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New Varieties and the Returns to Commodity Promotion: Washington Fuji Apples

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ARIZONA STATE UNIVERSITY

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Abstract

The Fuji apple variety is relatively new in the U.S. As a new product, questions concern the relative impact of consumer learning by experience, by variety-specific promotion, or by generic apple promotion. A two-stage (LES/LAIDS) model incorporating both types of promotion is used to estimate the effect of generic and variety specific promotion, as well as consumer experience, on the demand for Fuji apples. Estimates show each to have a positive impact, and also show new or specialty apple varieties to be relatively price inelastic, but income elastic. Grower returns to promotion are calculated with an equilibrium displacement model of price changes and producer surplus. Changes in producer surplus provide a base-scenario benefit:cost ratio of 14.73.

keywords: apple demand, experience, LAIDS, new products, producer surplus, promotion, varieties.

New Varieties and the Returns to Commodity Promotion: Washington Fuji Apples

Introduction

Calendar year 1997 was the "Year of the Fuji." The Fuji is an apple variety noted for its sweet taste and crisp texture, and is the leading variety in many Asia markets, particularly Japan, Korea, and China. Developed in Japan in 1958, growers in Washington state began growing Fujis in 1990. With nearly 11,000 bearing acres, Fujis now represent the third largest variety in terms of acreage in the state, surpassing even the Granny Smith. Faced with marketing production that has increased from virtually nothing at the beginning of the decade, to 3.1 million cartons in 1995-96, and to 6.9 million in 1996-97, Washington apple growers, through the Washington Apple Commission (WAC), recognize the need for a Fuji-specific promotional campaign. This variety-specific focus is relatively unique among commodity promoters because, in many respects, it represents an attempt to establish a brand identity for what is usually regarded as a homogeneous commodity.

Consequently, there was some concern that this type of program would be as effective as previous generic-promotion efforts (Ward, 1993).[1] Apple varieties are like brands in that they identify a subset of a product category whose members are likely to share more characteristics in common with each other than other members of the category. To the extent that variety-advertising is able to build and reinforce a favorable impression of these characteristics among

[1] For purposes of this paper, "generic" promotion consists of Washington Apple Commission (WAC) marketing expenditure designed to establish the image of Washington apples in general, whereas variety-specific promotion is that amount of expenditure that can be identified as emphasizing the particular traits of one variety. "Mature" apple varieties include Red Delicious, Golden Delicious, and Granny Smith. Production of these varieties has been stable for many years.

consumers, then it is likely to be effective. However, there is some question of the viability of variety-specific promotion when quality from year-to-year is difficult to control, when many producers sell the same variety, and given evidence in the trade-press indicating that consumers are not likely to consider variety in their apple choice (*The Packer,* 1996). Like most fruits and vegetables, in this sense apples are experience goods, so purely informative promotion is not likely to be as effective as promotion designed to induce trial purchases and to build reputation. Once consumers buy a certain type of apple, their experience and word-of-mouth may be enough to establish a market for the variety. As a result, growers are justifiably concerned over the economic viability of promoting Fujis.

Therefore, the critical problems facing growers and WAC marketing officials lie in determining the relative rates of return to generic and variety-specific promotion, and in determining whether new varieties respond differently to promotion than mature varieties. Will a new variety benefit more from an established brand name strengthened through repeated generic advertising programs that focus on expanding demand for the apple category, or through variety-specific promotion that emphasizes the unique characteristics of a new variety? This question goes beyond apples as other commodity marketers seek to introduce new varieties to the market - varieties that are difficult to brand, yet are in fact significantly different from established and accepted products.

Consequently, the objective of this research is to determine the return to Washington apple growers' investments in generic and variety-specific promotion. In order to determine grower returns to each type of promotion, this paper develops a model of the Washington apple market that considers several features of retail demand and FOB-price determination: the role of consumer experience in demand growth, the dynamics of generic and variety-specific promotion, inter-variety substitution and complementarity effects, and the effect of market structure on retail-FOB price transmission. Each of these issues may significantly impact the viability of a grower-funded promotion program.

First, all products are to differing degrees search or experience goods (Nelson). Whereas purely informative advertising is not likely to be effective for experience goods, it is necessary when consumers' incur considerable costs in searching for a product that meets their needs. Moreover, the relative importance of search and experience, or learning, differs between new and established varieties (Day). As a product moves along its life cycle of growth, maturity, and decline, search activities become less important than momentum built from past sales. Second, the dynamics of promotion vary with a product's life cycle (Little). Third, if varieties are considered close substitutes by consumers, then variety-specific promotion is likely to have a cannibalistic effect on other varieties - varieties that are often grown by the same sellers of the new variety. However, if generic promotion is effective in growing the demand for apples in total, then such synergistic or brand image effects may indeed be beneficial to growers of all varieties. Even if promotion results in a positive response in retail demand, this does not necessarily mean growers benefit if there are intervening factors between retail and FOB prices.

In particular, FOB prices will be higher in relation to domestic retail prices the greater the share of production that moves into premium export markets. Margins for specialty produce also depend upon their maturity as a product. Initially, growers of a superior new variety will have some ability to command premium prices -- an advantage that disappears with maturity and increased production by other growers. Further, retail-farm margins for various farm products have been shown to be dependent upon many other factors beyond grower control, such as quality characteristics (Parker and Zilberman), market power (Sexton, Durham and Sexton, Powers 1991), sluggishness of price-transmission (Shonkwiler and Taylor, Powers 1995), or whether retail prices are increasing or decreasing (Ward 1982, Kinnucan and Forker). Models designed to calculate the return to apple promotion should consider each of these factors.

The paper proceeds by describing one such model of Fuji apple promotion - a Muth-type Equilibrium Displacement (MED) market-model that takes into account retail demand, price-transmission, grower supply and market equilibrium. The second section presents the empirical models used to trace the effect of promotion from sales of all Washington apples, to specific varieties, and finally to FOB prices through a FOB-price linkage equation. The third section describes the data used to estimate and simulate the model, and explains the specific econometric methods involved. A fourth section presents the results from each stage of the analysis. A final section summarizes these results and presents some implications, limitations, and suggestions for future research.

A Conceptual Model of Washington Apple Promotion

For the purposes of this study, grower-returns to promotion are defined in terms of the net present value of a change in producer surplus resulting from a change in promotion expenditure, relative to promotion costs. Although the effects occur simultaneously, the model is best described in stages. First, a change in promotion spending causes a change in demand at the retail level to an extent measured by the promotion-response elasticity. Second, the change in FOB price in response to this change in demand is determined by the price-transmission elasticity - or the responsiveness of FOB prices to retail price changes. Third, once filtered down to the FOB level, this change in demand causes a change in both the equilibrium quantity and price, as handlers respond to the higher price by bringing a greater supply to the market. Ultimately, the increase in demand has a greater effect on price the lower the assumed elasticity of packer supply. Fourth, once a new equilibrium is achieved, producer surplus will be higher to the extent that both price and output are higher than before the promotion. To calculate the change in producer surplus, this study requires a model of the Fuji market equilibrium.

