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Optimal Seasonal Allocation of Generic Dairy Advertising Expenditures

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OPTIMAL SEASONAL ALLOCATION OF GENERIC DAIRY ADVERTISING EXPENDITURES

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Escalating media advertising costs have prompted shifts away from advertising to non-advertising promotion activities in the dairy industry's generic commodity promotion program. As advertising budgets become tighter, determining the optimal allocation of these funds becomes particularly important. Optimal seasonal generic advertising expenditure shares for the national fluid milk and cheese generic advertising programs were estimated, with shares higher in the first and fourth quarters for fluid milk and relatively even across quarters for cheese. Estimates of producer welfare gains from re-allocation were substantial, with average welfare gains of 12 to 24 percent of annual advertising investments.

I. INTRODUCTION

U.S. milk producers contribute 15 cents for every hundredweight (100 pounds) of milk sold to support generic advertising, promotion, and product research, designed with the ultimate goal of enhancing producer returns. Fluid milk processors contribute an additional 20 cents per hundredweight of fluid milk sales for fluid milk advertising through the Milk Processor Education Program. Combined, these programs have historically raised more than $300 million annually. Generic advertising efforts have received more attention and the largest share of checkoff budgets, but escalating advertising costs and the investigation of alternative forms of product promotion costs have prompted a shift away from generic advertising in recent years, particularly for the farmer-funded programs. As advertising budgets become tighter, determining the optimal allocation of those funds becomes particularly important. In order to maximize producer returns from a given annual budget, optimal temporal policies should be investigated. Do existing allocation decisions follow a seasonal pattern and, if so, why? Can producer returns be improved by altering the allocation investment rule? These are the types of issues explored here.

While an abundance of research in generic commodity promotion has focused on estimating producer returns on investment (or benefit-cost ratios), much less attention has focused on strategic issues, such as identifying preferred target markets and consumer groups, or determining optimal temporal advertising spending strategies. The objective of this paper is to estimate optimal seasonal generic advertising expenditure shares for the national fluid milk and cheese programs using empirical results from a time-varying parameter demand model. While optimal temporal strategies have been developed for fluid milk programs in New York State and New York City markets (e.g., Kinnucan and Forker, 1986; Liu and Forker, 1990; Van de Kamp and Kaiser, 2000), they have not been applied to the national generic advertising programs; nor have they been applied to other dairy products such as cheese. The demand model applied here is unique in that generic advertising response is allowed to vary over time as a function of various market and demographic characteristics. In addition, estimated generic advertising and price elasticities vary over time, leading to the logical application of estimating optimal temporal advertising spending patterns.

It is certainly the case that both the *level* and the *allocation* of advertising can be derived under optimal investment rules. However, we focus solely on the allocation of a fixed annual advertising budget, taking historical annual expenditures as given. While this ignores whether overall advertising is at the optimal level (in fact, most empirical studies indicate that generic advertising expenditures are substantially below optimal levels), it simplifies the analysis to something more logistically manageable (reallocation of a given budget), and avoids the burdensome structural and political pressures that often determine annual budgets.

II. BACKGROUND

Dorfman and Steiner (1954) evaluated the issue of optimal advertising allocations and concluded that profits from advertising are inversely related to the level of price sensitivity. For example, if price elasticities are lower in certain seasons, advertising intensity should be increased in those seasons to increase industry profits. Nerlove and Arrow (1962) developed a dynamic counterpart to the Dorfman and Steiner model, whereby optimal advertising levels are determined based on maximizing the present value of net industry revenues by appropriate price and advertising policies over time. They concluded that firms should keep a constant advertising to sales ratio, based on elasticities of demand with respect to price and advertising goodwill (Nerlove and Arrow, 1962). While they set the stage for much of the optimal temporal advertising work in generic advertising, both models assume that firms can control both price and output, which is not the case with promotion of agricultural commodities.

Determining optimal temporal advertising strategies in generic dairy promotion has, however, received more recent attention. Kinnucan and Forker (1986) allowed for seasonal variation in the response to generic advertising by incorporating monthly dummy variables interacted with the level of advertising goodwill in an econometric demand model for the New York City market. They found significant variation in the goodwill elasticities that followed a smooth seasonal pattern, peaking in the spring and reaching a low during the summer months. This pattern largely mimicked sales patterns; i.e. the cumulative effect of milk advertising on sales was greatest in months when consumer demand was strongest. Simulation results concluded, consistent with Nerlove and Arrow (1962), that producer returns from advertising would be maximized when expenditures followed a regular seasonal pattern.

Liu and Forker (1990) used a deterministic optimal control framework to identify optimal advertising expenditure patterns for the New York State fluid milk promotion program. Their results, like Kinnucan and Forker's (1986), indicate advertising more during the winter and less during the late spring and early summer -- a seasonal spending distribution largely the result of seasonal variation in the Class I fluid milk price differential.

Vande Kamp and Kaiser (2000) developed a dynamic optimization model to determine optimal temporal advertising strategies when consumers' response to advertising is asymmetric. The model was applied to the New York City fluid milk market. The asymmetric nature of demand response to generic advertising produced a pulsing advertising strategy, where periods of heavy advertising are followed by low or no advertising. This result was driven by the advertising asymmetry characteristic, as all other exogenous demand shifters outside of generic advertising (including farm milk price) were assumed constant at sample means.

Kinnucan and Myrland (2002) derived static decision rules to determine optimal seasonal allocations of fixed advertising budgets when substitution effects are important and prices are determined competitively. They applied their allocation rule to generic advertising of salmon in France. In contrast to optimal control models, the static framework permits a wider array of economic forces to be accounted for than is often feasible with dynamic models (Kinnucan and Myrland, 2002). Optimal allocation decisions are determined by seasonal price elasticities of supply and demand, advertising elasticities, and product expenditure shares. In addition, Kinnucan and Myrland identified economic conditions under their framework in which pulsing strategies could occur.

Schmit and Kaiser (2004) developed a time-varying demand model for fluid milk and cheese, incorporating generic advertising activity, that produces demand elasticities that vary over time. The main objective of this work was to empirically estimate market and demographic effects on changes in the level of advertising response over time. However, given the time-varying nature of the model, estimated seasonal price and advertising elasticities can be computed and applied directly to the static allocation rules developed by Kinnucan and Myrland (2002).

