A MULTI-MARKET MODEL OF GENERIC PROMOTION: MEASURING RETURNS TO U.S. DAIRY ADVERTISING

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Abstract
This paper develops a multi-market model to analyse the indirect effects of generic advertising as well as the direct effects of generic advertising that were usually discussed in previous research. As results of analytical and numerical analyses, the paper provides theoretical and empirical evidence that the horizontal demand and supply linkages have an important role in the effectiveness of generic advertising on market. The results of simulation present that evaluation of the impact of generic advertising should consider the horizontal linkages. This paper, basically, agrees the positive returns to generic promotion. However, the paper also showcases the possibility of over- (or under-) estimation of the effectiveness of generic advertising.

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I. Introduction

In the U.S., generic commodity promotion programs have played an important role in stimulating the demand for agricultural products. Since the Agricultural Marketing Agreement Act of 1937 set the federal legislative foundation for generic promotion programs, more than 100 generic promotion organizations have been established to stimulate commodity sales and increase producer prices and net returns. Annual expenditure on promotion efforts, including generic advertising, grading, and R&D, is on the order of hundreds of millions of dollars, financed to a large extent through taxes, also known as check-offs. According to Vande Kamp and Kaiser(1999), total budgets for all organizations in 1995 were $ 695,335,312. Generic promotion programs have been established for more than 50 agricultural commodities, ranging from milk to cotton and include a variety of both traditional(such as barley) and non-traditional products such as California raisins(Vande Kamp and Kaiser, 1999). Accordingly, a substantial agricultural economic literature has developed to model and measure the impacts of these programs on agricultural markets, and on producer welfare, in particular.

Of all the generic promotion programs, the one for dairy products is the largest. After The Dairy and Tobacco Adjustment Act was enacted in 1983, dairy farmers pay a mandatory assessment of 15¢ per hundred pounds of milk marketed in the U.S. as the dairy check-off payment. In 2004, $ 161.9 million was collected, and about $ 113 million was spent for dairy product marketing in the U.S. It is not surprising, then, that the dairy promotion program has received the most attention from economists. Many researchers have investigated the effect of generic promotion for dairy products, and all of them have found significant positive returns to producers' investment in promotion (for example, Blisard, Sun, and Blaylock, Blisard et al., Kaiser (1997) and (1999), and Kaiser and Chung). Such studies have been used to justify continued generic commodity promotion for dairy products.

In 1999, generic advertising in Korea was started by Korean dairy farmers. In order to promote the demand for fresh milk in Korea, the 83% of whole Korean dairy farmers set up a fund(₩ 1.7 billion) for generic advertising, and the Korean government also offered ₩ 0.8 billion for this program. Recently, about ₩ 2 billion is annually spent for generic advertising and the size of this budget becomes larger(Korean Dairy and Beef Farmers Association).

While Korean dairy farmers' efforts for generic promotion have shown progress, studies about generic promotion in Korea are just at the beginning stage. Most previous research in Korea analyzed consumers' response to generic advertising(Park, C.S.; Park, C.S. and Y.D. Kwon 2006b; Park, C.S. K.Y. Yeon and J.W. Yoon), or presented a strategy for more efficient generic promotion for Korean milk(Pak, I.W.). Some studies evaluated the economic effect of Korean dairy check-off program(Park, C.S. and Y.D. Kwon 2000a, 2001a, 2001b, 2002, 2003), estimated the effect of advertising on demand elasticity of milk (Roh, J.S., · J.W. Kim, and G.S. Kim), or analyzed the economic effect of generic advertising for milk through time-series data analysis(Yoo, D.I. and G.S. Kim).

An important limitation of the existing research is that it considers only the direct effects of advertising on the market for the advertised product. A growing literature on the multi-market effects of promotion has put into question the validity of the single-market approach(Piggott, Piggott, and Wright Kinnucan (1996) and (1997) and Alston, Freebairn, and James). The previous literature underscores the importance of demand relationships across markets for measuring the economic effects of generic advertising. In addition, for milk and other raw commodities that are used in multiple alternative products, product markets are linked through supply. Thus, promotion efforts that successfully increase the demand for advertised products will also result in a reallocation of raw commodities across products.

The implication of the demand and supply linkages across product markets is that the analyses that ignore these relationships do not accurately measure the economic effects of generic promotion. In order to solve these problems, this paper will broaden the analysis of generic dairy promotion to encompass explicit linkages across dairy product markets. The result will be a more accurate depiction of the economic effects on generic commodity promotion. For example, this research will offer a basic concept to develop a strategy for the generic promotion of milk, pork, beef, or any other agricultural products in Korea.

