MEASURING THE EFFECTS OF GENERIC PRICE AND NON-PRICE PROMOTIONAL ACTIVITIES: THE CASE OF WASHINGTON APPLES

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ABSTRACT

This paper develops a monthly domestic demand and supply equilibrium model for Washington apples that can be used to assess the effectiveness of price and non-price promotional activities. The econometric methodology employed takes into account market differences across the U.S. and is based on data pertaining to individual retail stores located throughout the U.S. The period of analysis is from September 1990 through August 2000 on a regional basis.

A unique feature of the model is its explicit allowance for multiplier effects to exist between the level of print media (newspaper ad and flyers) expenditures provided by the Washington State Apple Commission (WAC) in support of apple demand and supplementary funds provided by retailers in support of apple promotion.

In particular the model allows for the fact that Commission funds oftentimes represent only a relatively small fraction of the overall print media expenditures made in support of apple sales, and that Commission funds are often effectively only "pump priming" or serve as inducements for additional promotional activities by other entrepreneurs in the marketing chain. Also, the subset of promotional activities (print media and price reductions) provided by retailers is modeled in a dynamic fashion, whereby market conditions feedback affects the level of apple promotion provided by retailers.

The overall model includes a set of retail demand equations, a set of retail-F.O.B. price linkage equations, a set of ad lines – WAC Ad buys linkage equations, and an aggregate industry supply function. Additional factors such as asymmetry in retail-F.O.B. price response, the effects of information technology in retail pricing, and the effects of the large crops and the Asian and the Mexican crises on domestic supply are all simultaneously considered.

Results of this analysis indicate that, in the aggregate, price promotion is a significant factor positively impacting apple sales. Furthermore, price promotion elasticities were relatively high when compared to non-price promotional activities, leading to a conclusion that greater gains with respect to returns on promotional investment may occur when retail price reductions are pursued.

Despite an increased domestic supply and the effects of the Mexican and the Asian crises, among the non-price promotional activities, results indicated that both non-trade (TV and Radio) and trade-related efforts (in store demonstrations, point of sale displays, promotional give-aways, and ad buys) have contributed to increased demand for Washington apples. Sensitivity analysis of trade and non-trade expenditures indicated that trade-related activities were more effective in increasing demand at current expenditure levels relative to non-trade activities. Promotional efforts in the form of billboards, food

service expenditures, and other miscellaneous activities, which the industry also carried out during the historical period of analysis, did not have a measurable impact on demand in any of the regions.

It was also found that WAC ad buy expenditures resulted in a multiplier effect on the total number of ad lines. While the direct effect of these Commission expenditures on demand would be relatively small without the supplementary efforts forthcoming from retailers, the fact that retailers multiplied the Commission's expenditures into a substantially larger promotional effort resulted in a significant positive effect on apple sales when viewing the promotion program as a whole.

Key words: price and non price promotion, trade and non trade activities

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1. Introduction

Commodity programs and retailers in joint agreement or as separate entities, often conduct broadcast media and/or sales promotion to acquaint, or remind, consumers about the attributes of the products they have to offer. Cents-off, in store demonstrations, and point-of-purchase displays are types of sales promotion devices designed to supplement advertising and, sometimes, personal selling in the promotional mix (Cateora and Graham). The apple industry in the state of Washington has a long tradition in implementing most of these strategies through the Washington Apple Commission, which is an institution created by the industry to coordinate marketing efforts for long-term profitability. Specifically, the Commission conducts non-trade promotional activities (TV and Radio) and trade-related activities (ad-buy/print media, product display, and other trade merchandising activities). Within the print media category, however, Commission funds often represent only a relatively small fraction of the overall print media expenditures made in support of apple sales. The Commission funds are often effectively only "pump priming" or serve as inducements for additional promotional activities by other entrepreneurs in the marketing chain.

While several studies of commodity promotion evaluation have established a precedent for analyzing promotion and advertising's performance through models of demand response, (Richards and Patterson, Chung and Kaiser, Capps and Moen, Kinnucan and Miao to mention a few), these studies have not considered the multiplier effect that may result from joint agreements in sales promotion.

This paper develops a monthly domestic demand and supply equilibrium model for Washington apples that can be used to assess the effectiveness of price and non-price promotional activities, while considering the multiplier effects of joint sales promotion agreements. This paper presents a synthesis of economic theory as well as institutional realities, practical experience and knowledge gleaned from industry sources upon which each model component is based. Major findings pertaining to the demand, supply, print media multiplier effect, and industry returns per promotion type are also reported.

2. Methodology

The econometric methodology takes into account market differences across the U.S. and is based on data pertaining to individual retail stores located throughout the U.S.[1] The overall model includes a set of retail demand equations, a set of retail-F.O.B. price linkage equations, a set of ad lines – WAC Ad buys linkage equations, and an aggregate industry supply function, the former three differentiated by regions of the U.S. In addition, factors such as asymmetry in retail-F.O.B. price response, the effects of information

technology in retail pricing, and the effects of the large crops and the Asian and the Mexican crises on domestic supply are all simultaneously considered in the evaluation process. Data sources are shown in Appendix Table 1. Each model component is defined as follows:

2.1 The Demand Model

The demand for Washington apples is specified on a regional and a per capita basis and is a function of a vector of prices, income, price and non-price promotional expenditures, and other variables having an influence or demand. Thus, the demand function is empirically approximated as follows:

$$(1)\quad QDW_{tr}/POP_{tr} = f\Big(P_{retail_t}*(1\text{-}adexp_{tr}),\ Adprice_{tr}*adexp_{tr},\ RINC_{tr}/POP_{tr},\ PP_t,,\ ,$$

$$\sum_{i=0}^{n} Adlines_{t-i,r},\ \sum_{i=0}^{n} ADV_{t-i,j,r}/POP_{t-i,r}\ \forall j,\ QDW_{t-1,r}/POP_{t-1,r},$$

$$QDWR_{t-12,r}/POP_{t-12,r},\ T_t,\ T_t^2,\ T_t^3,\ \sum_{i=0}^{n} Logos_{t-i,,r},\ \sum_{i=0}^{n} Color_{t-i,r},,\ t,$$

$$\sum_{r=1}^{4} \text{Region}_r,\ \text{other},\ u_{tr}\Big)$$

Where:

QDW_t ≡ total quantity demanded of apples in month *t*, region *r*;

Pop_{tr} ≡ population in month *t*, region *r* (expressed in millions);

$P_{retailer_{tr}}$ ≡ the regular retail price per pound of Washington apples that prevailed during month *t*, region *r*;