We proceed now with a brief description of the Kinnucan and Myrland (K-M) allocation rule. Next we highlight the empirical specification of the Schmit and Kaiser (2004) time-varying parameter demand model. Then we describe our data and empirical results. We close with some summary conclusions and suggestions for future research.

A. K-M Optimal Seasonal Allocation

The K-M seasonal allocation rule originates from the traditional equi-marginal rule in economic theory. Specifically, producer profits are maximized when the last dollar spent on advertising in each season provides exactly the same increment to total revenue. Following Kinnucan and Myrland (2002), this can be expressed as:

$$(1) \quad q_1\left(\frac{\partial p_1}{\partial a_1}\right) = q_2\left(\frac{\partial p_2}{\partial a_2}\right) = \cdots = q_s\left(\frac{\partial p_s}{\partial a_s}\right),$$

where q_k, p_k, a_k are quantity, price, and advertising expenditures in the k^{th} season (k=1, …, s). It is clear from (1) that price enhancement by the advertising expenditure governs the allocation decision. Applying the allocation rule to quarterly demand and price estimates, we assume s=4. Converting (1) into elasticity form, Kinnucan and Myrland (2002) show:

$$(2) \quad \theta_1^{-1}E_{p1,a1} = \theta_2^{-1}E_{p2,a2} = \theta_3^{-1}E_{p3,a3} = \theta_4^{-1}E_{p4,a4} ,$$

where $\theta_k = a_k / p_k q_k$ represents the intensity of advertising relative to the value of production and $E_{pk,ak} = \frac{\partial p_k}{\partial a_k} \frac{a_k}{p_k}$ is the reduced-form price elasticity with respect to generic advertising that defines advertising's seasonal influence on price. Seasonal spending cannot exceed the fixed annual budget ($\bar{A}$); i.e., $\sum_{k=1}^{4} a_k = \bar{A}$. Dividing this by $\sum_{k=1}^{4} p_k q_k = PQ$ results in the budget constraint

(3) $\sum_{k=1}^{4} r_k \theta_k = \bar{\theta}$,

where $r_k = p_k q_k / PQ$ is the k^{th} season's revenue share and $\bar{\theta} = \bar{A}/PQ$ is the annual advertising expenditure intensity. Solving (2) and (3) simultaneously for the optimal seasonal advertising shares, $\kappa_k = a_k / \bar{A}$, Kinnucan and Myrland (2002) show that

(4) $\kappa_k = r_k E_{pk,ak} \Big/ \sum_{k=1}^{4} r_k E_{pk,ak}$.

The result is intuitively appealing in that it clearly distinguishes the two key components driving allocation decisions – season-specific revenue shares and the ability of generic advertising activity to influence price (Kinnucan and Myrland, 2002). Revenue shares are easy enough to compute; the reduced-form price elasticities, however, are not readily available, but can be derived from an economic structural model. Kinnucan and Myrland (2002) developed these elasticities based on a two-good system of demand and supply equations where product substitution is important and only one of the goods is advertised. In such a system, own- and cross-price elasticities are required, as well as own- and cross-advertising effects.[1] If substitution effects are unimportant -- a hypothesis from the Schmit and Kaiser (2004) model that we also posit here -- the reduced-form price elasticity with respect to generic advertising simplifies to a function of the single good parameters, or:

(5) $E_{pk,ak} = \alpha_k / (\varepsilon_k + \eta_k)$,

where α_k, ε_k, and η_k are season-specific advertising, supply, and demand (absolute value) elasticities. As a reduced-form elasticity, $E_{pk,ak}$ represents the net effect of an increase in generic advertising on price after taking supply response into account (Kinnucan and Myrland, 2002).

As Kinnucan and Myrland (2002) state, the simplification of ignoring product substitution does imply that the advertising price effect is unambiguously positive (as in Nerlove and Waugh, 1961), which may overstate producer welfare gains from advertising. However, given that the existence of clear (or at least strong) substitutes to fluid milk or cheese is debatable, with mixed results in the literature, and the time-varying parameter model does not explicitly account for substitution effects, we proceed with the simpler allocation decision. The time-varying parameter model is particularly well suited for an optimal temporal allocation evaluation; however, future research should examine more rigorously the importance of substitution effects for these products. Substituting (5) into (4) yields the optimal seasonal allocation rule:

(6) $$\kappa_k = \frac{r_k \alpha_k / (\varepsilon_k + \eta_k)}{\sum_{k=1}^{4} r_k \alpha_k / (\varepsilon_k + \eta_k)}.$$

B. Time-Varying Demand Model

The time-varying parameter model estimated in Schmit and Kaiser (2004) is useful to the study of optimal temporal allocation decisions as estimated generic advertising and price elasticities vary over time. For brevity, we briefly highlight the model formulation here. The time-varying parameter specification can be expressed as:

(7) $Y_t = \alpha_0 + \boldsymbol{\alpha}'\mathbf{X_t} + \phi BGW_t + \psi_t GGW_t + e_t$,

where Y_t is product disappearance at time period t (t=1,…,T), $\mathbf{X_t}$ is a K-dimensional vector of explanatory variables other than advertising, BGW_t and GGW_t are the goodwill stocks of brand and generic advertising expenditures, respectively, α_0, $\boldsymbol{\alpha}$, ϕ, and ψ_t are parameters to be estimated, and e_t is a random disturbance term with mean zero and variance σ_e^2.

The time-specific parameter specification immediately creates a degrees of freedom problem, which requires that some structure be placed on the time-varying response. Therefore, the goodwill generic advertising parameter is defined as:

(8) $\psi_t = \exp(\delta_0 + \boldsymbol{\delta}'\mathbf{Z_t}) + v_t$,

where $\exp(\cdot)$ represents the exponential function, δ_0 is the intercept parameter to estimate, $\mathbf{Z_t}$ is a vector of explanatory variables assumed to affect consumer response to generic advertising, $\boldsymbol{\delta}$ is a vector of parameters to be estimated, and v_t is a random disturbance term with mean zero, variance σ_v^2, $E(e_t, v_t) = 0 \,\forall\, t$, and $E(v_t, v_\tau) = 0 \,\forall\, t \neq \tau$.