For this purpose, changes in producer surplus are found using a simplified version of the Muth Equilibrium Displacement (MED) model (Kinnucan et al. 1995). This model solves for the simultaneous impact of a change in promotion expenditure on retail demand, export demand, FOB price, farm supply, and, ultimately, producer surplus. As interest lies in the response of each market variable to a change in promotion, all variables are expressed in terms of log-differentials. With this simplification, each parameter in the market model is an elasticity. Specifically, the partial equilibrium Fuji market model consists of equations representing retail demand:

$$d\ln \boldsymbol{Q_r} = \boldsymbol{N_r} d\ln \boldsymbol{P} + \boldsymbol{G} d\ln \boldsymbol{Z_r} + \boldsymbol{B_1} d\ln \boldsymbol{A_1} + \boldsymbol{B_2} d\ln \boldsymbol{A_2}; \qquad (1)$$

export demand:

$$d\ln \boldsymbol{Q_x} = \boldsymbol{N_x} d\ln \boldsymbol{P} + \boldsymbol{H} d\ln \boldsymbol{Z_x}; \qquad (2)$$

farm supply:

$$d\ln \boldsymbol{X} = \boldsymbol{E_s} d\ln \boldsymbol{W}; \qquad \mathbf{(3)}$$

price transmission:

$$d\ln \boldsymbol{W} = \boldsymbol{T} d\ln \boldsymbol{P}; \qquad \mathbf{(4)}$$

and market equilibrium:

$$\boldsymbol{w_x} d\ln \boldsymbol{Q_x} + \boldsymbol{w_r} d\ln \boldsymbol{Q_r} = d\ln \boldsymbol{X}; \quad \textbf{(5)}$$

while changes in producer surplus are expressed as,

$$\Delta PS = \sum_i S_i^f P_i Q_i d\ln W_i (1 + 0.5 d\ln X_i). \quad \textbf{(6)}$$

$\boldsymbol{W}$ is a vector of FOB variety prices; $\boldsymbol{X}$ is a vector of variety supplies; $\boldsymbol{P}$ is a vector of variety market prices (assuming for simplicity sake that export and retail prices are equal, or differ by some constant of proportionality that can be normalized to 1.0 without loss of generality); $\boldsymbol{Q_r}$ is a corresponding vector of retail quantities; $\boldsymbol{Q_x}$ is a vector of export quantities; $\boldsymbol{w_r}$ is the share of production sold at retail; $\boldsymbol{w_x}$ is the share sold as export; S_i^f is the grower's share of the retail dollar for the i^{th} variety; $\boldsymbol{Z_r}$ and $\boldsymbol{Z_x}$ are exogenous demand shifters in the retail and export markets, respectively; $\boldsymbol{A_1}$ is the amount of Fuji-specific promotion; and $\boldsymbol{A_2}$ is the amount of generic WAC promotion expenditure. With respect to the model parameters, $\boldsymbol{N_r}$ and $\boldsymbol{N_x}$ are matrices of retail and export demand price-elasticities, respectively; $\boldsymbol{B_k}$ are matrices of promotion elasticities for the k^{th} type of promotion; $\boldsymbol{T}$ is a vector of price-transmission elasticities; $\boldsymbol{G}$ is a matrix of demand elasticities with respect to exogenous retail factors, $\boldsymbol{H}$ is a matrix of elasticities with respect to exogenous export demand shifters; and $\boldsymbol{E_s}$ is the matrix of supply response elasticities. The elements in (1) - (6) are solved simultaneously for the change in retail price by substituting (4) into (3) and combining (1) and (2) into (5). Simplifying the result then provides a reduced form expression for the change in retail price in response to a change in either type of promotion or the other exogenous factors, such as consumer experience or apple expenditure:

$$d\ln \boldsymbol{P} = \boldsymbol{M}^{-1} \boldsymbol{G} d\ln \boldsymbol{Z_r} + \boldsymbol{M}^{-1} \boldsymbol{H} d\ln \boldsymbol{Z_x} + \boldsymbol{M}^{-1} \boldsymbol{B_1} d\ln \boldsymbol{A_1} + \boldsymbol{M}^{-1} \boldsymbol{B_2} d\ln \boldsymbol{A_2}, \quad \textbf{(7)}$$

where: $\boldsymbol{M} = \boldsymbol{E_s T} \quad \boldsymbol{w_d N_d} \quad \boldsymbol{w_x N_x}$. The resulting change in market price is then used to calculate the change in FOB price (4) and shipper supply through (3) and the change in producer surplus through (6). Comparing the present value of changes in producer surplus to the present value of the cost of its provision provides an estimate of the returns to promotion, expressed in terms of a present value benefit:cost ratio.

Kinnucan et al. describe three assumptions that may effect the accuracy of (6) as a measure of producer surplus. First, it assumes "...parallel shifts in linear demand schedules..." but "...the approximation error is probably negligible if the equilibrium displacements being considered are small..." (Kinnucan, et al p. 91). Second, the grower-assessment used to finance apple promotions is likely to shift the supply curve backward, causing some substitution to other crops. Third, if supply is not fixed, then some of the assessment incidence lies on apple consumers. To the extent that this tax-shift occurs, the surplus measure in (6) understates actual returns to promotion. The following section develops a two-stage model of consumer demand that is used to estimate the elasticities used in this simulation, incorporating promotion both at the category and variety levels.

A Two-Stage Model of Fuji Demand and Promotion

There are several reasons why a two-stage model of demand is particularly useful in evaluating the effectiveness of promotion expenditures. First, efforts to increase demand can change both the demand for an entire category, or just reallocate spending among specific products within the category (Duffy). While specific efforts may be made in promoting a particular variety of apple, consumers often fail to identify varieties or brands of any type in fresh produce (Patterson, et al.) so these efforts tend to spillover or affect the demand for related products. Second, generic messages intended to increase total apple category sales will have different effects on the sales of each variety. Once a consumer makes a decision to buy within the apple category, variety choice is ultimately made on factors perceived within the store at the time of purchase, independent of the general information provided by a generic ad. Third, these interaction effects may reduce the total value of category sales. Retailers in particular have cause for concern when promotion causes consumers to switch from high-margin to low-margin apples without a corresponding increase in category volume. Determining these effects requires a model of both category and variety demand.

To be consistent with the requirements of consumer utility-maximization, this study uses a two-stage budget allocation model. This approach assumes consumers allocate a fixed amount of income in the first-stage between apples, various other fruits, and all other consumer goods, while they allocate apple expenditure among varieties at the second-stage. Hausman uses a similar approach in estimating the demand for categories and brands of ready-to-eat cereal. Many studies of commodity promotion also use this approach to differentiate between first- and second-stage promotion effects (Goddard and Tielu, Goddard and Amuah, Richards, van Ispelen and Kagan).

Modeling the entire budgeting decision as a multi-stage process has many advantages over the alternative in that it allows for the specification of a more complete demand system, does not suffer from specification errors caused by considering each stage in isolation, and permits nested tests of the generic and variety effects of promotion. However, these advantages come at a cost of imposing a very specific structure on the demand model. Specifically, Gorman demonstrates that two-stage models can only be consistent with utility maximization by assuming preferences are homothetically separable, or that they are strongly separable into sub-branches that are of generalized Gorman polar form. Because the first alternative imposes the untenable restriction that each element of the variety (lower stage) model has unitary expenditure elasticities, this study adopts the latter. Examples of this approach include Brown and Heien, Blackorby, et al., Yen and

Roe, and Gao, Wailes, and Cramer. Specifying a demand system consistent with these restrictions also means that the price indices at the upper level are perfect price indices for each sub-group, so estimating the entire system through the iterative process of Anderson provides consistent estimates of both the structural and promotion elasticities at each level. One specification that meets these restrictions consists of an upper stage Linear Expenditure System (LES) and a lower stage Almost Ideal Demand System (AIDS).