$Adprice_{tr}$ ≡ the promotional retail price per pound of Washington apples that prevailed during month *t*, region *r*;

$Adexp_{tr}$ ≡ the time an ad is in effect in a given month expressed in ratio form;

$RINC_{tr}$ ≡ the real disposable personal income per million people in month *t*, region *r*;

PP_t ≡ a vector of substitutes measured in price per pound in month *t*, specifically bananas, and pears;

ADV_{tijr} ≡ a vector of advertising expenditures per million people in period *t* - *i*, for *i* = 0, 1,…,n; in category *j*, region *r*. For *j* = mass media, trade merchandising (display, give away products, trade services, and other in-store promotional activities);

$Adlines_{tr}$ ≡ the weighted number of ad lines in month *t*, region *r*;

$Color_{tr}$ ≡ the weighted number of lines in a colored format in month *t*, region *r*;

Logos_{tr} ≡ the weighted number of ads containing a logo in month *t*, region *r*;

$\text{QDW}_{t-1,r}$ ≡ total quantity demanded of apples in month *t*, region *r*, lagged one period;

$\text{QDW}_{t-12,r}$ ≡ total quantity demanded of apples in month *t*, region *r*, lagged 12 periods;

T_t, T_t^2, T_t^3 ≡ a polynomial time trend to capture seasonal consumption patterns, where $T_t = 1$ *in January*,...,$T_t = 12$ *in December;*

Other ≡ Other variables having an impact on demand such as quantities of apples demanded from New York, Michigan, and California, a time trend capturing secular changes in demand.

u_{tr} ≡ the error term to capture any remaining effect not included in the model.

In equation (1), all prices and advertising expenditures are in real terms. Details can be found in Van Voorthuizen. The regions are chosen based on territorial sales and population distributions as specified in Figure 1. The selection of the regional boundaries is influenced by information received regarding W.A.C. field representative territories. Note that regions are introduced in the model through indicator variables[2]. The Southwest indicator variable is excluded from the model and the Southwest becomes the base region for the analysis.

Important characteristics of the demand equation specification to note include: 1) the regular retail price and the promotional price are adjusted by a variable that accounts for the amount of time each price was in effect in a regional market, 2) the seasonal effects are captured by a polynomial time trend based on observed shipment patterns throughout the marketing season (t, t^2, and t^3), 3) physical measures of printed ads are used instead of expenditures (ad lines, ad containing a logo and colored ads); and 4) advertising carryover effects are evaluated using two lagged variables $QDW_{t-1,r}$ and $QDW_{t-12,r}$. The procedure used to capture the advertising and promotion carryover effects is different from procedures suggested by Nerlove and Waugh, Carman et al. Chung and Kaiser.

In the final model the variables proxying persistent consumption behavior, $\left(QDW_{t-1,r} \text{ and } QDW_{t-12,r}\right)$, prove to be statistically significant. Equation (2) depicts the *cumulated* carry over effect through time.

(2) $$(\partial QD / \partial Adv)_{12\text{months.cum}} = \partial QD / \partial Adv_{j,t} + \sum_{i=1}^{11} (\partial QD / \partial QD_{t-i} * \partial QD_{t-i} / \partial QD_{t-i-1} * \partial QD_{t-i-1} / \partial Adv_{j,t-i-1}) = b_{advj} + \sum_{i=1}^{11} b^{i}_{QD_{t-i}} * b_{advj}$$

In Equation (2), *QD* represents *QDW/POP* for simplicity of notation. Also, Adv_j is defined as Adv_j/POP (advertising expenditure per million people for category *j*). The b 's are the corresponding estimated coefficients, i = 1 (past month), 2,…,11th past month in which advertising expenses occurred, but still positively impacting the current month's consumption. Similarly, the marginal *cumulative* advertising effect on demand in the 13th month holding other variables in the entire system constant is given by:

$$(3)\quad (\partial QD / \partial Adv_j)_{13months,\,cum} = \partial QD / \partial Adv_t + \sum_{i=1}^{12} (\partial QD / \partial QD_{t-i} * \partial QD_{t-i} / \partial QD_{t-i-1} * \partial QD_{t-i-1} / \partial Adv_{j,t-i-1}) + (\partial QD / \partial QD_{t-1} * \partial QD_{t-1} / \partial QD_{t-13} * \partial QD_{t-13} / \partial Adv_{j,t-13} + \partial QD / \partial QD_{t-12,1st-year} * \partial QD_{t-12,1st-year} / \partial QD_{t-13} * \partial QD_{t-13} / \partial Adv_{j,t-13})$$

In Equation (3), the advertising carry-over effects in the thirteenth-month can be added to the cumulated carryover effects of the first marketing year. Cumulated advertising carryover effects for subsequent periods are obtained by continuing to differentiate the above equation through time and continuing to accumulate the results.

2.2 Adlines Response

In terms of print media (newspaper ads), the Commission partially covers the cost of apple ads in print media used by retailers. These expenditures are not included in the demand model because considerably more information regarding size of ad as well as ad attributes (logos, color and illustrations) is available and was used to refine the analysis of the effects of this type of promotion activity. The size of print ad is measured in terms of the number of lines appearing in an ad as measured in standard newspaper lineage (ad lines).

To determine the impact of ad buys on retail demand and, later, on derived benefit-cost ratios, an ad line-ad buy linkage equation (4) is formulated and estimated:

$$(4)\quad Adlines_{tr} = bo + b_1 Adbuys_{tr} + b_2 Adlines_{tr-1} + b_3 Adlines_{tr-12} + b_4 \text{Pretail}_{tr-1} + \sum_{i=1}^{11} B_{5i}\, Season_i$$

where : b_i are parameters to estimate, for i = 0, 1, 2…,5;

$Adlines_{tr}$ ≡ the weighted number of ad lines appearing in month *t*, region *r*;

$Adbuys_{tr}$ ≡ the total amount of ad buy expenditures authorized by WAC in month *t*, region *r*, expressed in real terms;

$Adlines_{tr-1}$ ≡ the weighted number of ad lines lagged one period;

$Adlines_{tr-12}$ ≡ the weighted number of ad lines lagged twelve periods;

$Pretail_{tr-1}$ ≡ the regular retail price lagged one period and expressed in real terms in month *t*, region *r*;

$Season_i$ ≡ January, February,…, December indicator variables to account for seasonal effects.

Equation (4) is needed because retailers do some level of newspaper advertising beyond the advertising supported by Commission funding. However, the ratio of the Commission supported ads to total ads is unknown.