To allow for carryover effects of advertising, the lag-weights were approximated using a quadratic exponential distributed lag structure (EDL). Following Cox (1992, p. 149), the EDL structure for generic advertising can be described as:

(9) $GGW_t = \sum_{j=0}^{J_g} w_{j,g} GADV_{t-j}$ and $w_{j,g} = \exp(\lambda_{0,g} + \lambda_{1,g} j + \lambda_{2,g} j^2)$,

where the subscript g identifies the generic advertising parameter, $w_{j,g}$ represents the J_g+1 lag weights, $GADV_{t-j}$ is the t-j^{th} generic advertising expenditure, and $\lambda_{i,g}$ (i=0,1,2) are generic advertising EDL parameters to be estimated.[2] A lag length of six quarters is modeled for all advertising variables: generic and branded, and fluid milk and cheese.[3]

Substituting (8) and (9) into (7) yields:

$$(10)\quad Y_t = \alpha_0 + \boldsymbol{\alpha}'\mathbf{X_t} + \phi \sum_{j=0}^{J_b} w_{j,b} BADV_{t-j} + \exp(\delta_0 + \boldsymbol{\delta}'\mathbf{Z_t}) \sum_{j=0}^{J_g} w_{j,g} GADV_{t-j} + \varepsilon_t$$

$$\text{where} \quad \varepsilon_t = e_t + v_t \sum_{j=0}^{J_g} w_{j,g} GADV_{t-j}.$$

An advantage of this formulation is that the combined demand equation in (10) reduces to a nonlinear least-squares estimation problem with generic advertising goodwill stocks interacting with the variables contained in **Z**. As a result, the demand response to generic advertising is allowed to vary over not only time, but also over those variables contained in **Z**.

In Schmit and Kaiser (2004), the fluid milk model was specified as:

$$(11)\quad \ln RFD_t = \alpha_0^m + \alpha_1^m \ln RFP_t + \alpha_2^m \ln INC_t + \alpha_3^m \ln T_t + \alpha_4^m \ln AGE5_t + \alpha_5^m BST_t$$
$$+ \alpha_6^m QTR1_t + \alpha_7^m QTR2_t + \alpha_8^m QTR3_t + \phi^m \ln BMGW_t + \psi_t^m \ln GMGW_t + e_t^m$$

and

$$\psi_t^m = \exp(\delta_0^m + \delta_1^m RFP_t + \delta_2^m INC_t + \delta_3^m AGE5_t + \delta_4^m BLACK) + v_t^m \ ,$$

where the *m* superscript refers to fluid milk demand parameters, *RFD* is per capita retail fluid milk demand (milkfat equivalent basis), *RFP* is the consumer retail price index (CPI) for fresh milk and cream deflated by the CPI for nonalcoholic beverages, *INC* is per capita disposable personal income deflated by the CPI for all items, *T* is a time trend (T_t = 1, …, 108), *AGE5* is the percentage of the U.S. population under six years of age, *BST* is an intercept dummy variable for availability of bovine somatotropin (bST) (1994-current equals 1, 0 otherwise), *QTR1*, *QTR2*, and *QTR3* are quarterly seasonal dummy variables, *BMGW* and *GMGW* are the national brand and generic advertising goodwill variables as defined above, and *BLACK* is the percent of the population identified as African American.

Similarly, the retail cheese demand model was specified as:

(12) $$\ln RCD_t = \alpha_0^c + \alpha_1^c \ln RCP_t + \alpha_2^c \ln INC_t + \alpha_3^c \ln FAFH_t + \alpha_4^c \ln OTHER_t + \alpha_5^c QTR1_t + \alpha_6^c QTR2_t + \alpha_7^c QTR3_t + \phi^c \ln BCGW_t + \psi_t^c \ln GCGW_t + e_t^c$$

and

$$\psi_t^c = \exp\left(\delta_0^c + \delta_1^c RCP_t + \delta_2^c INC_t + \delta_3^c FAFH_t + \delta_4^c AGE2044_t + \delta_5^c OTHER\right) + v_t^c \ ,$$

where the c superscript refers to cheese demand parameters, *RCD* is per capita retail cheese demand (milkfat equivalent basis), *RCP* is the CPI for cheese deflated by the CPI for meats, *OTHER* is the proportion of the population identified as Asian/Hispanic (specifically, non-White and non-African American), *FAFH* is the real per capita expenditure on food eaten away from home, and *BCGW* and *GCGW* are the brand and generic cheese advertising goodwill variables, respectively.

C. Elasticities

For brevity, the estimated coefficients in (11) and (12) from Schmit and Kaiser (2004) are included in the appendix.[4] Given the estimated parameters, quarterly price and generic advertising elasticities were computed for 1997-2001. The own-price elasticity of demand for fluid milk model can be expressed as:

(13) $$\frac{\partial \ln RFD_t}{\partial \ln RFP_t} = \alpha_1^m + \delta_1^m \exp\left(\delta_0 + \boldsymbol{\delta}'\mathbf{Z_t}\right) \ln GMGW_t \cdot RFP_t \ .$$

The parameters in (13) were replaced with their estimated values and elasticities computed using actual historical data values for price, advertising, and other variables in $\mathbf{Z_t}$. Cheese price elasticities of demand were similarly computed. Computed quarterly price elasticities from 1997 through 2001 are shown in Figure 1. Average quarterly price elasticities for fluid milk and cheese for 1997-2001 were approximately -0.051 and -0.303, respectively (Table 1).

As is apparent, seasonal variation in fluid milk price elasticities exists, with estimates generally lower in the first and fourth quarters. Using this information alone, the Dorfman and Steiner model would support advertising more intensely in these two quarters, a seasonal pattern recommended in the fluid milk applications of Kinnucan and Forker (1986) and Liu and Forker (1990). Somewhat less seasonal variation was exhibited in the cheese price elasticities; however, average cheese price elasticities were slightly lower in the first two quarters of the year.[5]

In order to account for carry-over effects of advertising, long-run advertising elasticities were used. These elasticities can be computed from the associated goodwill stock variables and were explicitly modeled in Schmit and Kaiser (2004). The long-run generic advertising elasticity for the fluid milk model can be expressed as:

$$(14) \quad \varepsilon_{LR}^{m} = \frac{\partial \ln RFD_t}{\partial \ln GMGW_t} = \exp\left(\delta_0 + \boldsymbol{\delta}'\mathbf{Z_t}\right) = \psi_t .$$

The long-run advertising elasticity for cheese follows analogously. The parameters in (14) were replaced with their estimated values and elasticities computed using actual historical data values for variables in $\mathbf{Z_t}$.