Deaton and Muellbauer provide a derivation of the LES model which this paper extends to include promotion. Using upper case letters to denote the upper, or category, level of demand, the basic LES becomes:

$$X_I \;=\; P_I Q_I(P,Y) \;=\; \Psi_I P_I \;+\; \mathrm{B}_I\left(Y \quad \sum_J \Psi_J P_J \right), \tag{8}$$

where X_I, is the expenditure on category *I*, *Y* is per capita income, P_I is a price index defined over the components of category *I*, B_I is the marginal budget share, and Ψ_I measures the subsistence amount of expenditure on good *I*. Pollak and Wales suggest including other arguments of the utility function as scaling factors, or variables that cause the effective price faced by consumers to vary by their exposure to advertising. Defining the scaling function as:

$$M_I \;=\; 1 \;+\; \theta_I (A_I / P_I) \ln P_I, \tag{9}$$

multiplying prices in the expenditure function underlying (8) and re-deriving the demand system leads to an upper-level demand model similar to Chang and Green:

$$X_I \;=\; P_I Q_I \;=\; P_I \Psi_I \;+\; \theta_I \Psi_I A_I \;+\; \mathrm{B}_I\left(Y \quad \sum_J \Psi_J P_J \right). \tag{10}$$

For this equation to be part of a system of demand equations that is consistent with constrained utility maximization, all $\mathrm{B}_I \geq 0$, $\sum \mathrm{B}_I = 1$, and $Q_I \geq \Psi_I \ \forall \ I$. As Ehrlich and Fisher argue, advertising (A_I^* in (10)) should be considered as an accumulated stock because consumers tend to acquire information only gradually over time. By the same token, however, consumers tend to forget past advertising messages after they are taken from the air or the newspaper. These competing effects suggests an explicit consideration of the dynamic effects of advertising's growth and decay.

Often, advertising is treated as contributing to a consumer's stock of knowledge regarding a category of products. Similar to a physical asset owned by a firm, akin to goodwill or brand equity (Nerlove and Arrow), this knowledge depreciates slowly over time as it is forgotten, becomes obsolete as new products come to the market (Kotler), or is superceded by strategic promotions from oligopolistic rivals (Erickson, Sorger). Further, promotion carryover may arise for several other reasons: a threshold level of knowledge may be required before purchase initiation occurs, patterns of brand loyalty take time to establish, habits may require repeated efforts to break (Chang), or simply that the process of disseminating information is not instantaneous.[2] Irrespective of the rationalization, defining promotion as a capital asset implies that the current amount of A_I^* is a distributed lag of previous investments: $A_I = \sum_i b(i) A_{t\ i}$, where $b(i)$ are lag-weights. Similar considerations for promotion carryover enter the second-stage model.

At the second, or variety-demand stage, a linear Almost Ideal Demand System (LAIDS) satisfies the requirement for two-stage budgeting in that the implied preferences are of Gorman polar form (Deaton and Muellbauer). Blanciforti and Green summarize the advantages and

[2] Feichtinger, Hartl, and Sethi provide a comprehensive categorization of theoretical and empirical rationales for modeling the dynamic effects of promotion into models of promotion as a capital stock, models of dynamic sales-responsiveness, market growth models, multiple state-variable models that allow for cumulative purchase, or experience effects, and models of dynamic oligopoly promotion-games.

limitations of estimating demand with this form of the AIDS model, while many authors demonstrate its ability to provide plausible estimates of the effect of promotion on demand. In the current case, the share of each apple variety becomes:

$$w_i \; = \; \alpha_i \; + \; \sum_j \gamma_{ij} \ln(p_j) \; + \; \beta_i \ln(X_A/P_A), \tag{11}$$

where w_i, is the share of variety i ($p_i q_i / X_A$); p_i is the price of variety i; X_A is the amount of expenditure on the A commodity sub-group, and ln P_A is a Stone price index for this group such that $\ln P_A \; = \; \sum_i w_i \ln p_i$, . Scaling prices in the AIDS expenditure function by the function $m_i(\boldsymbol{A_i}) \; = \; \boldsymbol{A_i}^{\delta_i}$ and applying Shephard's Lemma leads to promotion-augmented share equations of the form:

$$w_i \; = \; \alpha_i \; + \; \sum_j \gamma_{ij} \ln p_j \quad \sum_j \gamma_{ij} \delta_j \ln \boldsymbol{A_j} \; + \; \beta_i \ln(X_A / P_A), \tag{12}$$

where $\boldsymbol{A_j^*}$ is a vector of variety-specific promotion stocks.[3] Baye, Jansen, and Lee describe the usual set of parametric restrictions to ensure symmetry, homogeneity, and adding-up extended to include scaling. While (12) is a common specification for the effects of promotion on demand, consumers also obtain product knowledge from sources other than advertising. Particularly for new varieties of a mature product, such knowledge can be acquired by search or experience (Nelson).

Experience is especially important for goods whose characteristics are difficult to convey, and highly variable - even items that are the same variety and from the same source (Lilien and Kotler). Therefore, accumulated consumption of a new product may also explain much of the

[3] Although retail prices are endogneous in the aggregate market model, the disaggregate demand system is estimated with weekly data in local markets where prices are more likely to be predetermined. Moreover, Hausman tests fail to reject exogeneity of variety price.

increase in demand typical of the growth stage in the life cycle of a new product -- through both consumers' self discovery and through knowledge gained by word-of-mouth, or learning from others (McFadden and Train). The notion of a product life cycle implies that information from experience and promotion are likely to have different effects on the demand for mature and new varieties. New apple varieties are likely to spend some time in the introductory phase, where promotion that generates awareness and initiates first-purchase will be most effective, but the stock of consumer experience will be small. As a variety becomes established and its characteristics well known, more variety-specific promotion aimed at differentiating it from other types of apples is expected to prove more important than purchase experience. Promotion at this stage should seek to encourage habit formation among consumers that have tried the variety. Varieties in the late-maturity and decline phases, however, benefit more from price-promotions and discounting (Belch and Belch). By allowing each share intercept to vary with cumulative consumption: $\alpha_i = \alpha_{0i} + \alpha_{1i}\sum_{t=0}^{T} Q_t$, the variety demand model incorporates an indicator of consumption experience, or stage of the product life cycle. Failing to include the effect of consumption experience would likely lead to estimates that overstate the role of both prices and promotion in increasing variety demand.