In Equation (4), ad buys are expected to have a positive effect on the number of weighted ad lines in period t. Also, it is hypothesized that the number of ad lines in a specific period would depend on how much advertising is conducted in the previous month and one year earlier. Therefore, ad lines lagged one period and ad lines lagged 12 periods were both included in the model and are expected to have positive impacts on current ad lines.

Regional retail prices are also included in the lines equation so as to examine the effect of retailer participation in response to changing retail prices. It is hypothesized that when regular retail prices decrease, retailers advertise more. Equation (4) is specified on a regional basis to account for any regional differences in the number of ad lines placed during the year. Also, it is hypothesized that the industry would tend to advertise more in the fall and winter months relative to spring and summer for two reasons: the new crop becomes available in the fall, and because of the Christmas holidays. September is the base period for seasonality.

2.3 The Supply and Price Transmission Models

During the period of study (September 1990 through August 2000), the Washington Apple industry was exposed to factors that exerted a direct impact on supply response. Among those factors are seasonal effects, the Mexican devaluation, Asian economic crisis, and inventory levels, to mention a few. Each factor was thought to impact month-to-month decisions in terms of product allocation in domestic markets. Hence, the supply of Washington apples is empirically modeled as:

$$(5) \qquad QSW_t = \begin{pmatrix} PFR_t, PFR_{t-1}, POM_t, POM_{t-1}, w_t, T_t, T_t^2, T_t^3 MC_t, \\ AC_t, LCRP_t, IMI_t, EX_{t-1}, u_t \end{pmatrix}$$

where:

$QSW_t \equiv$ the total quantity of fresh apples supplied to the domestic market in month *t*;

$PFR_t \equiv$ expected F.O.B. price per pound of fresh apples in month *t*;

$POM_t \equiv$ the prices from alternative markets such as the export market and the processing sector, in month *t*, expressed in dollars per pound;

$w_t \equiv$ a matrix of input costs for producing and warehousing fresh apples in month *t*, expressed in nominal terms;

$T_t, T_t^2, T_t^3 \equiv$ a polynomial time trend to capture seasonal consumption patterns, where $T_t = 1$ *in January*,...,$T_t = 12$ *in December;*

$MC_t \equiv$ Mexican crisis affecting aggregate supply to domestic markets and proxied by the Mexican exchange rate in month *t*;

$AC_t \equiv$ Asian crisis affecting aggregate supply to domestic markets and proxied by exchange rates in month *t*;

$LCRP_t \equiv$ an indicator variable for large crop years (1994, 1996 and 1998)

$IMI_t \equiv$ the beginning inventory in month *t*;

$EX_{t-1} \equiv$ total exports lagged one month;

$u_t \equiv$ the error term that captures effects of variables not included in the model.

The retail-FOB price transmission equation models the relationship between retail and FOB prices and is used later to evaluate the impact at the FOB level of the array of promotion programs conducted by the industry. The model includes: 1) a PC sales variable (accumulated PC sales over time and depreciated over three year period term) that is used to test the hypothesis that advances in information technology in the retail sector has had a negative effect on retail price; 2) the Asian crisis and Mexican crisis variables are included in the supply equation under the hypothesis that if they had an effect on domestic supply, the increased surplus on the domestic market would cause retail prices to decrease due to the initial disequilibria that occurs between pre-existing demand and supply. Hence, the price transmission equation is empirically approximated as follows:

(6) $$Pretail_{tr} = \alpha + \sum_{r=1}^{5} b_{1r}(RI_r * Pretail_{t-,1,r}) + \sum_{r=1}^{5} b_{21r}(RI_r * PFI_t) +$$

$$\sum_{r=1}^{5} b_{22r}(RI_r * PFF_t) + \sum_{r=1}^{5} b_{3r}(RI_r * TC_t) + \sum_{r=1}^{5} b_{4r}(RI_r * Wage_t + \sum_{r=1}^{5} b_{5r}(RI_r * PCsales_t) +$$

$$b_6 * MC_t + B_7 * AC_t + \sum_{i}^{11} b_8 Seasonality_i$$

Where:

$\alpha, b_{j1}, b_{j21}, b_{j22}, b_{j3}, .. bj_5, b_6, b_7, b_8$ estimated parameters,

$Pretail_{tr}$ ≡ the nominal retail price per pound of Washington apples in region *r*, month *t*, expressed in nominal terms;

RI_r ≡ regional indicator variables, $j = 1,2,\ldots,5$. Where 1 is for the Midwest, 2 for the Northeast, 3 for the Southeast, 4 and 5 for the Southwest and West, respectively;

$Pretail_{t\text{-}1r}$ ≡ the nominal lagged retail price per pound of Washington apples in region *r*;

PFI_t ≡ a vector of cumulative increases in the nominal F.O.B. price per pound of fresh apples in month *t*;

PFF_t ≡ a vector of cumulative decreases in the F.O.B. price per pound of fresh apples in month *t* and expressed in nominal terms

TC_t ≡ a U.S. transportation cost index in month *t*;

$Wage_t$ ≡ a U.S. retail wage index in month *t*;

MC_t ≡ a variable to capture the Mexican crisis effects and is proxied by the exchange rate in month *t*;

AC_t ≡ a variable to capture the Asian crisis effects and is proxied by a weighted exchange rate in month *t*;

$PCsales_t$ ≡ the total nominal value of cumulated and depreciated personal computer sales in the U.S. in month *t*;

Seasonality ≡ indicator variables for each month of the year, where 1 is for January,…, and 12 is for December.

In the above model, retail price stickiness is tested through the lag of the dependent variable. Asymmetry in retail price response with respect to FOB price changes is examined through the method suggested by Kinnucan and Forker.

2.4 Average Industry Returns

Once the supply, demand, ad line-ad buy, and price transmission relationships were estimated, each month's equilibrium conditions and other endogenous variables in the system (e.g., ad lines and retail prices) were solved simultaneously. The exogenous variables were evaluated at their historical monthly levels except for those variables that were directly affected by the endogenous variables (e.g. shipments and inventories), which also were solved simultaneously. The monthly results were then used to solve the next month's results in an interactive fashion. Once the equilibrium was determined for the entire period of analysis, revenues with advertising and revenues under simulated scenarios of no advertising were computed and summed across months within a year. The differences in annual revenues with and without advertising were then divided by the annual difference in the cost of the advertising programs. The outcome is a benefit-cost ratio, which is used as the basis for determining average industry returns to advertising and promotion.