It should be noted that the goodwill advertising elasticities are based on the historic lag structures, and this implies that the pattern of the lag structure does not differ by season. If these patterns differ by season -- for example, the peak advertising effect may occur immediately for advertisements placed in the first quarter, but be delayed a quarter for advertisements placed in the third quarter -- the goodwill elasticities would need to be decomposed to take this dynamic effect into account. As in Schmit and Kaiser (2004), we assume that lag structure does not vary with the season, and leave this for future research with an alternative model formulation that could take this into account.

Computed quarterly long-run generic advertising elasticities are illustrated in Figure 2. Generic advertising elasticities were similar in magnitude over this time period, with average estimates of 0.029 and 0.030 for fluid milk and cheese, respectively (Table 1). In addition, while the absolute levels of changes are not large, clearer seasonal patterns exist, particularly for cheese. Cheese advertising elasticities were higher in the first two quarters of the year than in the last two. Schmit and Kaiser (2004) showed this variation to be largely the result of seasonal differences in per capita spending on food eaten away from home and an increasing proportion of Asians and Hispanics throughout the sample period.

Fluid milk generally exhibited higher advertising elasticities in the first and fourth quarters, but the differences were relatively smaller than those seen with cheese.[6] Changes in the level of response were largely the result of declines in the proportion of young children in the population, and changes in income levels and African American population proportions (Schmit and Kaiser, 2004). Both elasticity patterns would, however, support advertising more intensely in the same periods favored by the price elasticity levels above.

III. INPUT DATA

The time-varying parameters from Schmit and Kaiser (2004) were estimated using national quarterly data from the time period 1975 through 2001. Advertising expenditure data came from Dairy Management, Inc. (DMI, 2002) and were deflated by a media cost index constructed from information provided by DMI. Fluid milk and cheese quantities (on milk-fat equivalent basis) represent aggregate market disappearance and were matched with milk class prices (USDA, 2002a). Demographic and income data came from Economagic, LLC. (2002), while food expenditure data came from USDA (2002b). Average quarterly values of model elasticities, data variables, and computed parameters needed for the K-M allocation rule are included in Table 1.

Farmer checkoff dollars go to fund both fluid milk and cheese advertising programs. However, milk processor advertising is also directed to the fluid milk market, and the econometric model from Schmit and Kaiser (2004) sums both farmer and processor sources of fluid milk advertising expenditures together. Therefore, optimal allocation estimates for fluid milk are made with respect to total generic advertising efforts for fluid milk, including both farmer and processor contributions. Ultimately then, any revisions in allocation of promotion funds would require a cooperative effort of both parties. Average quarterly advertising spending (Table 1) indicates higher spending in the first two quarters for fluid milk, but no consistent seasonal trend was exhibited when looking at each year. This is due, in part, to the fact that the historic seasonal spending patterns for farmer and processor advertising were different. Cheese advertising does seem to indicate some drop in activity in the third quarter, but patterns over the last two years show reasonably equal quarterly levels of advertising activity.

Prices received by milk producers are based on the distribution of product to alternative uses. Fluid milk processors pay a higher Class I price (P1), while cheese processors pay the Class III price (P3).[7] To determine individual optimal allocations for fluid milk and cheese advertising, class prices (i.e., P1 for fluid milk and P3 for cheese) and product disappearance levels were used to estimate seasonal farm-level revenue shares. While no strong seasonal trends were exhibited, Class I prices were higher on average in the first and fourth quarters, while the third (primarily) and fourth quarters were highest for cheese (Table 1). Stronger seasonal trends were exhibited on the consumption side, with fluid milk disappearance higher in the first and fourth quarters and cheese disappearance higher in the final two quarters.

IV. APPLICATION AND RESULTS

Class prices and product disappearance levels were used to compute seasonal industry revenue shares for fluid milk and cheese (Figure 3). The price and disappearance patterns are reinforced here, with first and fourth quarter average revenue shares highest for fluid milk, and third and fourth quarter average revenue shares highest for cheese (Table 1). Changes in seasonal variation across years were also apparent; most notably for fluid milk in 2000 and 2001.

From (5), reduced-form price elasticities with respect to generic advertising were computed. Seasonal supply elasticities were not available, so a seasonal invariant long-run supply elasticity (ε) estimate of 0.313 was used (Schmit and Kaiser (2002)). Reduced-form price elasticities for cheese demonstrated a clear seasonal pattern, with higher elasticities in the first half of the year. A seasonal pattern was less apparent for the reduced-form price elasticities for fluid milk; however, on average, reduced-form generic advertising elasticities were higher in the first and fourth quarters (Table 1).

Finally, applying the empirical estimates from Figures 3 and 4 to (6) results in the optimal seasonal allocation results in the first section of Table 2. For each year, 1997 through 2001, the K-M allocation rule was applied, taking annual expenditure budgets as given and using the time-specific computed parameter values. Seasonal allocation decisions varied by year. Specifically, from 1997 to 1999, allocations for fluid milk were *u*-shaped, reflecting higher allocations in the 1^{st} and 4^{th} quarter; but in 2000 and 2001 the allocation patterns were nearly reversed. This was due to the seasonal flattening of the reduced-form price elasticities in 2000 and 2001 and revenue shares that increased throughout both years.

Even larger differences across years were apparent in the optimal seasonal allocation decisions for cheese. Specifically, seasonal allocations were *u*-shaped in the first two years, mixed in 1999, and hump-shaped in 2000 and 2001 (Table 2). Given that seasonal revenue shares and advertising price elasticities demonstrated largely offsetting effects (i.e., revenue shares were generally higher in the final two quarters of the year, while advertising's impact on price was larger in the first two quarters), a higher level of sensitivity to the final allocation decisions resulted. With no consistent seasonal spending pattern in actual expenditure levels, relative changes from actual to optimal levels varied widely for both products.

It is clear from these results that forecasting appropriate seasonal allocations would be difficult, ex ante. That is, given differences in the magnitude of seasonal trends in prices, elasticities, and product demand, the ability to forecast what to do in future years seems elusive at best. Therefore, rather than simply using actual historical levels and seeing what "should have been done," we adopted a simple operational decision for forecasting the needed parameters, and then applied the K-M allocation rule. Specifically, we assumed that quarterly class prices, product disappearance, price elasticities, and generic advertising elasticities would be equal to their historical five-year averages (e.g., see Table 1). These values were then used to compute revenue shares and reduced-form price elasticities. The results of this approach are given in the bottom of Table 2, as Allocation Investment Rule 2.