II. A Multi-market Model of the U.S. Dairy Industry

I develop a Muth model of the U.S. dairy industry for the purpose of demonstrating the role of linkages between related markets for determining the effects of generic promotion(see Alston, Norton, and Pardey for a recent treatment of Muth models). To keep the exposition relatively simple, I assume (a) milk components, milk fat and milk protein, are produced in fixed proportions with raw milk, (b) dairy products(e.g., fluid products and manufactured products) are produced from the components using fixed proportions technologies, (c) the production technology of dairy products is constant returns to scale, (d) milk component markets and dairy product markets are perfectly competitive, and (e) generic advertising is funded by per unit check-off. The resulting model is as follows:[1]

(1)	*Milk supply*	$M=M(W_f)$
(2)	*Milk fat supply*	$a=AM$
(3)	*Milk protein supply*	$b=BM$
(4)	*Production of fluid products*	$X_1=h_1(a_1, b_1)$
(5)	*Production of manufactured products*	$X_2=h_2(a_2, b_2)$
(6)	*Fluid product demand*	$X_1=X_1(P_1, P_2, t_1M, t_2M)$
(7)	*Manufactured products demand*	$X_2=X_2(P_1, P_2, t_1M, t_2M)$
(8)	*Pricing of fat for fluid products*	$W_{1a}=g_{M1a}P_1$
(9)	*Pricing of fat for manufactured products*	$W_{2a}=g_{M2a}P_2$
(10)	*Pricing of protein for fluid products*	$W_{1b}=g_{M1b}P_1$
(11)	*Pricing of protein for manufactured products*	$W_{2b}=g_{M2b}P_2$
(12)	*Price discrimination on fat*	$W_{1a}=W_{2a}+D_a$
(13)	*Price discrimination on protein*	$W_{1b}=W_{2b}+D_b$
(14)	*Blend price for fat*	$W_a=(a_1W_{1a}+a_2W_{2a})/a$
(15)	*Blend price for protein*	$W_b=(b_1W_{1b}+b_2W_{2b})/b$
(16)	*Milk pricing*	$W=AW_a+BW_b$
(17)	*The farm price*	$W_f=W-t_1- t_2$
(18)	*Milk fat adding up condition*	$a=a_1+a_2$

[1] The model has 19 unknown variables: M, a, b, a_1, b_1, a_2, b_2, X_1, X_2, W_f, W_a, W_{1a}, W_{2a}, W_b, W_{1b}, W_{2b}, W, P_1, P_2.

(19) *Milk protein adding up condition* $b=b_1+b_2$

Equation (1) expresses the supply of milk, M, as a function of the farm price of milk, W_f. Equations (2) and (3) express the(fixed proportions) production relation between milk components and raw milk, where A and B are the quantities of milk components per unit of milk. Equations (4) and (5) are the production functions for dairy products, X_i, for which milk fat, a_i, and milk protein, b_i are inputs, and equations (6) and (7) are dairy product demand. Demand for each dairy product is a function of prices for both products, P_1 and P_2, as well as advertising expenditure for both products, t_1M and t_2M. One thing different from previous research is that independent variables of demand function in this paper include price and advertising expenditure of non-advertised product. Most of previous studies set variables of price and/or advertising expenditure of only advertised product, which limites analysis of the cross-effects of advertising. Equations (8) through (11) express the competitive market equilibrium condition for milk components, that the price of each component for fluid product or manufactured product is the equal to the value of marginal product of that component in its alternative uses(g_{Mia} or g_{Mib} indicate the marginal products of a or b). Equations (12) and (13) represent price discrimination by marketing orders, which raise the price of milk components used in the fluid market by a fixed mark-up, D_a and D_b. The mark-up presents the current situation of milk market dominated by Federal Milk Marketing Orders (FMMOs). FMMOs sets the price of "Class I milk," which is used for fluid milk processing, higher than other class of milk, and thus fluid milk processors pay more money for milk components. Equations (14) and (15) show that the blend prices for milk components, W_a and W_b, are the weighted averages of prices of milk components for each dairy product. In equation (16), the blend price of milk is calculated as the value of milk components. Equation (17) defines the (net) farm price as the blend price less the per unit check-off collected for dairy product advertising, t_i, and equations (18) and (19) are the market clearing conditions that the supply equals the demand for each milk component.