3. Results

3.1 Demand Model

Except for the polynomial time trend used to capture seasonal patterns in consumption, the final demand model was linear in all of the variables and in their respective parameter estimates. The model was estimated using 2SLS. The endogenous variables in the final model were total quantity shipped of the five varieties (Red and Golden Delicious, Granny Smith, Gala, and Fuji), retail price, promotional price of Washington apples, the current month's trade category expenses, and the current month's ad lines. The R^2 for the second stage is reported in Table 1. The Durbin h test reported in Table 2 suggests that no autocorrelation is present. Descriptive statistics and coefficient estimates from the second stage of 2SLS are also reported in Table 1.

3.1.1 Price Promotion Effects

The retail price and the promotional price coefficients were found through a Wald test to be insignificantly different. Therefore, a single weighted measure of the form ($P_{retail_{tr}}*(1-adexp_{tr}) + Adprice_{tr}*adexp_{tr}$) was created to replace the individual variables in the final demand equation. The weighted price is expressed as price per pound in real terms. The mean value of the new weighted price per pound is 0.564 cents. The marginal effects of either type of price change are the same, suggesting that a dollar increase (a dollar decrease) in either price, in a given region, would decrease (increase) monthly regional demand by the value of 229,262 pounds per million people[3]

The retail price elasticity is -0.113 percent while the corresponding promotional price elasticity is –0.06 percent (Table 7).

3.1.2. Effects of Non-Price Promotional Efforts

Based on the outcome of a Wald test, demos, displays, and giveaway products were aggregated into one category (trade category). Similarly, radio and TV were aggregated into a single category (non-trade category) according to the results of the Wald test. Both categories had significant and positive impacts on the demand for Washington apples. Table 7 shows the corresponding elasticities.

Other promotional expenditures such as food service, trade, billboards, and Run on Press (these are the ads produced directly by W.A.C. and supplied to retailers) did not have individual statistically measurable impacts on the demand for Washington apples. Thus, these variables were removed from the final model. Ad lines had a positive effect on regional demand.

Regarding logos and color ads (Table 1), throughout the estimation process, expressing the demand equation as a function of total number of logos and total color ad lines created multicollinearity problems, hence, the proportion of logos and the proportion of color ads were used and had positive and significant additive effects on the demand for Washington Apples.

Lag structures were also tested throughout the modeling process. Only the non-trade strategy category lagged one-month was significant. The lags of the other promotional activities were non-significant.

3.1.3 Persistent Preferences and Promotional Effects

Cumulative promotion effects on current demand were induced by persistent preferences (Table 1). The previous month's consumption of apples was positively related to the current month's consumption. Also, apple consumption in the corresponding month of the previous year was also positively related to the consumption of apples in the current month. The significance of the lagged quantity variables (quantity lagged one period and quantity lagged twelve months) implies that additional returns accrue to promotion activities in the long run as compared to the short run.

3.1.4 Other Factors Affecting Demand

The regional income variables (RINC) in Table 1 were highly correlated amongst each other. Principal component analysis was used to mitigate the multicollinearity problem. The income variable coefficients associated with the principal component scores were positive and significant across regions indicating that apples are normal goods and as income rises, a greater quantity of apples is demanded. Note that the t-values across regions are the same because only one principal component was used to represent the collinear income variables.

Substitutes in the final demand model (Table 1) were imported apples, Michigan and New York apples, imported and domestic pears, and imported bananas. The Wald test indicated that the effects of Michigan and New York shipments were insignificantly different, and these variables were combined in the final model. An increase (decrease) in Michigan and/or New York shipments reduces (increases) demand for Washington apples.

The imported apple price effects were measured in interaction with March, April, and May, which are the months when imports are most pronounced and when domestic shipments of Washington apples are higher relative to the rest of the season. Import price interacted with the months of June and July were also tested, but the effect was non-significant. The coefficient sign for the imported apple price interacting with March, April, and May was positive as hypothesized. The magnitude of estimate was 129,408.70 indicating that as price increases (decreases) by a dollar, demand for apples would increase (decrease) by 129,408.70 pounds.

Imported and domestic pear prices also had the hypothesized sign and they were significant in magnitude. These variables were introduced in the model as the simple average of both prices. A volume weighted measure of both prices was tested, but it was non-significant. The coefficient for the CIF price of bananas was also significant and positive as initially hypothesized.

Seasonality of demand was also evident across months within a marketing year (Table 1). By adding the seasonal time trend (T_t, T_t^2, T_t^3) and evaluating it at each month of the year (1 for January, 2 for February, ..., 12 for December), differences in demand across seasons is apparent. Differences in consumption patterns throughout the U.S. were also detected in the final results. In addition to the polynomial time trend, the overall yearly time trend (YT) included in the model to capture secular changes in demand over time was also found to have a negative impact on the current month's demand for Washington apples. The negative coefficient for the time trend variable potentially reflects the emergence of more diverse eating habits and the growing demand for specialty and ethnic fruits over time.

3.2 Adlines Model

Each regional ad lines equation, as specified in (4), was estimated using OLS. This method was used because all variables used to describe the behavior of ad lines were considered predetermined, including ad buys. The Hausman test for endogeneity was non-significant, supporting OLS as the appropriate regression technique. The R^2 ranged from 0.77 to 0.82 suggesting the exogenous variables in each equation explained most of the variation in ad lines. The autocorrelation tests were insignificant for all equations.

All variables in each of the equations were expressed in linear form. The ad lines observations contained unexplained outliers. Therefore, indicator variables for the months in which these outliers occurred were added to the model. The anomalous outliers were not consistent across regions so the indicator variables for the outliers vary across equations (regions). Results for each individual equation are shown in Tables 2 through 6.

According to the results in Tables 2 through 6, specific inferences can be made with respect to the manner in which ad lines appear in a region and their relationship with the WAC's ad buys/print media expenditures. These inferences are the following:

1) The coefficients of ad buys and the level of ad buy expenditures for the Midwest and Southeast region are higher relative to the other regions. The ad lines-ad buys elasticity evaluated at the mean level for both regions were 0.24 and 0.37, respectively.
2) The ad line-ad buy elasticity evaluated at the mean level for the Northeast and West region were 0.14 and 0.21 respectively.
3) The Southwest region had the lowest coefficient and lowest level of ad buy expenditures among all regions. The elasticity evaluated at the mean level was 0.10 percent.
4) These elasticities reflect the level of funding the commission contributes to overall print media.
5) The number of ad lines used in the current period depends on the number of ad lines that were used in the past month for all regions. Ad lines lagged 12 periods were not a significant factor in explaining current period ad lines.
6) Fewer ad lines are run in late spring and in early summer in each marketing year in all regions.
7) More ad lines were used in marketing years of 1997 and 1998 in all regions relative to other marketing years.