This rule may provide a "reasonable" prediction of the future, reducing annual fluctuations due to other year-specific circumstances, and it is more operationally feasible for staff to administer. One could easily apply other prediction rules to capture the needed parameters. The simple operational decision implemented here is used to highlight typical seasonal investment behavior and compute producer welfare gains from a logistically feasible approach.

Using Rule 2, the optimal fluid milk advertising expenditure allocation was a seasonal spending pattern consistent with the New York applications of Kinnucan and Forker (1986) and

Liu and Forker (1990). Optimal quarterly allocations were estimated to be 0.27, 0.23, 0.23, and 0.27 for quarters one through four, respectively (Table 2). While a clearer seasonal spending pattern resulted, the magnitude of change across quarters was moderate; i.e., 54% of annual budgets should be allocated to the first and fourth quarters, 46% to the second and third quarters. This is not unexpected given that the seasonal allocation results from Rule 1 varied across years. Compared with average actual spending patterns, the optimal allocations from Rule 2 support spending less in quarter 2 and more in quarter 4.

Given the relatively larger differences in optimal allocations for cheese from Rule 1, it was not surprising that the Rule 2 allocation results were even more similar across quarters. Specifically, optimal quarterly allocations were estimated to be 0.26, 0.24, 0.25, and 0.25 for quarters one through four, respectively (Table 2). This more even distribution of advertising would imply relatively significant increases in third quarter spending and decreases in fourth quarter spending, compared to actual historical averages.

V. PRODUCER WELFARE IMPACTS

To determine what economic gains would follow from optimizing allocation of advertising expenditures, changes in producer surplus were calculated for each quarter, 1997-2001.[8] Given shifts in seasonal advertising expenditures in both positive and negative directions, some quarters may see producer surplus gains, while others may see reductions. However, on an annual basis, producer welfare will be improved by the reallocation. Average gains by quarter for both investment rules are displayed in Table 3. Producer surplus losses in quarter two (four) for fluid milk (cheese) result from the reductions in advertising spending compared to actual historical levels.

As expected, gains from the Rule 1 approach were larger than those from Rule 2. Average annual producer surplus gains from advertising reallocation were approximately $30 million for fluid milk and $13 million for cheese (Table 3). While these gains are small relative to annual industry revenues (i.e., less than 0.5 percent based on class prices and product disappearance), they are substantial relative to the annual advertising investment. That is, gains in producer welfare from reallocating existing annual budgets are approximately 18 percent and 24 percent of annual advertising investments for fluid milk and cheese, respectively (Table 3).

The results from Rule 1 give estimates of producer welfare changes if optimal allocation decisions were made each year. That is, the allocation results indicate what should have been implemented optimally to maximize producer returns to advertising if one knew a priori what the actual market parameters were going to be. The Rule 2 approach is based on predicting what the parameter estimates will be in order to determine optimal allocation for the future, and for this reason, welfare gains from this approach are probably more realistic than the Rule 1 results. Annual welfare gains from the second approach are approximately two-thirds of those realized by the Rule 1 approach, but the gains are still substantial: producer surplus changes relative to annual advertising investments are 12 percent and 14 percent for fluid milk and cheese, respectively. That both scenarios show gains highlights the importance of considering seasonal advertising allocation decisions so as to achieve greater benefits from existing advertising investments.

VI. CONCLUSIONS

Though studies have been made of optimizing seasonal allocations of generic advertising for fluid milk markets in New York City, no analogous studies have been made of national fluid milk and cheese advertising programs. This paper applied a seasonal advertising allocation rule to empirical results from a time-varying parameter demand model on national fluid milk and cheese disappearance that incorporates generic advertising expenditures. National farmer-funded programs for both fluid milk and cheese advertising were considered, as were contributions to fluid milk advertising from fluid milk processors.

Using annual historical data and parameter estimates, we found optimal seasonal allocation decisions to be relatively variable across years, particularly for cheese products. This variability makes such results not particularly useful for planning purposes, and so an alternative decision rule based on historical average statistics was used. Consistent with previous studies of New York fluid milk, average seasonal advertising allocations on a national basis for fluid milk exhibited higher optimal expenditures in the fall and winter, and lower expenditures in the spring and summer. These results reflect both higher revenue shares and generic advertising's impact on price during these periods. Average seasonal allocations for cheese, however, exhibited optimal expenditures that were more even across quarters, reflecting higher revenue shares in the latter half of the year and generic advertising's stronger influence in the first half of the year.

Estimates of producer welfare gains are substantial, with average gains of 12 to 24 percent of annual advertising investments over all products and investment rules evaluated. Such favorable results should provide an incentive for policy makers and marketers alike to adjust promotion campaigns according to market signals and allocation rules that return the highest benefits to the producers who fund them. Also, the empirical results indicate that the optimal seasonal spending patterns for fluid milk and cheese clearly differ, highlighting differences in domestic consumption patterns.

Given that optimal seasonal allocations varied across years, using mean historical data as a forecast tool may be insufficient. Future applications should consider determining appropriate price, elasticity, and advertising forecasts so as to better predict what advertising budget allocations would be optimal in the future. Also, unless separate estimates of advertising's effectiveness by farmer and milk processor groups are available, achieving optimal allocations will require the collaboration of both participants.

While the allocation investment rule is general enough to allow for product substitution effects, the empirical application here ignores these and therefore may overstate welfare gains from advertising. Future research should examine more rigorously the importance of substitution effects for these products. Finally, while seasonal allocation decisions are an important component of maximizing returns to farmer-funded advertising efforts, a more complete analysis should investigate both the level and distribution of advertising dollars.

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FOOTNOTES

[1] For further details, see Kinnucan and Myrland (2002).

[2] The brand advertising goodwill variable is similarly constructed to compute the brand advertising lag-weights from estimated coefficients $\lambda_{i,b}$ (i=0,1,2).

[3] The lag weight on the sixth lag is defined to be approximately zero (exp(-30)) and the current period is normalized to one. Using these restrictions and collecting terms, we arrive at the following lag-weight formulation: $w_{j,g} = \exp\left(-5j + \lambda_{2,g}\left(j^2 - 6j\right)\right) \quad j = 1,\ldots,6$.

[4] For further estimation details and empirical results, see Schmit and Kaiser (2004).

[5] Separate pairwise comparisons were made for each year and for the five-year average price elasticities to determine whether the quarterly price elasticity estimates within each year were statistically different from one another. Both Likelihood Ratio (LR) and Lagrange Multiplier (LM) tests were computed using the PROC MODEL procedure in SAS. Statistical differences occurred in 83% to 100% of pairwise comparisons across both tests and products. Specific test results are available upon request.