Totally differentiating equations (1) through (19) and converting to an elasticity form yields a system of equations linear in percentage changes. Using the symbol E to denote percentage change, the model is as follows:

(20) $EM = \varepsilon_f EW_f$

(21) $Ea = EM$

(22) $Eb = EM$

(23) $EX_1 = k_{1a}Ea_1 + k_{1b}Eb_1$

(24) $EX_2 = k_{2a}Ea_2 + k_{2b}Eb_2$

(25) $EX_1 = \eta_{11}EP_1 + \eta_{12}EP_2 + \alpha_{11}(Et_1 + EM) + \alpha_{12}(Et_2 + EM)$

(26) $EX_2 = \eta_{21}EP_1 + \eta_{22}EP_2 + \alpha_{21}(Et_1 + EM) + \alpha_{22}(Et_2 + EM)$

(27) $EW_{1a} = -\frac{k_{1b}}{\sigma_1}Ea_1 + \frac{k_{1b}}{\sigma_1}Eb_1 + EP_1$

(28) $EW_{2a} = -\frac{k_{2b}}{\sigma_2}Ea_2 + \frac{k_{2b}}{\sigma_2}Eb_2 + EP_2$

(29) $EW_{1b} = \frac{k_{1a}}{\sigma_1}Ea_1 - \frac{k_{1a}}{\sigma_1}Eb_1 + EP_1$

(30) $EW_{2b} = \frac{k_{2a}}{\sigma_2}Ea_2 - \frac{k_{2a}}{\sigma_2}Eb_2 + EP_2$

(31) $EW_{1a} = \gamma_a EW_{2a}$

(32) $EW_{1b} = \gamma_b EW_{2b}$

(33) $EW_a = \rho_{1a}EW_{1a} + \rho_{2a}EW_{2a}$

(34) $EW_b = \rho_{1b}EW_{1b} + \rho_{2b}EW_{2b}$

(35) $EW = v_a EW_a + v_b EW_b$

(36) $EW_f = \omega_f EW - \omega_{t1}Et_1 - \omega_{t2}Et_2$

(37) $Ea = s_{1a}Ea_1 + s_{2a}Ea_2$

(38) $Eb = s_{1b}Eb_1 + s_{2b}Eb_2.$

In this system, ε_f is the elasticity of supply of milk with respect to the farm price k_{ia} and k_{ib} ($i = 1, 2$) are the cost shares of a and b in total costs for product i; η_{ij} is the elasticity of demand for product i with respect to the price of product j; α_{ij} is the elasticity of demand for product i with respect to advertising expenditure for product j; σ_1 and σ_2 are the Allen elasticities of substitution between fat and protein in the production of fluid and manufactured dairy products; γ_a (= W_{2a}/W_{1a}) and γ_b (= W_{2b}/W_{1b}) are the ratios between milk component price for fluid milk and for manufactured products; ρ_{ia} (= $(a_i/a)(W_{ai}/W_a)$) and ρ_{ib} (= $(b_i/b)(W_{bi}/W_b)$) are the revenue shares for milk components used for dairy product i; v_a and v_b are the value share of fat and protein in raw milk; ω_f (= W/W_f) is the ratio of the blend price to the net farm price; ω_{ti} (= t_i/W_f) is the ratio of the per unit check-off for dairy product i to the farm price; s_{ia} and s_{ib} are the shares of fat and protein, respectively, allocated to dairy product *i.* In equations (23) and (24), if the sum of k_{ia} and k_{ib} is equal to one, this model follows from an assumption of constant returns to scale technology in dairy product manufacturing; if the sum of k_{ia} and k_{ib} are more than one, this model follows from an assumption of increasing returns to scale; and if the sum of k_{ia} and k_{ib} are less than one, this model follows from an assumption of decreasing returns to scale.[2]

Based on the above system of equations, I conduct the numerical simulation to measure the effect of generic advertising on prices and quantities of dairy products, milk, milk components. In order to evaluate the producer's benefit from generic advertising, I take the formula for the change in producer surplus as following:

(39) $\triangle PS = W_{f0}M_0[EW_f]\ [1 + 0.5EM]$

where subscript *0* indicates initial price and quantity, and EW_f and EM are calculated as solution of the system of equations (20) through (38).[3]

In addition, I derived the optimal advertising expenditure for dairy products from the following producer's problem, which maximizes the net producer surplus:

(40) $PS = TR - TVC = W_fM - TVC(M) = (W - t_1 - t_2) - TVC(M)$

where PS is the net producer surplus for dairy farmers, TR is the total milk revenue, and TVC is the total variable cost of producing milk. The first order condition for the optimal per unit check-off for fluid milk advertising is

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2 The role of sum of k_{ia} and k_{ib} can be shown more easily under the assumption that production function in equations (23) and (24) are CES function (In particular, Cobb-Douglas function).

