-intuitive signs on the lagged price variables for all specified equations and the lack of theoretical support for retaining the polynomial lag structure, the polynomial lag structure of apple price transmission was rejected.

In order to more fully explore the role of lagged prices in the apple industry, the equations were re-estimated using a distributed lag formulation.

The general form of the distributed lag is

$$(6) \quad Y_t = \alpha + \sum_{i=1}^{n} \beta_i X_{t-i} + e_t,$$

where the price of the commodity at a higher market level, $\mathbf{Y_t}$, is a function of successive lagged prices of the commodity at a lower market level, $\mathbf{X_{t-i}}$. The distributed lag formulation implies that successive lags contribute to the pricing structure at a consistently decreasing rate.

The estimation of the second degree polynomial lag structure required the use of four lag periods. Consequently, each equation was re-estimated with up to four periods distributed lag. The results indicated that lags of four months were not important for fresh apples and apple juice. For all market levels, the results can be found in Table 1. Variable definitions can be found in Table 3. Results suggest that models specified as either a combination of current prices and one period price lags or as one of these prices had the greatest significance. R-square values for the equations estimated using **FGLS** in **SAS** ranged from 0.749 to 0.902. Strong positive t-ratios were found on both the current price and price variables lagged one period across all market levels. Explaining the significance of the current price in the price transmission process is difficult. Even if the wholesale market is fully integrated and operationally efficient, as argued by Ward, it seems impossible that price information from one market level can be transmitted instantaneously to the next level of the market.

Wholesale - Retail Price Spread

Results in the market for New York red delicious apples, reported in Table 1, indicate that current wholesale price (**WNYRDC**) and wholesale price lagged one period (**WNYRD1**) are statistically significant. The retail index (**RET**) is significant and positive. These results suggest that marketing costs and prices at the wholesale level affect the retail price.

Shipping Point - Wholesale Price Spread

Table 1 also presents equations 4-6 for the shipping point- wholesale price spread. At the wholesale market level for New York red delicious apples, current shipping point price (**FHVRD**) is significant at the 5% level both when it is specified with the lagged price (**FRD1**) and when it is specified by itself. The shipping point price lagged one period (**FRD1**) is significant at the 5% level only in equation 5 without the current price. In all equations, the t-ratios on **STOR** are significant and the coefficients are negative. This is consistent with economic theory indicating that increases in storage would decrease the change in wholesale prices.

Grower - Shipping Point Price Spread

The results of the grower-shipping point price spread, presented in Table 1, are similar to those presented for the shipping point-wholesale price spread. The t-ratio on the coefficient of the grower price lagged one period (**FPPP1**) increased from 1.639 to 3.634 when the current grower price was dropped from equation 7. The changing t-ratio is indicative of the problems associated with correlation between price variables. The t-ratio for the current grower price (**FP**) maintained consistency at the 5% level in both equations 7 and 9. The coefficients of $\mathbf{IR_1}$ are insignificant in all equations. It appears that the interest rate does not capture the true operating costs of storage or it does not isolate its effect at this level.

Grower - Shipping Point Price Spread For Apple Juice

The results, seen in Table 1, for the distributed lag on the grower-shipping point price spread for apple juice were unanticipated. A priori the coefficients on grower price variables were expected to be positive; i.e. increases in the grower price of apples should lead to increases in the price of apple juice.

Contrary to expectations, the signs on the grower price coefficients were negative. Two explanations for the phenomenon exist. First, the price of apples used in processing juice is relatively minor compared with the price of processing, packaging and marketing services involved in apple juice production. Therefore, the cost of marketing services could drive the pricing process for apple juice. Changing apple prices would then have less of an impact on shipping point prices than increased efficiency in these areas, thereby causing negative coefficients. Second, imports of apple juice concentrate have been increasing over the last decade. More apple juice on the market from sources outside the United States could cause a drop in apple juice prices which overshadows the forces driving apple markets in the United States. Negative price coefficients could result.

T-ratios on the current grower price (**FP**) are insignificant in both equations 10 and 11. Furthermore, the grower price lagged on period (**FPPP1**) is significant in equation 11. These results suggest that lag pricing structures of up to one month are important in the apple juice industry. $\mathbf{IR_2}$ is significant in all equations. This suggests that the holding costs of processing technology are important factors in shipping point prices of apple juice.