[6] LR and LM tests of statistical differences in quarterly advertising elasticities were conducted. Statistical differences occurred in 73% to 100% of pairwise comparisons across both products and test procedures. These relatively high levels of statistical difference lend confidence to their use in the optimal allocation application.

[7] The Class I price is defined as the Class III milk price (or Basic Formula price) plus a fixed fluid milk price differential.

[8] Following Kinnucan and Myrland (2002), quarterly producer surplus changes (ΔPS_k) were computed using the formula: $\Delta PS_k = p_k q_k E_{pk,ak} a_k^* \left(1 + 0.5\varepsilon\, E_{pk,ak} a_k^*\right)$, where a_k^* is the relative change in advertising expenditures needed to equal the optimal allocation. This calculation

inherently assumes parallel demand shifts and a linear supply curve in the relevant region (Kinnucan and Myrland, 2002).

ABBREVIATIONS

ADV: Advertising

CWT: Hundredweight

EDL: Exponential Distributed Lag

K-M: Kinnucan-Myrland

MFE: Milk Fat Equivalent

P1: Class I Milk Price

P3: Class III Milk Price

TABLE 1

Average Quarterly Input Variables, Elasticities, and Computed Parameters, 1997-2001

	Generic Advertising Expenditures ($mill)[a]		Class and Farm Prices ($/cwt)			Fluid Supply and Product Disappearance (MFE)[b]		
Quarter	Fluid Milk	Cheese	Class I	Class III	Blend Price	Milk Supply	Fluid Milk	Cheese
1	43.454	13.943	16.38	12.21	14.47	40.48	14.00	15.97
2	43.080	13.324	15.57	11.97	13.93	41.85	13.49	16.64
3	37.211	11.567	15.97	14.09	15.13	39.72	13.59	16.92
4	39.211	15.055	17.11	12.95	15.30	39.77	14.16	17.70
Average	40.739	13.472	16.26	12.81	14.71	40.45	13.81	16.81

	Price Elasticities		Generic Adv. Elasticities		Revenue Shares[c]		Reduced Form Adv. Elasticities	
Quarter	Fluid Milk	Cheese	Fluid Milk	Cheese	Fluid Milk	Cheese	Fluid Milk	Cheese
1	0.046	0.298	0.0304	0.0336	0.255	0.226	0.085	0.055
2	0.052	0.297	0.0290	0.0305	0.234	0.231	0.079	0.050
3	0.055	0.307	0.0286	0.0273	0.241	0.276	0.078	0.044
4	0.050	0.308	0.0290	0.0277	0.270	0.266	0.080	0.045
Average	0.051	0.303	0.0293	0.0298	0.250	0.250	0.080	0.048

[a] Advertising expenditures and prices are in real $2001.
[b] Product disappearance is on a Milk Fat Equivalent basis (MFE).
[c] Revenue shares are computed using class prices and product disappearance.
Source: 2002 DMI (advertising expenditures), 2002 USDA Livestock, Dairy, and Poultry Outlook (prices, farm supply, and product disappearance).

TABLE 2

Optimal Seasonal Generic Advertising Expenditure Shares, 1997-2001

		Fluid Milk			Cheese		
Year	Quarter	Actual	Optimal	Percent Difference	Actual	Optimal	Percent Difference
Allocation Investment Rule 1 (Historical Quarterly Estimates):							
1997	1	0.273	0.282	3.4%	0.274	0.283	3.4%
	2	0.256	0.253	-0.9%	0.258	0.226	-12.3%
	3	0.232	0.209	-10.0%	0.190	0.229	20.4%
	4	0.240	0.256	6.7%	0.278	0.262	-5.8%
1998	1	0.253	0.243	-3.9%	0.250	0.230	-8.0%
	2	0.241	0.225	-6.4%	0.269	0.212	-21.2%
	3	0.231	0.236	2.4%	0.202	0.244	20.7%
	4	0.276	0.296	7.1%	0.279	0.314	12.5%
1999	1	0.287	0.340	18.4%	0.250	0.286	14.4%
	2	0.260	0.193	-25.6%	0.247	0.238	-3.9%
	3	0.240	0.202	-15.6%	0.195	0.272	39.4%
	4	0.213	0.264	24.1%	0.307	0.204	-33.6%
2000	1	0.217	0.246	13.2%	0.273	0.263	-3.6%
	2	0.287	0.246	-14.2%	0.227	0.265	16.8%
	3	0.276	0.249	-9.7%	0.242	0.253	4.3%
	4	0.219	0.258	17.8%	0.258	0.219	-15.0%
2001	1	0.306	0.230	-24.9%	0.250	0.235	-6.2%
	2	0.295	0.238	-19.3%	0.233	0.270	16.0%
	3	0.147	0.275	86.7%	0.244	0.265	8.6%
	4	0.252	0.258	2.2%	0.273	0.230	-15.7%
Allocation Investment Rule 2 (Average Historical Quarterly Estimates):							
	1	0.267	0.269	0.5%	0.259	0.259	-0.2%
	2	0.268	0.231	-13.9%	0.247	0.241	-2.3%
	3	0.225	0.234	3.7%	0.215	0.253	17.9%
	4	0.240	0.267	11.3%	0.279	0.247	-11.5%

TABLE 3

Average Producer Surplus Changes from Alternative Allocation Rules

	Fluid Milk [a]		Cheese [a]	
Quarter	Rule 1	Rule 2	Rule 1	Rule 2
1	6.04	1.31	1.25	0.56
2	-21.01	-21.35	0.02	-1.62
3	22.57	17.42	21.40	20.47
4	22.50	22.34	-9.84	-11.84
Total	$30.10	$19.72	$12.83	$7.58
Avg. Annual Advertising	$162.96	$162.96	$53.89	$53.89
Proportion	0.18	0.12	0.24	0.14

[a] Million 2001 dollars

FIGURE 1
Own-Price Elasticities of Demand (absolute value)