When $X_i = h_i(a_i, b_i) = Ca_i^A b_i^B$, totally differentiating yields

$$dX_i = \frac{\partial h_i}{\partial a_i} da_i + \frac{\partial h_i}{\partial b_i} db_i = CAa_i^{A-1} b_i^B da_i + CBa_i^A b_i^{B-1} db_i$$

Converting to elasticity form yields

$$EX_i X_i = CAa_i^{A-1} b_i^B Ea_i a_i + CBa_i^A b_i^{B-1} Eb_i b_i = CAa_i^A b_i^B Ea_i + CBa_i^A b_i^B Eb_i$$

$$EX_i = \frac{CAa_i^A b_i^B}{X_i} Ea_i + \frac{CBa_i^A b_i^B}{X_i} Eb_i = AEa_i + BEb_i$$

By definition of Cobb-Douglas production function, A + B = 1 presents the constant returns to scale technology in production.

3 Our measure of the change in producer surplus assumes that supply and demand are linear in the region of interest.

(41) $\frac{\partial W}{\partial t_i}=1$.[4]

Noting that W is the processor price of milk, equation (41) indicates that producers should continue to increase the check-off as long as the vertical shift in derived aggregate demand is large enough to raise the equilibrium processor price by the change in the check-off, leaving the net farm price no lower than without the check-off. (Note from equation (17) that $\frac{\partial W}{\partial t_i}=1$ implies that $\frac{\partial W_f}{\partial t_i}=0$.)

This first order condition can be restated in proportional change form:

(42) $$\frac{EW}{Et_i}=\frac{t_i^*}{W}$$

or

(43) $$t_i^*=\frac{EW}{Et_i}W.$$

It follows that optimal advertising expenditure is

(44) $$A_i^*=\frac{EW}{Et_i}WM.$$

These equations (43) and (44) show that the optimal check-off for advertising and the optimal advertising expenditure are the proportional to the proportional change of milk price due to 1% increase in per unit check-off for i dairy product advertising, EW/Et_i, which can be derived from the system of

4 The first order condition for the optimal per unit check-off at equation (40) is

$$\frac{\partial PS}{\partial t_i}=\frac{\partial W}{\partial t_i}M+W\frac{\partial M}{\partial t_i}-M-t_i\frac{\partial M}{\partial t_i}-\frac{\partial TVC}{\partial M}\frac{\partial M}{\partial t_i}$$
$$=(\frac{\partial W}{\partial t_i}-1)M+(W-t_i)\frac{\partial M}{\partial t_i}-MC\frac{\partial M}{\partial t_i}=0$$

Under the maintained hypothesis of perfect competitive markets,
$W_f(=W-t_i)=MC$,
so that
$$\frac{\partial PS}{\partial t_i}=(\frac{\partial W}{\partial t_i}-1)M=0.$$

Then, assuming a strictly positive quantity of milk at the optimum, we will have $\frac{\partial W}{\partial t_i}=1$.

equations (20) through (38). I will use these equations (43) and (44) to measure the optimal per unit check-off and optimal advertising expenditure through simulation.

III. Numerical Simulation

For ease of exposition, I have thus far limited the analysis to a relatively simple case. I now turn to numerical simulation to quantify the effect of generic dairy advertising in the U.S. dairy sector. Specifically, I model the markets for three products(fluid milk, cheese, and other dairy products) produced from milk components and potentially related in demand. To simulate the model, I draw parameter values from the literature where available, and I use data on the 2005 U.S. dairy market from public sources. I consider a range of possible values for the cross-advertising elasticities of demand($\alpha_{ij},\ i \neq j$), because no published estimates exist.