PRICE SYMMETRY AND ESTIMATION

The hypothesis of asymmetric price response behavior states that price increases and price decreases at lower market levels impact prices at higher market levels differently. Based on research by Wolffram, Houck developed a method of estimating irreversible functions which can be applied to tests of price asymmetry in the apple industry. More specifically, Houck defined an irreversible function as

$$(7) \quad Y_t = \beta_o t + \beta_1 R_t + \beta_2 D_t.$$

The dependent variable $\mathbf{Y_t}$ is a function of increases $\mathbf{R_t}$ and decreases $\mathbf{D_t}$ of the independent variable **X** such that

$$R_t = \Delta X_t' = X_t - X_{t-1} \text{ if } X_t > X_{t-1} \text{ ;=0 } \textit{otherwise,}$$

and

$$D_t = \Delta X_t'' = X_t - X_{t-1} \text{ if } X_t < X_{t-1}, = 0 \textit{ otherwise.}$$

The coefficient β_o represents a trend variable.

Specifying and estimating the general equations in this manner enables testing the null hypothesis that the pricing structure is symmetrical:

$$H_o: \beta_1 = \beta_2$$

against the alternative:

$$H_a: \beta_1 \neq \beta_2$$

that the pricing structure is asymmetric. The t-statistic used for this test is:

$$t = \frac{(\hat{\beta}_1 - \hat{\beta}_2) - (\beta_1 - \beta_2)}{\sqrt{var(\hat{\beta}_1) + var(\hat{\beta}_2) - 2cov(\hat{\beta}_1, \hat{\beta}_2)}}$$

where β_1 and β_2 are the estimated coefficients on the rising and falling prices respectively. The values for variance and covariance are calculated in **SAS** during the estimation procedure. Consistently low Durbin-Watson statistics for the **OLS** estimation again required the use of the autoregression correction procedure, **FGLS**, available in **SAS**.

Wholesale - Retail Price Spread

Estimates for the wholesale-retail price spread are presented in Table 2. The calculated t-value of 4.838, exceeds the t-criterion, 1.994, at the 5% level of significance indicating that price transmission is asymmetric for the wholesale-retail price spread of New York red delicious apples. A highly significant t-ratio of 6.611 on **RUWNYR** indicates that rising wholesale prices play an important role in determining retail prices. The insignificant t-statistic on **FDWNYR** suggests that falling wholesale prices of New York red delicious apples exhibit little influence on the retail price of fresh apples. This suggests that two variables, the rising wholesale price of New York red delicious apples, **RUWNYR**, and trend, **TRD**, drive the retail price for fresh apples, and decreases in wholesale price have little impact on retail price. In the marketing of New York red delicious apples, **RET** was the correct sign.

Shipping Point - Wholesale Price Spread

Estimates for the shipping point-wholesale price spread are presented in Table 2. The null hypothesis of symmetric pricing for New York red delicious apples was not rejected. Furthermore, the coefficients on both price increases (**RUFHVR**) and price decreases (**FDFHVR**) were insignificant at the 5% level suggesting that price increases and decreases at the shipping point level do not influence wholesale prices. The high t-ratio, 8.545, on **TRD** and the insignificance of **STOR** indicate that forces other than shipping point prices and marketing service costs are more influential in determining wholesale prices.

These results suggest that the transmission of prices between the shipping point and wholesale levels of the market may be a weak link in the pricing structure of New York red delicious apples. In fact, prices may flow from wholesale to shipping points. Ward's study suggested that a concentrated wholesale market can influence prices at both the shipping point and retail levels in the fresh fruit and vegetable industry. Consequently, these results indicate more research is needed at this market level to examine the direction of causality and the structure of the industry.

Grower - Shipping Point Price Spread

Results reported in Table 2 lead to the rejection of the null hypothesis that increasing prices and decreasing prices behave symmetrically. Hence, shipping point prices of New York red delicious apples respond differently to grower price increases and decreases. Furthermore, the results, indicate that both increasing grower prices (**RUUFP**) and decreasing grower prices (**FDDDFP**) are significant in determining shipping point prices. The results suggest that grower price increases impact shipping point prices by 0.615 cents per pound and that grower price decreases influence shipping point prices by 0.487 cents per pound. The coefficient of $\mathbf{IR_1}$ is negative and insignificant. This is not consistent with a priori expectations. Because this variable acts only as a proxy variable for storage costs, however, it could be that the variable does not fully capture storage costs.