Combining estimates of the first- and second-stage demand parameters leads to elasticities of variety sales with respect to prices and promotion that take into account both the category and variety response, so the total price elasticity of demand is written as:

$$_i = \left(\frac{\gamma_{ii}}{w_i} \quad \beta_i \right) + \left(\frac{\beta_i}{w_i} + 1 \right) \left(\frac{\Psi_I w_i P_I}{X_I} (1 \quad B_I) \right) \quad 1.0, \qquad \textbf{(13)}$$

and the cross price elasticity:

$$ {}_{ij} = \left(\frac{\gamma_{ij} \quad \beta_i w_j}{w_i} \right) + \left(\frac{\beta_i}{w_i} + 1 \right) \left(\frac{\Psi_I w_i P_I}{X_I} \left(1 \quad \mathrm{B}_I\right) \right), \qquad \textbf{(14)} $$

and the total long-run promotion elasticity is written as:

$$ {}_{i,A_i} = \left(\frac{\delta_i}{w_i} \right) \left(1 \quad \beta_i \ln p_i\right) + \left(\frac{\beta_i}{w_i} + 1 \right) \left(\frac{\theta_i A_i}{X_I} \right). \qquad (15) $$

In calculating these elasticities, prices, budget shares, promotion-stock amounts, and expenditure levels in (13) - (15) are each evaluated at their respective means. Although these elasticities indicate the responsiveness of retail apple sales to changes in prices, promotion, and expenditure, changes in producer surplus depend upon the FOB price transmission elasticity.

Whereas other studies use synthetic price transmission elasticities (for example, Kinnucan, et al.), this study estimates this elasticity using a reduced-form marketing margin equation derived from a model of optimal shipper behavior. Factors that explain the difference between FOB and retail prices include labor and transportation costs, export-market price premiums, or the premium initially due to Fujis' status as a new variety in relatively limited supply. Further, differences between retail and orchard prices may arise if there are lags in the adjustment of FOB prices to changes in retail demand. Wohlgenant and Mullen describe a model of the retail-farm price margin in which the difference in price is due to a derived demand for marketing services by middlemen. In the current example, the profit maximization problem faced by a representative apple distributor is written as:[4]

[4] To simplify the marketing channel to only two players, all agents beyond the grower are included in one "middleman" designation. Middlemen's interest lies in obtaining a high retail price, while keeping FOB prices as low as possible.

$$\max_{q^r} \quad {}_i = \max_{q^r}[(p^r \quad kp^f)q^r \quad c(w,q^r)], \qquad \textbf{(16)}$$

where q^r is the retail quantity; p^r is the retail price; p^f is the FOB price; k is a constant of proportionality representing shrinkage and loss from the orchard to the store, and $c(w, q^r)$ is the cost of selling apples with input prices, w. Because apple distributors have the option of buying Fujis for domestic sale, or for export sale (q^x), or other more established varieties (q^o), the FOB price is a function of the relative demand for each: $p^f = f(q^r, q^x, q^o)$. If the proportion of exported to total apples rises, then FOB prices are likely to rise due to the premium earned from off-shore sales.[5] On the other hand, a rise in domestic Fuji sales relative to existing varieties is likely to mean the erosion of the new product premium commanded by Fujis in the past. Defining ${}_d$ as the retail elasticity of demand for Fujis; ${}_x$ as the elasticity of export demand with respect to the FOB price, ; as the elasticity of demand for other; mature apple varieties; θ_x as the conjectural variation of export demand with respect to retail demand (dq^x/dq^r); and θ_o as the conjectural variation of mature variety sales with respect to Fuji retail sales, aggregating over a homogeneous set of distributors provides a solution to (16) at the market level:

$$p^f = (p^r/k)\left(1 + \quad {}_d + \left(\frac{q^x}{q^r}\right)\theta_x \quad ^1 + \left(\frac{q^o}{q^r}\right)\theta_o \quad ^1 \quad \frac{\partial c}{\partial q^r}\right). \qquad \textbf{(17)}$$

Although this shows how FOB prices are ideally linked to retail prices, marketing costs, and quantities that flow into alternative markets, farm prices rarely respond instantaneously to changes in retail prices (Heien, Ward, 1982, Kinnucan and Forker, Powers, 1995).

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[5] Export premiums are possible due to the successful differentiation of Washington apples from others on world markets. As a result, Washington apple growers have some ability to price discriminate between the domestic and off-shore markets.

Rather, suppose FOB prices change only a proportion of the way towards equilibrium during any given period, *t*. This slow adjustment could be due to costs of adjusting prices, lags in moving information through the system, or a conscious realization on the part of retailers that it is in their interests to raise their selling prices before paying growers a higher price for their apples. Simplifying the right-side of (17) as M_t , let $p_t^f \;=\; \beta M_t$. If prices adjust a proportion, , towards this amount each period, then (17) becomes:

$$p_t^f \;=\; \beta(1 \quad\;)M_t \;+\; \quad p_{t\;1}^f \;+\; e_t. \qquad \textbf{(18)}$$

where e_t is a random error in adjusting the farm price. Writing this conceptual model as a linear function of the variables available to this study provides a means of estimating the price-transmission elasticity. The estimated econometric model is, therefore, written as:

$$p_t^f \;=\; \alpha_o \;+\; \alpha_1 p_{t\;1}^f \;+\; \alpha_2 p_t^r \;+\; \alpha_3(q_x/q_r) \;+\; \alpha_4(q_o/q_r) \;+\; \alpha_5(\boldsymbol{w}) \;+\; e_t, \qquad \textbf{(19)}$$

and estimated for each market using independent instrumental-variable regressions as described below. The following section describes the data and specific methods used in estimating both the demand model and this price linkage specification.

Data and Methods

The data used in this analysis were drawn from a variety of sources made available by the WAC, including the *Market Vu*, *Ad Activity*, and *Unloads* reports, from September 1995 to May 1997 on a weekly basis. These reports contains data on prices, promotion activities, and shipments to a large number of markets, respectively. In order to make the analysis tractable, the study focuses on a set of sample markets consisting of Charlotte, Los Angeles, Minneapolis, Philadelphia, Phoenix, Richmond, San Antonio, San Francisco, Seattle, St. Louis, Tampa, and Washington, D.C. Because of the geographic dispersion of these markets, the retail price data exhibit considerable variability.

In fact, pooling variety-specific data over time and markets means that prices vary by city, week, and variety. The *Market Vu* data not only satisfy this requirement, but also provide price data on apple grade, size, container, source, and quality, as measured by a subjective scale developed by WAC field staff. In order to define a "standard" apple of each variety in each market and in each week, a hedonic price-correction method adjusts for all other effects on price (Goldman and Grossman; Cox and Wohlgenant).   Because the shipment data from the *Unloads* report are defined on a zip code basis, market definitions corresponding to those used in the *Market Vu* reports are found by aggregating over all contiguous zip codes within a market area. Details on this aggregation process are available from the authors. These markets, in turn, correspond closely to those used by WAC marketing officials in allocating promotional and advertising budgets across different regions.

Budgeted amounts for all retail promotion activities are provided by the WAC Retail Marketing Department. The budget reports contain lines for each retail account, defined by store and market, and specify periods over which the activity may occur. Another data source, the *Ad Activity Report*, prepared by Leemis Market Research, reports the gross rating points (GRPs) for Fujis and all other Washington apple variety advertisements. GRPs for each retail account and budget period are used as weighting factors in allocating budget expenditures over time to either Fuji apples or all other varieties. These data are augmented by mass media expenditure data prepared for the WAC by McCann-Erickson. These sources provide data series for both total Fuji promotion expenditures and for expenditures on all other apples.