3.3 The Supply Model and the FOB-Price Transmission Model

Each coefficient significance level supported our a priori hypotheses. The R^2 of the supply model (0.810) indicated that most of the variability occurring in quantity supplied was explained by the variability of the explanatory variables (Table 8).

Among the results for the supply equation, the most intriguing one is that the lagged FOB price parameter estimate was negative (Table 8). However, when both the current month and past month

effects are jointly analyzed[1] the results make sense from the packer's perspective. Rising F.O.B. prices (both current and lagged) will cause an increase in the current month's volume shipped. However, the increase will be muted as some packers anticipate further price increase and attempt to restraint sales to take advantage of those anticipated price increases in the future.

Conversely, a declining F.O.B. price will reduce the current month's quantity supplied. However, the decrease will be partially offset as some packers anticipate further declines and attempt to move additional quantities before profits vanish.

Logically, when lagged price and current price move in opposite directions, the effect of the current FOB price on quantity supplied is amplified by the lagged price effect. Mixed price signals may increase packer's uncertainty about the future causing an exaggerated response to current market conditions.

Results for the price transmission equation are shown in Table 9. Results for all variables are as initially hypothesized. The "price stickiness" of retail prices was confirmed. Moreover, the relationship between retail and FOB prices was found to be asymmetric, with retail price response to increases and decreases in the FOB prices being statistically different in magnitude.

3.4 Industry Returns

Benefit cost ratios pertaining to this analysis are shown in Table 10. For all years, benefits were greater than one indicating that for each dollar invested in advertising and promotion, the industry received more than a dollar in increased returns. However, trade-merchandising activities, including the ad-buys/print media multiplier, were greater relative to the non-trade activities.

4. Conclusions

This paper developed a monthly domestic demand and supply equilibrium model for Washington apples that can be used to assess the effectiveness of price and non-price promotional activities. The econometric methodology employed took into account market differences across the U.S. and is based on data pertaining to individual retail stores located throughout the U.S. The period of analysis is from September 1990 through August 2000 on a regional basis.

A unique feature of the model is its explicit allowance for multiplier effects to exist between the level of generic advertising expenditures provided by the Washington State Apple Commission in support of apple demand and supplementary funds provided by retailers in support of apple promotion, specifically through print media ads.

[1] The authors examined several models of supply. The final model presented in this article appeared to be the most defensible when considering both statistical and economic implications of the results.

In particular the model allows for the fact that Commission funds oftentimes represent only a relatively small fraction of the overall print media expenditures made in support of apple sales, and that Commission funds are often effectively only "pump priming" or serve as inducements for additional promotional activities by other entrepreneurs in the marketing chain. Also, the subset of promotional activities (print media and price reductions) provided by retailers is modeled in a dynamic fashion, whereby market conditions feedback affect the level of promotion that retailers contribute in support of apple demand.

Results of this analysis indicate that, in the aggregate, price promotion is a significant factor positively impacting apple sales. Furthermore, price promotional elasticities were relatively high when compared to non-price promotional activities, leading to a conclusion that greater gains with respect to returns on promotional investment may occur when retail price reductions are pursued.

The relative importance of price promotions is particularly salient given the price stickiness observed in this model. Reducing price at the FOB level does not result in an immediate reduction in price at the retail level. Further, the retail price decline, when it does occur, does not reflect the full decline that occurred at the FOB level.

It is commonly believed within the Washington industry that retailers tend to establish an "everyday" price at the beginning of the season and maintain that price as long as it remains within some acceptable range of competitor prices. Assuming this belief to be a reasonable reflection of reality, the results of this model imply that a key WAC activity would be to attempt to influence the initial prices set at retail in light of the projected crop size.

Despite an increased domestic supply and the effects of the Mexican and the Asian crises, among the non-price promotional activities, results indicated that both non-trade (TV and Radio) and trade-related efforts (in store demonstrations, shippers display, and products give-away, ad buy-print media expenditures) have contributed to increased demand for Washington apples. When scenarios of varying levels of expenditures made in each type of these specific promotional activities were examined, it was found that the trade-related activities were more effective in increasing demand at current expenditure levels relative to the non-trade activities. Promotional efforts in the form of billboards, food service expenditures, and other miscellaneous activities, which the industry also used during the period of analysis, did not have a measurable impact on demand in any of the regions.

Regarding the Commission ad buy-print media expenditure multiplier effect, it was found that the Commission's promotional efforts in this specific promotional outlet in fact did constitute only a relatively small fraction of the overall print media efforts by retailers. While the direct effect of Commission expenditures on demand would be relatively small without the supplementary efforts forthcoming from retailers, the fact that retailers multiplied the Commission's expenditures into a

substantially larger promotional effort resulted in a substantially positive effect on apple sales when viewing the promotion program as a whole.

Results also suggest that promotional efforts in the form of billboards, food service expenditures, and other miscellaneous activities alone did not have a significant impact on demand in any of the regions analyzed. The effects of income from current results combined with slow population growth (Cateora, p.68) suggest that a slow growth in demand for Washington apples has been observed in the last eight years.

Substitutes for Washington apples were imported apples, domestic and imported pears, shipments from Michigan and New York. Imported apples had a significant impact on demand only in the months of March, April, and May. Imports of apples and domestic shipments of Washington apples combined are pronounced in these months relative to the other months of a marketing year.

Another finding of the study is that consumers across the U.S. should not be treated homogeneously. In this study, regional differences in demand patterns were apparent. Consumers from the Northeast, Southeast, and Midwest were found to demand fewer Washington apples relative to consumers in the West and the Southwest. Unfortunately, the reasons for these differences are unknown.

Endnotes

[1] Details on variable development are found in Van Voorthuizen

[2] After several pre-runs, indicator variables were the most statistical defensible way to proceed.

[3] In the modeling process, population was expressed in millions. E.g. the Northeast population size is 52.0 million people.