Grower - Shipping Point Price Spread For Apple Juice

Results reported in Table 2 indicate the test of price asymmetry for the grower-shipping point price spread of apple juice failed to accept the alternative hypothesis that price asymmetry exists at this market level. Furthermore, both increases and decreases in grower prices are insignificant at the 5% level. Estimation suggests that increases and decreases in grower prices of apples do not influence the shipping point price of apple juice. This is consistent with negative coefficients on the increasing and decreasing price variables and the hypothesis that forces other than the price of processing apples drive the pricing structure of apple juice. In fact, positive significant coefficients on **TRD** and $\mathbf{IR_2}$ further support the aforementioned hypothesis.

CONCLUSIONS

Due to insufficient data, it is impossible to determine the existence of lagged price transmission for fresh apples. More specifically, the estimation of the distributed lag structure indicated that monthly data lack sufficient periodicity to determine price lags for fresh apples. Based on these results, it is hypothesized that lagged price transmission processes operating in the markets for fresh apples may lie somewhere between the current price and the price lagged one month. Significance of both the current price and the price lagged one period support this hypothesis.

Price response from the grower level to the shipping point level for apple juice appears to have a different lag length. Results indicate that price transmission from the grower level to shipping point level are lagged one month. The fresh apple and apple juice results suggest that product perishability may influence lag length.

Generally, the tests for price asymmetry in the marketing system of fresh apples indicate that pricing asymmetry exists only for the wholesale-retail and the grower-shipping point price spreads. Moreover, the results indicate that retailers and shipping point traders respond more fully to price increases than to price decreases. This suggests that consumers bear the burden of increasing input costs.

The results indicate that increasing wholesale prices of New York red delicious apples is a significant factor in determining retail prices. In contrast, the results of price behavior for the shipping point-wholesale price spread indicate that wholesale price is not determined by shipping point price increases and decreases. This suggests a weak link in the price transmission process and that the direction of price flows assumed in this analysis may need further analysis. Finally, the results indicate that both grower price increases and decreases impact shipping point prices for New York red delicious apples.

Results for apple juice price spreads were unexpected and inconclusive. They indicated that grower price increases and decreases of apples may not influence shipping point prices of apple juice. Furthermore, results suggest that forces outside the United States apple production, namely; increasing imports and increasing efficiency in processing and marketing apple juice are more significant in determining shipping point prices of apple juice.

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TABLE 1
RESULTS OF THE DISTRIBUTED LAG MODEL

WHOLESALE-RETAIL PRICE SPREAD

DEPENDENT VARIABLE: RUS

EQU #	1	2	3
INT	-0.326 (-2.201)	0.894 (0.411)	-0.340 (-2.438)
WNYRDC	0.792 (4.659)*		1.127 (6.914)*
WNYRD1	0.402 (2.634)*	0.424 (2.662)*	
RET	0.00391 (5.116)*	0.00263 (2.215)*	0.00416 (5.627)*
R^2	0.883	0.857	0.800
RHO	-0.730 (-9.064)	-0.889 (-17.783)	-0.580 (-6.533)
OBS	76	86	87

SHIPPING POINT-WHOLESALE PRICE SPREAD

DEPENDENT VARIABLE: WNYRD

EQU#	4	5	6
INT	5.662 (3.284)*	7.073 (4.352)*	5.994 (4.164)*
FHVRD	0.517 (2.786)*		0.530 (3.877)*
FRD1	0.0656 (0.378)	0.428 (2.751)*	
STOR	-0.000532 (-2.948)*	-0.000530 (-2.931)*	-0.000411 (-2.863)*
R^2	0.726	0.694	0.727
RHO	-0.545 (-4.415)	-0.631 (-6.039)	-0.617 (-5.811)
OBS	50	58	58