These price, quantity, and promotion data are used in both a variety-level demand model, and aggregated for use in the first-stage, or category-level demand model. For purposes of the category-level model, the Washington apple price variable is a Stone's price index calculated over all varieties. An average price for apples from all other sources is calculated from the *Market Vu* reports on a market-by-market basis. Prices for alternative fruits (bananas, grapes, and fresh navel oranges) are taken from the Bureau of Labor Statistics (BLS) *Consumer Price Index: Average Price* database, while regional CPI values are from BLS *Consumer Price Index: State and Area* data. This index is used as a proxy for the price of "all other consumption goods" in the first-stage model. Personal disposable income is from the Bureau of Economic Analysis *Regional Programs* data, while population values are from the Bureau of Census *State Population Estimates*.

In estimating the retail-farm price transmission elasticity, marketing costs are measured by the price of No. 2 diesel fuel, taken from *Monthly Energy Review,* and the wage rate for production workers in SIC 21 (food and kindred products) taken from *Employment and Earnings*. The FOB price are from the Washington Growers' Clearing House. With these data, estimates of the price transmission elasticity are found for each market using independent, single-equation regressions. Because of the endogeneity of several explanatory variables in (18), these equations are estimated using an instrumental variables procedure, where the set of instruments includes all exogenous variables and lagged values of all endogenous variables. Estimating the LES/LAIDS demand model employs an iterative algorithm described by Anderson (1979).

In estimating the demand model, Anderson's iterative procedure ensures that the Washington apple price index is indeed a true or "perfect" index of varietal prices. Creating perfect price indices is desirable because they allow the first-stage prices to reflect substitution between goods that comprise the aggregate commodity group. An iterative approach captures this substitution effect because the first-stage index-weights are functions of the second-stage parameters, and the second-stage parameters are, in turn, functions of expenditures at the first-stage. Anderson's procedure begins by estimating the first-stage LES model. This model provides a fitted expenditure value for all Washington apples. Estimates of the LAIDS variety-share system are then made conditional on this fitted expenditure, deflated with a Stone's price index defined over all apple Washington apple varieties. A new price index is found using fitted share values from this second-stage model. Substituting this price index into the first-stage LES and reestimating provides a new predicted expenditure value. Substituting this new expenditure amount into the LAIDS model and reestimating yields updated variety-weights and a new price index. Continuing this procedure until the sum of the first- and second-stage log-likelihood function values does not differ by more than 0.0001 indicates convergence. Because the first stage consists of only Fuji expenditures, the LES estimates are obtained using single-equation non-linear least squares, while iterative seemingly unrelated least squares (ITSUR) provides estimates of the full LAIDS variety-share system. As Barten demonstrates, the resulting ITSUR estimates are equivalent to maximum likelihood estimates and are, therefore, invariant to the equation that is excluded, provided there is no autocorrelation present. To maintain consistency with constrained consumer budgeting, both homogeneity and symmetry are imposed on the second-stage LAIDS model.[6] Within the second-stage model, however, there remains some question as to the specification of the weighting scheme used to construct a stock of consumer goodwill created through promotion.

Cox reviews the various methods used to model the dynamics of promoting farm commodities. These consist of various distributed lag methods, including Pascal lags, geometric lags, polynomial lags, or simple linear weighting schemes. For this paper, linear or geometric processes are inappropriate given empirical evidence showing that the response to promotion

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[6] Tests of symmetry and homogeneity fail to reject the null hypothesis in both cases. Durbin and Watson's d test fails to reject the null hypotheses of no positive nor negative autocorrelation for all share equations.

peaks some time after its introduction, and then decays slowly until a new ad is released (Little, Feichtinger et al). Although Pascal and polynomial lags can generate this structure, Cox develops a parsimonious quadratic exponential lag model, which has been recently applied to study meat promotion by Brester and Schroeder. This study uses endpoint restrictions similar to Cox in order to keep the specification as simple as possible, but arbitrarily assumes a longer six-period lag due to greater data frequency. In the first-stage, a higher rate of decay is expected as there is greater competition for consumer attention at an aggregate level -- apple knowledge is likely only a small part of a consumer's entire stock. Therefore, promotion enters the LES model as a three-period moving average of past expenditures. Given each of these considerations, the elasticity estimates from this model are used to determine the net effect of promotion and cumulative consumption on Fuji prices, allowing for feedback effects through other apple varieties.

Because changes in producer surplus are likely to be affected by these elasticity estimates, and other parameters in the simulation model (6), alternative results are obtained and reported for higher and lower values of: the grower share of the retail dollar, the elasticity of supply from apple shippers, and the retail elasticity of demand.[7] Because growers and WAC officials alike are interested in the effectiveness of the "Year of the Fuji" campaign in particular, simulations for each parameter regime are conducted for the entire sample and for only the 1997 observations. Further, these simulations compare the relative contribution of each source of knowledge in increasing demand by conducting experiments where: (1) cumulative consumption and total WAC promotion are held constant, and Fuji-specific promotion is increased by 10%; (2) cumulative consumption and Fuji-specific promotion are held constant and total WAC promotion is increased by 10%; (3) both types of promotion are held constant and cumulative consumption rises by 10%;

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[7] Under all scenarios, the export demand elasticity is held constant at -1.0. This is consistent with estimates reported by Richards, Van Ispelen, and Kagan.

and (4) total WAC promotion is held constant while both Fuji-specific promotion and cumulative consumption are increased by 10%. The results of each scenario are compared on the basis of increment to producer surplus and, for the promotion variables, the benefit-to-cost ratio of investing in promotion. The next section presents these results after a brief discussion of the structural demand and price-linkage estimates.

Results and Discussion

Although the key results of this paper concern the calculated returns to Fuji apple growers' promotion investments, the structural demand and FOB-price linkage parameters are themselves of considerable interest. In particular, the first-stage demand parameters show how all Washington apples respond to changes in income, competing good prices, and total apple promotion expenditure, while estimates of the second-stage parameters show how apple varieties respond to varietial prices, total apple expenditures, and promotional expenditures.

Table 1 shows the elasticity estimates from stage one. These results imply an own-price elasticity for Washington apples of -0.0898 and an income elasticity of demand of 0.0139, suggesting that apples are staples, or habitually-purchased items that respond very little to changes in price or income. Price-inelastic demand is perhaps to be expected from a good with a small budget share, but the complementarity with bananas and grapes is somewhat surprising. This may reflect a common retailer practice of positioning bananas and grapes in the produce section so as to increase traffic past high-margin items such as apples (*The Packer*). Of greater concern to this study, however, is the effect of aggregate WAC promotion on the Washington apple category. Table 1 shows that the elasticity of all Washington apples with respect to all-promotion is 0.0390, suggesting that WAC promotion does indeed increase Washington apple sales in aggregate, irrespective of its individual variety effects.