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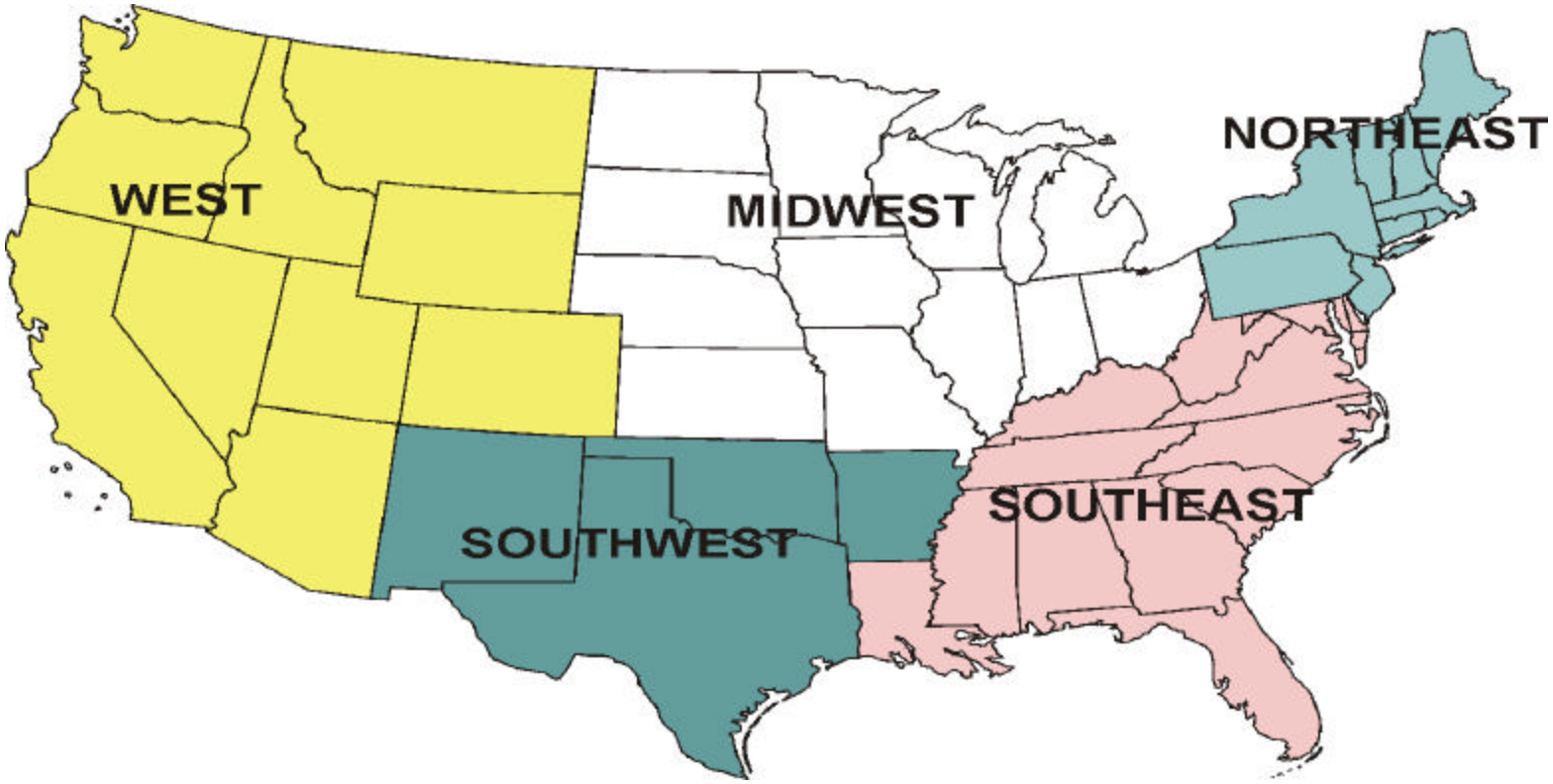

Figure 1. U.S. divided by regions

Table 1. Statistical results for the demand equation

Variable name	Mean Value	Standard Deviation	Parameter Estimate	T for H_O: Parameter = 0
$(P_{retail_{tr}}*(1\text{-}adexp_{tr}) + Adprice_{tr}*adexp_{tr})$ in real terms	0.564	0.069	-229,262	-2.44
(QDW_{t-1}/POP_{t-1})[a]	726,356.00	245,964.00	0.12	3.83
(QDW_{t-12}/POP_{t-1})[a]	729,628.00	246,169.00	0.39	11.99
Mid-West RINC[a]	14,484	714.85	2.19	2.79
North-East RINC[a]	17,684	1,117.90	3.45	2.79
South-East RINC[a]	14,377	711.98	2.02	2.79
South-West RINC[a]	14,411	963.49	2.91	2.79
West RINC[a]	16,203	685.77	1.90	2.79
CIF for bananas (real terms)	0.08	0.01	1,054,830.00	1.70
Simple average of Price of pears (real terms)+import price of pears (real terms)	0.26	0.16	78,099.38	2.06
Import price of Apples (real terms) in March, April, and May	0.05	0.08	129,408.70	2.04
QNY (in lbs)[a] + QMI (in lbs)[a]	798,161.00	528,729.00	-0.03	-3.04
Ad lines	2,927.30	2,219.40	16.53	4.77
Logos/Ad lines	0.76	0.18	66,249.25	3.30
Color/Ad lines	0.80	0.16	98,174.66	6.94
Non-trade expenditures in real terms lagged one period[a]	48.14	56.52	2.81	1.960
Trade expenditures (real terms)[a]	2,264.70	2,994.90	223.85	2.39
Other promotional expenses (real terms)[1 a]	21.49	128.10	76.29	1.90
Midwest indicator variable			-95,320.80	-6.16
Northeast indicator variable			-91,161.60	-5.11
Southeast indicator variable			-79,184.40	-4.87
West indicator variable			90,714.02	4.85
Indicator variable for the 98 crop year			74,517.12	5.69
YT			-2,276.97	-5.89
T			38,196.44	1.85
T^2			-8,692.57	-2.23
T^3			474.36	2.29
Indicator variable for December of each marketing year			108,594.90	3.90
Indicator variable for March of each marketing year			67,054.77	4.99
QDW/POP (dependent variable)	727,389.00	246,163.00		
POP (Regional population in millions)	52.61	12.67		
Regional CPI for food items	1.53	0.12		
R^2 =0.99 N = 575		Durbin h test = 2.98		

[1] Refers to different trade related efforts realized altogether but segregation were not possible while organizing the data for analysis.