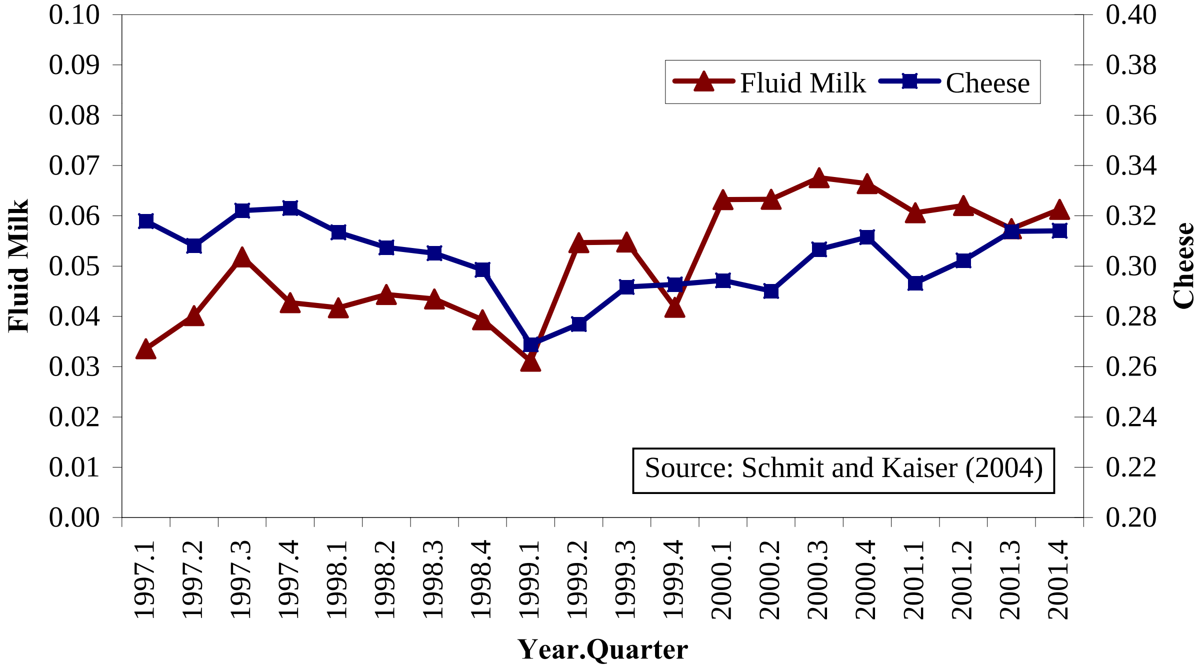


FIGURE 2
Long-Run Generic Advertising Elasticities of Demand

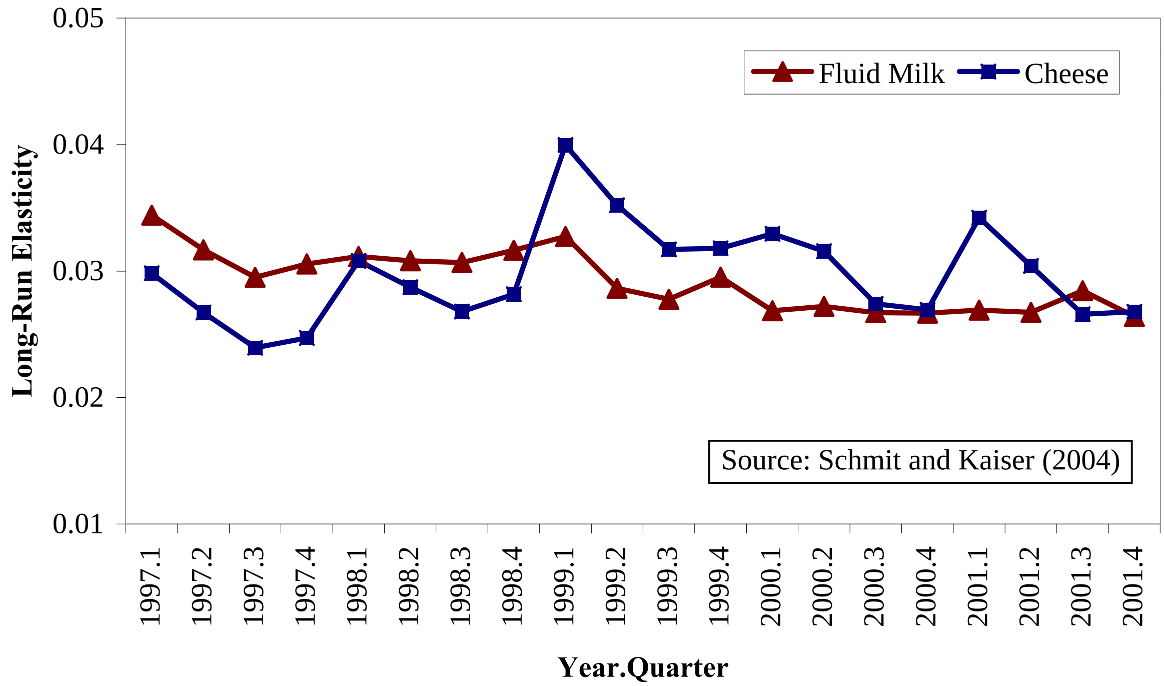


FIGURE 3
Quarterly Farm-Level Revenue Shares

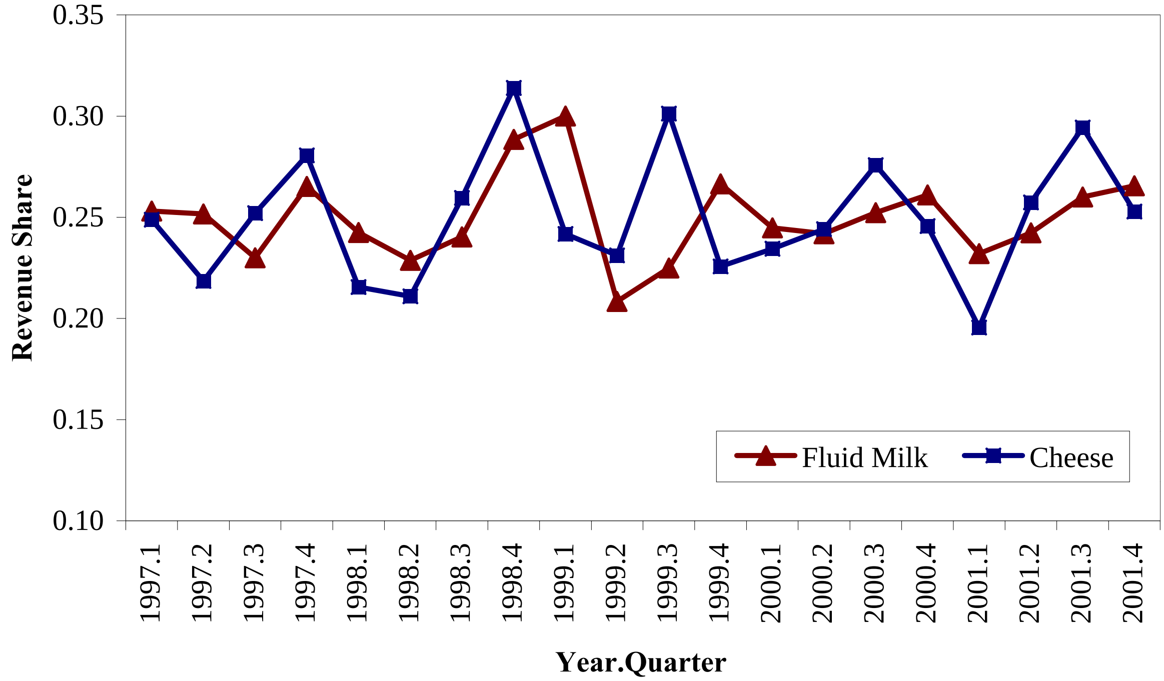
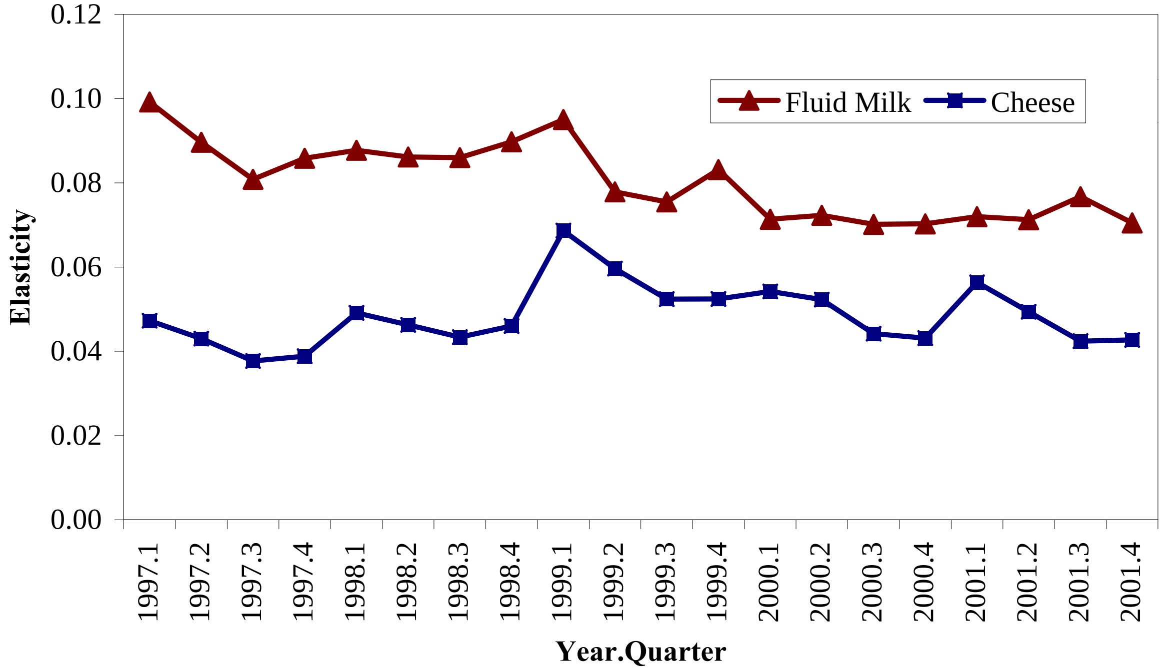


FIGURE 4
Reduced-Form Elasticities for Price with Respect to Generic Advertising



APPENDIX
TABLE A1
Econometric Estimates From Time-varying Parameter Model

Variable	Parameter	Fluid Milk[a]	Cheese[a]
Intercept	α_0^m,α_0^c	-2.704	-10.236
		(1.050)	(1.539)
ln *Price*	α_1^m,α_1^c	-0.160	-0.377
		(0.190)	(0.140)
ln *Income*	α_2^m,α_2^c	0.107	0.691
		(0.140)	(0.187)
ln *T*	α_3^m	-0.078	na
		(0.019)	
ln *FAFH*	α_3^c	na	0.694
			(0.247)
ln *AGE5*	α_4^m	-0.250	na
		(0.417)	
ln *OTHER*	α_4^c	na	0.121
			(0.106)
BST	α_5^m	-0.043	na
		(0.013)	
QTR1	α_6^m,α_5^c	-0.008	-0.082
		(0.004)	(0.007)
QTR2	α_7^m,α_6^c	-0.051	-0.050
		(0.004)	(0.008)