[table one in here]

These variety effects are estimated in the second-stage LAIDS model. Combining elasticities from the LES model with the variety-specific results obtained for the second-stage model provides "total" price, expenditure, and promotion elasticities. Elasticities obtained at this stage are of particular concern because they indicate the likely scope for cannibalistic promotion effects - whether advertising or price-promotion simply reallocates demand among varieties, or expands overall demand. In terms of own-price elasticity, the results in table 2 show that all varieties are inelastic in demand, except for Fujis. Two other varieties, Jonagolds and Romes, also have relatively low price-elasticities, suggesting that specialty varieties tend to be less elastic in demand. In fact, specialty apples also tend to have expenditure elasticities greater than one, lending further evidence to the contention that they are luxury goods. In terms of cross-price elasticities, only Braeburns are significant Fuji-substitutes, while Reds appear to be complementary. Therefore, higher (but opposing) spillover responses to Fuji promotion are expected for these two varieties.

In fact, Braeburns have the second-strongest response to Fuji promotion next to Fujis themselves. Significantly, none of the cross-promotion effects are negative when both aggregate and share-effects are taken into account, indicating that Fuji-specific promotion does not cannibalize net sales of other varieties. Reds, however, respond very little to either Fuji promotion, or to total WAC promotion for that matter, while Galas, Braeburns, and Jonagolds each have elasticities with respect to total WAC promotion greater than 0.10. This result, combined with the fact that Fujis are only marginally less responsive than these other specialty types, suggests that promotion as a source of information is particularly valuable for specialty varieties. The dynamic response to promotion, however, appears to depend critically on the type of promotion.

While the quadratic-exponential lag parameter for Fuji-specific promotion is -0.875, the equivalent estimate for generic, or total WAC promotion is 1.964.[8] These results suggest that Fuji-specific promotion causes both a larger short-term rise in Fuji consumption, and its effect tends to be more persistent than is the case with generic promotion, which dies out within two periods. This result, however, does not necessarily mean that product-information is of no value, because consumers can obtain variety-information through sources other than promotion.

In particular, although the parameter estimates are not shown, estimates of this model support the notion that consumers' experience with a variety is critical in his or her demand, especially for new varieties. In fact, if consumers either learn from their own experience, or through the behavior of others (McFadden and Train), then it can be expected that consumers' acquisition of variety-knowledge should favor those varieties that represent true improvements on existing apples. It is perhaps not surprising then to find a point-estimate of the elasticity of Red demand with respect to cumulative Red consumption of 0.0046, while the same elasticity for Fujis is 0.0675. Further, while cumulative consumption is strongly statistically significant in explaining Fuji share, the cumulative consumption of Reds is only marginally significant. Clearly, while the experiential nature of Fujis remains important, promotions aimed at helping consumers acquire this information will prove most effective. Although these results show a strong impact of both promotion and cumulative consumption on retail-demand, the ultimate return to growers depends upon how much of this is passed on in terms of higher FOB prices.

[table two in here]

Estimating the retail-farm price transmission model (19) for each market provides the needed FOB-price response elasticities. Further, although these estimates are obtained using

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[8] Both of these parameters are significantly different from zero. The t-ratio for Fuji-specific promotion is -8.965, while the generic promotion t-ratio is 153.550. See Cox for a graphical presentation of the specific lag structure implied by these estimates.

single-equation methods for each market, several of the results shown in table 3 for Minneapolis alone are consistent across all markets.[9] First, FOB prices do not adjust instantaneously to changes in retail demand, requiring roughly 1.5 periods before changes in the retail price are fully reflected in FOB prices. This result is consistent with those obtained by Powers (1995) for iceberg lettuce, or Ward (1982) in fresh vegetables or Kinnucan and Forker for dairy products. Second, retail prices themselves exhibit considerable "stickiness" in that the lag-structure of FOB prices depends upon both current retail prices and a moving average of past retail prices, again consistent with these earlier studies. Third, FOB prices rise with the share of Fujis that are exported as more apples are sold into the premium market, but FOB prices fall in Fujis' domestic market share. This latter effect may be due to a maturing Fuji market -- as a new variety matures or moves through its product life-cycle it necessarily becomes less of a specialty item, commanding less of a premium in the retail market. As expected, FOB prices fall with marketing wages, but, unexpectedly, FOB prices rise in fuel costs. This result suggests that fuel costs are a more important factor in determining apple production rather than marketing costs. The key result from this model, however, is the price-transmission elasticity, or the percentage change in FOB price for a percentage change in the retail price.

Using the results in table 3, and similar estimates for other markets, the average long-run price-transmission elasticity for Fuji apples is 0.604.[10] For all other varieties, the transmission elasticity is calculated using an expression from Gardner:

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[9] Only results from the Minneapolis market are presented for brevity's sake. Results for other markets do not differ appreciably, but are available from the authors upon request.

[10] Kinnucan and Forker derive retail-farm price transmission elasticities for milk that consistently exceed 1.0, claiming that the opposite case, as found here, is somewhat anomalistic. However, Gardner's condition for $T_i < 1.0$, using his equation for the transmission elasticity is simply that $e_a > e_b$. In the weekly data of this study, this scenario is not only possible, but highly likely as marketing costs are largely fixed in the short-run, while shipments from cold storage are highly elastic.

$$T_i = (\;_i + e_b)/[\;_i + S_i^f e_b + (1 \quad S_i^f) e_a]; \qquad \textbf{(20)}$$

where   is the elasticity of substitution between farm and marketing inputs; e_a is the elasticity of supply of farm inputs; e_b is the elasticity of supply of marketing inputs; and, S^f is the farm-share of the retail dollar. As in Kinnucan, et al.,   is assumed to be zero, while S_i^f is taken from the data. Unlike Kinnucan, et al., however, the values for e_a and e_b are 1.30 and 0.50, respectively. These values are chosen by fixing e_b and then calibrating (20) to be consistent with the estimated Fuji transmission elasticity. Using these transmission elasticities, equation (6) provides estimates of the effect of changing promotion and experience on producers' surplus.

[table 3 in here]

In order to test the sensitivity of changes in producer surplus to different values of the model parameters, alternative simulations are conducted as described above. To answer the objectives of this paper, "grower returns" to promotion or experience are defined both in terms of the present value increment to producer surplus and the ratio of the change in the present value of benefits to the change in present value of costs of promoting. The simulation results for both the entire sample period and the "Year of the Fuji," assuming a 5% interest rate, are shown in table 4.

[table 4 in here]

In the base scenario, a 10% rise in Fuji promotion generates a benefit:cost ratio (BC) of 14.73 for the entire sample period, but falls to 8.59 for the "Year of the Fuji" campaign. This reduction in returns over the later period may be due to one of many factors. First, promotional expenditures are likely to exhibit declining marginal returns -- beyond a minimal amount required to establish a market presence, each additional dollar of expenditure generates a lower increment in sales than did the previous one. Second, by early 1997 the number of consumers who had not yet tried Fuji apples is likely to have been very small. If this is the case, then the ability of promotion to precipitate new purchases has passed and the role of advertising then becomes one of building purchase habits instead. Whereas promotion is necessary to establish a new product in the market, such high rates of return associated with the rapid growth phase of a product's life-cycle are unlikely to be sustainable as purchases become more habitual and price-sensitive. Third, lower retail prices may be responsible for more of the increase in Fuji consumption than in the past. Nonetheless, the returns to promotion are still strongly positive and many times their cost of provision under all alternative parameter assumptions. However, these results do appear to be sensitive to other parameters in the simulation model.