[a] Per million people

Table 2. Statistical results for the ad lines equation (Midwest region)

Variable name	Mean Value	Standard Deviation	Parameter Estimate	T for H_O: Parameter = 0
Intercept			7,025.27	4.19
Ad buy expenditures	12,273.80	6,406.00	0.06	2.63
Lines lagged one period	3,313.70	2,444.10	0.43	5.96
Retail price lagged one period	0.64	0.05	-8,331.64	-3.38
Indicator variables for the months				
April			-846.04	-2.08
May			-1,641.23	-4.20
June			-2,126.07	-5.12
July			-1,120.60	-2.60
August			-1,025.12	-2.41
Indicator variables for the Marketing year				
1992			-1,766.68	-4.12
1993			-539.29	-1.33*
1994			-569.38	-1.33*
1995			1429.62	3.27
1997			834.53	1.92
1998			3,640.04	3.03
1999			2,688.06	2.24
October of 1997 marketing year				
March of 1998 marketing year				
Ad lines (dependent variable)	3,310.600	2,445.8		
CPI for food items	1.52	0.12		
$R^2 = 0.81$ N = 113	Durbin h test = 0.71			

* Non significant at the 0.10 level

The Base period for the monthly indicator variables and marketing year indicator variables are those months (years) not appearing in these results.

Table 3. Statistical results for the ad lines equation (Northeast region)

Variable name	Mean Value	Standard Deviation	Parameter Estimate	T for H_O: Parameter = 0
Intercept			411.67	2.30
Ad buys expenditures	10,461.9	7,468.4	0.02	2.30
Lines lagged one period	1,646.50	1,240.60	0.46	7.45
Indicator variables for the months:				
January			467.04	2.30
May			-397.31	-2.04
June			-644.91	-3.21
July			-413.38	-1.99
August			-393.01	-1.87
Indicator variables for the Marketing Year:				
1996			279.69	1.49*
1997			1,022.95	4.65
1998			1,045.94	4.32
1999			344.33	1.61*
January and February, 1994			2,323.28	5.23
October 1998			2,473.73	4.15
October 1999			1,606.11	2.70
Ad lines (dependent variable)	1,643.20	1,243.70		
CPI for food items	1.57	0.09		
$R^2 = 0.82$ N = 115		Durbin h test = 0.63		

* Non significant at the 0.10 level

The Base period for the monthly indicator variables and marketing year indicator variables are those months (years) not appearing in these results.

Table 4. Statistical results for the ad lines equation (Southeast region)

Variable name	Mean Value	Standard Deviation	Parameter Estimate	T for H_O: Parameter = 0
Intercept			768.94	2.22
Ad buys expenditures	11,826.90	6,507.5	0.12	5.26
Lines lagged one period	3,788.70	2,465.80	0.33	5.13
Indicator variables for the months:				
October			1,844.82	4.39
May			-844.54	-2.12
June			-551.03	-1.28*
Indicator variables for the Marketing year:				
1992			-1,271.89	-3.09
1993			-924.74	-2.26
1996			1,093.73	2.77
1997			2,720.33	5.86
1998			1,977.17	4.60
1999			1,097.25	2.64
February of 1992			-1,689.45	-4.23
December of 1994			3,870.72	3.14
Ad lines (dependent variable)	3,742.30	2,444.40		
CPI for food items	1.57	0.12		
$R^2 = 0.79$ N = 115		Durbin h test = 0.54		

* Non significant at the 0.10 level

The Base period for the monthly indicator variables and marketing year indicator variables are those months (years) not appearing in these results.

Table 5. Statistical results for the ad lines equation (Southwest region)

Variable name	Mean Value	Standard Deviation	Parameter Estimate	T for H_O: Parameter = 0
Intercept			2,226.37	3.13
Ad buys expenditures	6,227.40	3,723.90	0.03	1.83
Lines lagged one period	1.909.90	1,115.30	0.20	2.68
Lines lagged two periods	1,933.70	1,115.70	0.16	2.26
Retail price lagged one period	0.62	0.06		
Indicator variables for the months:			-1,564.72	-1.51
May			-842.49	-4.25
June			-819.06	-4.02
July			-814.94	-3.86
August			-527.51	-2.29
Indicator variables for the Marketing year:				
1992			-823.19	-3.96
1993			-526.59	-2.50
1997			314.39	1.55
1998			225.49	1.08*
March of 1993			1,660.62	2.72
December of 1994			1,588.69	2.67
October of 1997 and 1998			3,034.70	6.94
February of 1998			1,218.06	2.01
Ad lines (dependent variable)[a]	1895.10	1,117.00		
CPI for food items	1.48	0.11		
$R^2 = 0.77$ N = 115				

* Non significant at the 0.10 level

[a]The error term ($u_t = y_t - bX_t$) was also regressed against the variables shown in this table and u_{t-1}. The pvalue of u_{t-1} was 0.261 indicating no problems of autocorrelation.

The Base period for the monthly indicator variables and marketing year indicator variables are those months (years) not appearing in these results.

Table 6. Statistical results for the ad lines equation (West region)

Variable name	Mean Value	Standard Deviation	Parameter Estimate	T for H_O: Parameter = 0
Intercept			3,716.07	10.61
Ad buys expenditures	9,652.9	6,159.40	0.09	4.57
Lines lagged one period	4,131.70	2,288.90	0.17	2.62
Indicator variables for the months:				
November			-918.99	-2.32
December			-710.09	-1.88
April			-1,038.08	-2.60
May			-2,684.60	-7.39
June			-2,938.27	-7.65
July			-3,388.43	-8.46
August			-3,063.24	-7.38
Indicator variables for the Marketing year:				
1992			-1,140.40	-3.42
1995			-978.84	-2.76
1997			730.06	1.97
1998			1,034.09	2.98
April 1995			4,588.36	4.22
March 1997			2,752.03	2.53
October of 1997			2,761.67	2.43
October of 1998			1,884.04	1.73
Ad lines (dependent variable)	4,075.80	2,281.50		
CPI for food items	1.53	0.12		
$R^2 = 0.83$ N = 115		Durbin h test = 0.48		

The Base period for the monthly indicator variables and marketing year indicator variables are those months (years) not appearing in these results.