QTR3	α_8^m,α_7^c	-0.049	-0.052
		(0.003)	(0.007)
ln *BAGW*	ϕ^m,ϕ^c	-0.004	-0.001
		(0.007)	(0.017)
Intercept (ψ)	δ_0^m,δ_0^c	-10.986	-3.011
		(3.504)	(10.545)
Price (ψ)	δ_1^m,δ_1^c	0.948	1.033
		(1.551)	(3.166)
Income (ψ)	δ_2^m,δ_2^c	0.022	-0.008
		(0.014)	(0.043)
FAFH (ψ)	δ_3^c	na	-0.044
			(0.043)
AGE5 (ψ)	δ_3^m	1.258	na
		(0.498)	
AGE2044 (ψ)	δ_4^c	na	0.071
			(0.117)
BLACK (ψ)	δ_4^m	-0.456	na
		(0.292)	
OTHER (ψ)	δ_5^c	na	1.562
			(0.968)
AR(1)		0.221	na
		(0.140)	
Brand Weight	$\lambda_{2,b}$	-1.918	-1.490
Parameter		(0.310)	(0.450)
Generic Weight	$\lambda_{2,g}$	-5.545	-2.099
Parameter		(0.743)	(0.558)
Adjusted R-square		0.945	0.988
Test $\delta_t = 0 \ \forall\ i > 0$	LR Stat.	17.61	12.62
	Pr>Chi.Sq.	0.002	0.027

[a] Standard errors are in parentheses. Dependent variable is the natural logarithm of per capita disappearance.

Source: Schmit and Kaiser (2004)

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