In particular, as expected, returns over the entire sample rises to 21.53 if growers receive 80% of the retail dollar, but falls to 12.57 if they receive only 40%. This latter scenario could arise if marketing costs rise significantly, if consolidation at the retail level substantially increases apple buyers' power to set prices, or if significant competition for retail space arises from other regions' apples, or even other products within the produce section. Perhaps the most important simulation considers different elasticities of supply from shippers. Conducting sensitivity analysis with this parameter is necessary because little is known of the true supply elasticity in weekly data with significant amounts of storage. If supply is inelastic, or nearly fixed (0.5), the return to promotion rises to 26.71 from the base case. In this case, any increase in demand will cause FOB prices to rise significantly, while causing little change in quantity supplied. On the other hand, a supply elasticity more than double that considered in the base scenario (3.0) causes the returns to promotion to fall to 8.66, as growers respond to higher prices by increasing the quantity supplied more than proportionately. However, such a supply elasticity is unlikely in the medium and long run for an agricultural product subject to significant production lags and constraints on land, labor, and other key inputs. Changing the elasticity of retail demand also produces the expected changes in returns to promotion, with variety-specific promotion becoming more effective the lower the elasticity of demand. In fact, reducing the demand elasticity to levels closer to the mature varieties provides a BC estimate of $23.05 for the next dollar invested, suggesting that this promotion will become more profitable as the variety matures and its demand becomes less elastic. Qualitatively, these conclusions hold for each of the other combinations of promotion and experience, but the net returns differ considerably.

In particular, the BC ratio for a 10% rise in total WAC promotion is less than one in the base case, for both the entire sample and the "Year of the Fuji." Negative returns are due both to the small estimated response elasticities and the sheer size of overall promotion expenditures, again implying strong diminishing marginal returns to promoting apples. As in the previous case, the greatest returns are found under scenarios of high farm-retail price ratio, and a low demand or supply elasticity. Unlike the case for Fuji-specific promotion, however, the return to total WAC, or generic, promotion is higher during the "Year of the Fuji" campaign than over the full sample. This suggests that there were greater synergies between the two types of promotion when Fujis were being promoted aggressively. Such synergistic effects are also apparent in comparing Fuji-specific promotion with and without taking account of cumulative Fuji consumption.

Because promotion and learning are two alternative sources of information, there is a potential that they may substitute for one another. However, it may also be the case that promotion in fact reinforces learning and vice versa. This indeed appears to be true as the returns to Fuji-specific promotion, when allowing for the accumulation of experiential knowledge through consumption, are uniformly higher than when Fuji-specific promotion is considered alone. In fact, table 4 shows that the return to Fuji-specific promotion in this scenario may be as high as $30.21 for the next dollar invested if demand is inelastic (-0.5) or $35.51 if supply is inelastic. The most conservative estimate of returns arises when shipper supply is highly elastic, but still provides a margin return of $11.28 for the next dollar of promotion. Under the base-scenario, Fuji-specific promotion returns $19.27 per dollar of promotion for the entire sample, and $11.25 per dollar for the "Year of the Fuji" campaign. In the scenario that considers only Fuji-specific promotion, product life cycle-stage is offered as one explanation for this difference in returns. However, by including the effect of cumulative consumption, this simulation takes into account any stage-of-life-cycle effects that may exist. Finding a significant difference in returns between the two time periods provides more support for the argument that there are declining marginal returns to promotion. Although a benefit:cost ratio cannot be calculated for the effect of a rise in cumulative consumption in isolation, it is instructive to compare changes in producer surplus that result from a sustained increase in this experience-proxy.

Whereas a 10% increase in Fuji-specific promotion provides an additional $977,100 in producer surplus, a similar increase in cumulative consumption generates an increase of $297,900 over the sample period, assuming the base-case parameters. At current promotion expenditure levels, this means that an incremental dollar expenditure on Fuji promotion leads to $14.14 of producer surplus, while an additional dollar of consumer expenditure on Fujis causes producer surplus to rise by only $0.14. Although in-store samples are often used, this result suggests that such a strategy is an inefficient way to generate new producer surplus. One reason for the small response to experience may be a relative lack of learning from others for this type of product (McFadden and Train). If a product has a small budget share, is non-durable, is seasonal, and has inherently variable quality characteristics, consumers will obtain very little of their knowledge about the product from other consumers, learning instead from their own consumption. As in the previous cases, the increment to producer surplus from a change in cumulative consumption is greatest when the farm share of the retail dollar is high, and elasticities of supply and demand are low.

Conclusions and Implications for Future Research

In general, this study finds very high rates of return to Fuji apple growers' promotional investments. Although these rates of return are superior to returns on other investments available to growers, they are consistent with the returns to promoting other produce items (Alston, et al.). This study not only adds to a growing body of evidence demonstrating the effectiveness of cooperative grower-promotion programs, but considers issues that have not been explicitly addressed in other studies of this type. Namely, it compares the relative effectiveness of variety-specific promotion, generic or product-promotion, and consumer experience in generating producer surplus.

Returns to each of these factors are estimated with a market-simulation model of producer surplus, incorporating demand elasticities from a two-stage LES/LAIDS model of variety demand, and transmission elasticities taken from dynamic empirical models of the retail-FOB price linkage. With this model, the return to Fuji-specific promotion is uniformly positive over a variety of parametric assumptions. Generating almost $15.00 of producer surplus for a $1.00 investment in promotion, such targeted expenditures appear to be a much more effective use of growers' checkoff money than generic promotion. In fact, generic promotion returns less than a dollar in producer surplus for each dollar in costs to Fuji apple growers. The highest returns are obtained when Fuji-specific promotion and consumer experience are considered together, due the complementary effects between learning and promotion in increasing demand. Despite these positive findings, some caveats and limitations must be kept in mind.

First, this study shows that the returns to Fuji promotion were lower during the intensive "Year of the Fuji" campaign (1997) compared to the entire sample. While benefit:cost ratios in excess of $10.00 are common over the entire sample period, returns fall by an average of 40% during the Fuji campaign. Although this may be due to the fact that a "normalization" of Fuji prices was required in order to move a crop that was more than double the previous year's, it may also be due to the diminishing marginal returns of commodity promotion. This reduction in returns may also be simply due to the maturation of Fuji apples as a product. Fuji apples are still a new product to consumers, so the primary constraint to increased sales may be a lack of experiential knowledge of Fujis' taste, texture, and storability. Traditional methods of promotion can help in removing this obstacle, but are not perfect substitutes. Consequently, promotion may become more effective over time as consumers learn about Fujis on their own or by word of mouth.

Second, aggregate data such as that provided by the *Market Vu*, *Unloads*, and *Ad Activity* provide only approximate measures of the actual variables required to measure the return to promotion. These data do not contain information on differences among advertising media, nor the total amount of exposure generated by each dollar of expenditure. In order to better understand the issues surrounding the effectiveness of promoting a specific variety, future empirical research should consider the effect of specific programs on measures of consumer awareness and consumer purchase behavior. A greater empirical understanding of the causes of purchase incidence, purchase frequency, and variety choice will help all commodity marketing officials optimally allocate their promotion budgets.