Table 7. Estimated demand elasticities

	Mean Value	Elasticities
Quantity demanded in pounds per million people	727,389	
Own price elasticity (real terms):		
Pretail * (1-adexp)	0.641*0.56	-0.113
Adprice*adexp	0.462*0.44	-0.064
Total own price elasticity	0.56	-0.177
RINC (real terms)		
Midwest	14,484	0.04
Northeast	17,684	0.08
Southeast	14,377	0.04
Southwest	14,411	0.06
West	16,203	0.04
Cross price elasticity, Washington apples with:		
Banana[1]		0.12
U.S. pears	(0.120)	0.006
Imported pears	(0.406)	0.021
All pears	0.262	0.027
Imported apples	0.048	0.008
Cross quantity elasticity (quantities expresses per million people):		
WA-New York apples	333,308	-0.012
WA –Michigan apples	466,444	-0.018
Total WA- New York and Michigan apples	799,752	-0.030
Advertising and Promotion elasticities (expressed in real terms and per million people):		
TV	1460.80	0.006
Radio	803.90	0.003
Total Non-trade strategy (TV and Radio)	2,264.70	0.009
Demos	10.86	0.003
Display	27.59	0.008
Give-Away products	9.69	0.003
Total trade Strategy (demos, display, give-away products)	48.14	0.014
Other promotional expenses	21.47	0.002
Ad Lines	2927.30	0.066
Proportion of ad lines containing a logo	0.759	0.069
Proportion of ad lines in color	0.795	0.107
Proportion of Fuji	0.031	0.022
Proportion of Gala	0.205	0.069

Table 8. Statistical results for the supply function

Variable name	Mean Value	Standard Deviation	Parameter Estimate	T for H_O: Parameter = 0
Intercept			65.313	1.310*
PFR_t (F.O.B. price)	0.331	0.049	498.261	3.900
PFR_{t-1}	0.329	0.057	-219.301	-3.220
Inventories in millions of lbs.	2229.000	1337.900	0.007	2.450
Exports lagged one period in millions of lbs.	82.629	30.739	-0.278	-2.750
Apple producer prices paid index	1.032	0.178	-45.134	-2.590
Processing price per lb. lagged one period	0.053	0.045	-339.090	-2.880
T	6.500	3.467	78.508	8.580
T^2	54.167	46.292	-17.234	-11.970
T^3	507.000	553.900	0.949	13.710
Mexican exchange rate X Mcrisis[a]			1.642	2.210
Weighted Asian Exchange rates	17.408	1.713	2.341	1.890
Large crop year indicator	0.300	0.460	37.915	7.330
Indicator for November and December of 1993 and January and February of 1994 (calendar year)			-25.546	-2.240
Total supply in millions of pounds (Dependent Variable)	198.7	40.519		
R^2 = 0.812 N =119			Durbin-Watson Test = 1.881	

* Non significant at the 0.10 level

[a] Mcrisis is an indicator variable with 1 from January 1995 through August 1995 (calendar year), 0 otherwise.

Table 9. Statistical results for the Retail-F.O.B. price transmission Equation

Variable name	Mean Value	Standard Deviation	Parameter Estimate	T for H_O: Parameter = 0
Intercept			-0.243	-0.890*
$Pretail_{t-1}$*Midwest indicator	0.204	0.400	0.150	1.260*
$Pretail_{t-1}$*Northeast indicator	0.213	0.440	0.096	1.200*
$Pretail_{t-1}$*Southeast indicator	0.195	0.399	0.351	3.310
$Pretail_{t-1}$*Southwest indicator	0.185	0.374	0.234	2.890
$Pretail_{t-1}$*West indicator	0.194	0.385	0.345	3.630
Accumulative increases in F.O.B. prices (PFI)	0.686	0.302	1.018	9.180
Accumulative decreases in F.O.B. Prices (PFF)	-0.693	0.316	0.928	8.360
Wage x Midwest indicator	0.903	1.767	0.119	2.340
Wage x Northeast indicator	0.827	1.706	0.120	2.490
Wage x Southeast indicator	0.838	1.713	0.104	2.090
Wage x Southwest indicator	0.864	1.735	0.115	2.350
Wage x West indicator	0.890	1.757	0.070	1.440
Transportation cost (TC) x Midwest	0.882	1.723	0.115	2.880
Transportation cost x Northeast	0.816	1.678	0.155	3.500
Transportation cost x Southeast	0.827	1.687	0.088	2.050
Transportation cost x Southwest	0.849	1.702	0.092	2.270
Transportation cost x West	0.871	1.716	0.114	2.740
Mexican Crisis indicator (MC)			-0.006	-2.060
PC sales$^{0.05}$	1.509	0.448	-0.034	-3.200
October			0.031	1.860
November			0.054	3.060
December			0.055	2.970
January			0.070	3.850
February			0.076	4.190
March			0.077	4.060
April			0.080	3.950
May			0.108	5.00
June			0.118	5.340
July			0.071	3.230
August			0.079	0.021
Retail Prices (Dependent variable)	0.990	0.1086	Durbin h = 2.15	
R2 = 0.715 N =359				

*Non significant at the 0.10 level

September is the base period for the monthly indicator variables.

Table 10. Simulated Average industry returns for the non-price promotional efforts

Marketing Crop Year	Trade Activities	Non-Trade Activities
1992	17.83	2.42
1993	22.67	3.07
1994	25.59	3.63
1995	28.35	4.20
1996	28.99	3.48
1997	30.02	3.91
1998	30.26	2.15
1999	39.62	2.64

Trade activities includes demos, display, give-away products, ad buys/print media, and other promotional activities
Non trade activities includes TV and Radio

Appendix Table 1 Data sources

Information from the Industry:	Specific Source:
Domestic shipments and Exports	USDA, Federal Inspection Service, Unloads Reports provided by W.A.C.
Regular retail price	W.A.C.. "Marketvu" reports
Ad price, ad exposure, ad lines, ad with logos and ad lines in color, market shares, account shares	Ad Activity Report of a subsidiary of Leemis Marketing provided by W.A.C.
Advertising Expenditures	W.A.C.. Requisition reports and McCann Erickson. Internal data
Information from other Sources:	Specific Source:
State disposable Personal Income	U.S. Department of Commerce, Bureau of Economic Analysis
State population	U.S. Department of Commerce, Bureau of Census
Import data	USDA, FAS World Horticultural Trade and U.S. Export Opportunities Report. Various issues
Michigan, California, and New York Domestic Shipments	USDA, Agricultural Marketing Service, Fresh Fruit and Vegetable Shipments, Various issues
Return to growers for pears	USDA, ERS, Fruit and Tree Nuts Annual Report. Various issues
Consumer price index for non food items	U.S. Department of Commerce, Bureau of Labor Statistics (see references for Series ID)
Producer Price index for TV and Radio Broadcasting and newspaper publishing	U.S. Department of Commerce, Bureau of Labor Statistics (see references for Series ID)
Wages and transportation index	USDA, Agricultural Outlook. Various issues
Consumer Price Index (Chicago, Dallas Miami, Los Angeles, New York, Boston, and Philadelphia	U.S. Department of Commerce, Bureau of Labor Statistics. Consumer Price Index (see references for Series ID)