GROWER-SHIPPING POINT PRICE SPREAD

DEPENDENT VARIABLE: FHVRDC

EQU #	7	8	9
INT	0.111 (3.407)*	0.162 (4.654)*	0.132 (4.421)*
FP	0.573 (3.888)*		0.695 (5.404)*
FPPP1	0.235 (1.639)	0.499 (3.624)*	
IR_1	0.000233 (0.142)	-0.000417 (-0.212)	-0.000101 (-0.062)
R^2	0.813	0.771	0.806
RHO	-0.798 (-10.583)	-0.821 (-12.082)	-0.796 (-10.592)
OBS	68	68	68

GROWER-SHIPPING POINT PRICE SPREAD

DEPENDENT VARIABLE: JUICE

EQU #	10	11	12
INT	5.580 (21.349)*	5.537 (23.835)*	5.498 (21.176)*
FP	-0.252 (-0.365)		-0.343 (-0.489)
FPPP1	-0.619 (-0.378)	-0.632 (-2.310)*	
IR_2	0.115 (5.545)*	0.115 (5.490)*	0.115 (5.600)*
R^2	0.799	0.801	0.786
RHO	-0.665 (-8.014)	-0.677 (-8.380)	-0.652 (-7.796)
OBS	85	86	85

*indicates significance at 5%

TABLE 2
RESULTS OF THE PRICE SYMMETRY EQUATION SPECIFICATION

WHOLESALE-RETAIL PRICE SPREAD		SHIPPING POINT-WHOLESALE PRICE SPREAD	
DEPENDENT VARIABLE: RUS		**DEPENDENT VARIABLE: WNYRD**	
TRD	0.245 (1.244)	TRD	11.135 (8.545)*
RUWNYR	1.238 (6.611)*	RUFHVR	0.311 (0.958)
FDWNYR	0.143 (0.759)	FDFHVR	0.216 (0.560)
RET	0.00214 (1.915)	STOR	-0.00045 (-1.406)
R^2	0.882	R^2	0.691
RHO	-0.876 (-15.432)	RHO	-0.761 (-7.959)
OBS	76	OBS	50

GROWER-SHIPPING POINT PRICE SPREAD		GROWER-SHIPPING POINT PRICE SPREAD	
FHVRDC		**JUICE**	
TRD	0.257 (8.631)*	TRD	5.380 (20.295)*
RUUUFP	0.615 (2.973)*	RUUUFP	-0.566 (-0.862)
FDDDFP	0.487 (2.401)*	FDDDFP	-1.532 (-1.623)
IR_1	-0.000988 (-0.431)	IR_2	0.115 (4.895)*
R^2	0.772	R^2	0.812
RHO	-0.896 (-16.136)	RHO	-0.730 (-9.322)
OBS	68	OBS	80

* indicates significance at 5%

TABLE 3
VARIABLE NAMES

DEPENDENT VARIABLES	
RUS	Retail price[2] of fresh apples in the U.S.
WNYRD	Wholesale price of New York Hudson Valley red delicious apples
FHVRD	Shipping point price of Hudson Valley red delicious apples
JUICE	Shipping point price of apple juice per 12/32 oz. containers
PRICES USED IN ESTIMATING THE DISTRIBUTED LAG STRUCTURE	
WNYRDC	Current wholesale price of New York Hudson Valley red delicious apples
WNYRD1	Wholesale price of New York Hudson Valley red delicious apples lagged one period
FHVRDC	Current shipping point price of Hudson Valley red delicious apples
FHVRD1	Shipping point price of Hudson Valley red delicious apples lagged one period
FP	Current price received by growers for fresh apples
FPPP1	Price received by growers for fresh apples lagged one period
PRICES USED IN TESTING FOR PRICE ASYMMETRY	
RUWNYRD	Increasing wholesale price of New York Hudson Valley red delicious apples
FDWNYRD	Decreasing wholesale price of New York Hudson Valley red delicious apples
RUFHVRD	Increasing shipping point price of Hudson Valley red delicious apples
FDFHVRD	Decreasing shipping point price of Hudson Valley red delicious apples
RUUFP	Increasing price received by growers for fresh apples
FDDDFP	Decreasing price received by growers for fresh apples
VARIABLES REPRESENTING MARKETING COSTS	
RET	Retailing costs
STOR	Monthly Storage levels
IR_1	Opportunity cost of storage
IR_2	Opportunity cost of processing equipment

[2]All price variables for fresh apples were converted to cents per pound.