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Table 1. LES Elasticity Estimates of Aggregate Washington Apple Demand

Variable	Elasticity Estimate	t-ratio
Wash. Apple Price[1]	-0.0898*	-1.8475
Other Apple Price	0.0171	0.2831
Banana Price	-1.1858*	-4.7455
Grape Price	-0.2433*	-3.3216
Navel Orange Price	1.1684*	10.6110
Other Consumer Good Price	3.0918*	2.4155
Personal Disposable Income	0.0139*	22.9871
Total WAC Promotion	0.0390*	1.9561

[1] A single asterisk indicates the estimate is significantly different from zero with a 95% level of confidence. This model also included binary market variables, but are not displayed here for brevity's sake. Model estimates are obtained by pooling data over twelve sample markets and eighty-eight weeks of Fuji shipments.

Table 2. Total Elasticities of Washington Apple Demand: Top Eight Varieties

	Red[1]	Gold	Gran.	Fuji	Gala	Brae.	Jong.	Rome	Exp.	Fuji Promo.	All WAC Promo.	Cumulative Consum.
Red	-0.126*	0.274*	0.410*	0.463*	0.468*	0.461*	0.483*	0.475*	0.884*	0.019*	0.025*	0.005
	(-3.403)	(11.003)	(22.791)	(23.151)	(25.625)	(35.597)	(43.737)	(44.407)	(49.685)	(8.461)	(12.403)	(0.737)
Gold	-0.442*	-0.055	-0.061	0.279*	0.062	0.204*	0.278*	0.190*	1.034*	0.033*	0.046*	0.002
	(-6.270)	(-0.332)	(-0.635)	(3.259)	(0.599)	(3.671)	(8.314)	(5.678)	(28.897)	(7.529)	(14.053)	(0.124)
Gran.	-0.452*	-0.701*	-0.160	0.129	0.459*	0.304*	0.054	-0.040	0.822*	0.036*	0.019*	-0.061*
	(-3.160)	(-2.379)	(-0.528)	(0.658)	(1.988)	(2.442)	(0.668)	(-0.442)	(11.640)	(4.246)	(3.142)	(-1.929)
Fuji	-0.506*	0.277	0.126	-1.266*	0.113	0.286*	-0.004	-0.089	1.681*	0.228*	0.065*	0.068*
	(-2.334)	(0.769)	(0.463)	(-3.517)	(0.409)	(1.717)	(-0.045)	(-0.846)	(15.024)	(16.095)	(7.261)	(4.191)
Gala	-0.114	-0.474	0.540*	0.117	-0.134*	-0.661*	-0.203*	0.296*	1.071*	0.074*	0.150*	-0.114*
	(-0.624)	(-1.218)	(1.896)	(0.473)	(-3.386)	(-4.103)	(-2.112)	(2.700)	(11.031)	(5.903)	(7.606)	(-3.506)
Brae.	-0.875*	-0.110	0.622*	0.426	-1.500*	-0.160	-0.283*	0.294*	1.973*	0.109*	0.110*	0.059*
	(-3.638)	(-0.248)	(1.920)	(1.363)	(-4.438)	(-0.548)	(-2.479)	(2.488)	(13.954)	(6.164)	(8.526)	(1.886)
Jong.	0.108	1.330*	-0.015	-0.322	-1.236*	-0.727*	-0.523*	0.052	1.457*	0.064*	0.136*	0.071
	(0.384)	(2.300)	(-0.031)	(-0.771)	(-2.715)	(-2.796)	(-2.028)	(0.214)	(9.450)	(3.215)	(7.981)	(1.150)
Rome	-0.059	0.933*	-0.787*	-0.429	-0.243	0.209	0.178	-0.976*	1.284*	0.019	0.065	0.062*
	(-0.269)	(1.876)	(-1.862)	(-1.326)	(-0.610)	(0.953)	(0.809)	(-4.666)	(10.483)	(1.266)	(6.132)	(8.154)

[1] A single asterisk indicates the estimate is significantly different from zero with a 95% level of confidence.

Table 3. Retail-FOB Price Linkage Equation: Minneapolis Market.

Variable	Estimate	t-ratio	Variable	Estimate	t-ratio
P_{t-1}^{f}	0.497*	6.332	**Wages**	-0.494*	-4.475
P^{r}	0.174*	1.815	**Exp. Share**	0.146*	3.269
P_{t-1}^{r}	-0.252*	-3.620	**Dom. Share**	-0.815*	-2.007
Fuel	0.852*	3.878	**Constant**	5.309*	4.693
R^2	0.814				

A single asterisk indicates the parameter is significantly different from zero with 95%level of confidence. The variables in this table are defined as follows: P^{f}_{t-1} is the FOB price, lagged by one week; P^{r} is the retail price; Exp. Share is the share of Fujis that are exported; Dom. Share is the percentage of all Washington apples shipped that are Fujis.

Table 4. Grower Returns to Fuji and WAC Promotion Expenditure: November 1995 - May 1997

	Fuji Promo		All WAC Promo		Fuji Cumulative		Fuji Promo & Cumulative	
	Entire Sample	Year of the Fuji	Entire Sample	Year of the Fuji	Entire Sample	Year of the Fuji	Entire Sample	Year of the Fuji
	Change in Producer Surplus							
Base Case[1]	977.1	567.7	339.8	197.4	297.9	173.1	1,279.1	743.2
High Farm Share	1,428.7	830.1	496.9	288.7	435.7	253.1	1,870.4	1,086.8
Low Farm Share	714.3	415.1	248.5	144.4	217.8	126.6	935.2	543.4
High Supply Elasticity	574.3	333.7	125.3	72.8	170.8	99.3	748.4	434.8
Low Supply Elasticity	1,772.3	1,029.7	430.2	249.9	578.1	335.9	2,355.9	1,368.9
High Demand Elasticity	617.7	358.9	215.2	125.0	188.7	109.6	808.0	469.5
Low Demand Elasticity	1,529.2	888.5	530.5	308.3	465.1	270.2	2,004.4	1,164.6
	Benefit/Cost Ratio							
Base Case	14.73	8.59	0.23	0.37	N.A.	N.A.	19.27	11.25
High Farm Share	21.53	12.57	0.34	0.55	N.A.	N.A.	28.19	16.46
Low Farm Share	10.77	6.28	0.17	0.27	N.A.	N.A.	14.10	8.22
High Supply Elasticity	8.66	5.05	0.09	0.14	N.A.	N.A.	11.28	6.58
Low Supply Elasticity	26.71	15.59	0.29	0.47	N.A.	N.A.	35.51	20.73
High Demand Elasticity	9.31	5.43	0.15	0.24	N.A.	N.A.	12.18	7.11
Low Demand Elasticity	23.05	13.45	0.36	0.58	N.A.	N.A.	30.21	17.63

[1] In this table: Base Farm Share = 0.547, High Farm Share = 0.80, Low Farm Share = 0.40; Base Supply Elasticity = 1.30, High Supply Elasticity = 3.0, Low Supply Elasticity = 0.5; Base Demand Elasticity = -1.266, High Demand Elasticity = -2.5, Low Demand Elasticity = -0.5. N.A. means that the measure is not applicable.