1. Simulation Scenarios

In order to quantify the importance of cross-market linkages in measuring the effects of dairy advertising, I simulate 40-percent increases in the check-off for fluid milk and for cheese. In each case, I measure the market effects under four parameter scenarios:

1. Base scenario with horizontal supply and demand linkages: the cross-advertising elasticities between fluid milk and cheese are imputed using Basmann’s adding-up condition, assuming fluid milk and cheese are a separable group, and all other model parameters reflect likely values (<Table 1> and <Table 2>).
2. A restricted model assuming no horizontal demand linkages (i.e., all cross-price and cross-advertising elasticities of demand are zero), but allowing for horizontal supply linkages (i.e., dairy product markets are integrated through their common use of milk).

3. A restricted model assuming no horizontal demand or supply linkages.
4. A restricted model assuming zero cross-advertising elasticities.

Comparing scenarios 2 and 3 to scenario 1 provides a measure of the empirical implications of the cross-market effects for measuring the effects of generic advertising. To simulate the restricted model assuming no horizontal demand or supply linkages (scenario 3), the model of the effects of advertising for fluid milk (product 1) in equations (20) through (38) is modified as the system of equations under the assumption that $EX_2 = EM_2 = Ea_2 = Eb_2 = 0$ and $EW_2 = EP_2 = EW_{2a} = EW_{2b} = 0$. Scenario 4 was developed to analyze the role of linkages through markets in the case of no cross-effects of generic advertising. Since there is no attempt to estimate cross-advertising elasticities in previous literature, I derived cross-advertising elasticities for simulation through Bassmann's condition, like other previous papers. Thus, this simulation will show whether the linkages through markets still work without cross-advertising effects that were not empirically estimated but theoretically accepted.

TABLE 1. Demand Elasticities Used in Base Scenarios

	Elasticity with respect to					
	Price of (η_{ij}):			Advertising Expenditure for (a_{ij}):		
Demand for:	Fluid milk	Cheese	Other dairy Products	Fluid milk	Cheese	Other dairy Products
Fluid milk	-0.463	0.028	-0.043	0.036	-0.055	0.00
Cheese	0.028	-0.460	-0.016	-0.018	0.027	0.00
Other dairy products	-0.043	-0.016	-0.513	0.00	0.00	0.031

TABLE 2. 2005 U.S. Dairy Market Statistics Used in Simulations

	Units	
Prices		
Farm price of milk (W_f)	\$/cwt	14.92
Blend price of milk (W)	\$/cwt	15.07
Blend milk fat price (W_a)	\$/cwt	170.95
Processor price of milk fat in fluid products (W_{1a})	\$/cwt	173.59
Processor price of milk fat in cheese (W_{2a})	\$/cwt	170.43
Processor price of milk fat in other products (W_{3a})	\$/cwt	170.43
Blend milk protein price (W_b)	\$/cwt	246.02
Processor price of milk protein in fluid products (W_{1b})	\$/cwt	248.20
Processor price of milk protein in cheese (W_{2b})	\$/cwt	245.04
Processor price of milk protein in other products (W_{3b})	\$/cwt	245.04
Retail price of fluid milk (P_1)	\$/gallon	3.19
Retail price of cheese (P_2)	\$/lb.	4.13
Retail price of other dairy products (P_3)	\$/lb.	1.13
Per unit check-off		
Check-off for fluid milk advertising (t_1)	¢/cwt	3.85
Check-off for cheese advertising (t_2)	¢/cwt	5.85
Check-off for other dairy products advertising (t_3)	¢/cwt	0.50
Quantities		
Farm supply of milk (M)	mil. lbs. per year	176,989
Milk fat supply (a)	mil. lbs. per year	6,478
Milk fat sold for fluid products (a_1)	mil. lbs. per year	1,051
Milk fat sold for cheese (a_2)	mil. lbs. per year	2,577
Milk fat sold for other dairy products (a_3)	mil. lbs. per year	2,850
Milk protein supply (b)	mil. lbs. per year	5,335
Milk protein sold for fluid products (b_1)	mil. lbs. per year	1,666
Milk protein sold for cheese (b_2)	mil. lbs. per year	720
Milk protein sold for other dairy products (b_3)	mil. lbs. per year	2,949
Retail supply of fluid milk (X_1)	mil. lbs. per year	54,543
Retail supply of cheese (X_2)	mil. lbs. per year	10,349
Retail supply of other diary products (X_3)	mil. lbs. per year	18,635

Note: All prices and quantities are from the data of the U.S. Department of Agriculture (USDA-NASS Agricultural Statistics 2005 and Federal Milk Marketing Order (FMMO) Statistics) and the U.S. Department of Labor. Check-off is based on the 2003 Dairy Management Inc (DMI) annual report.

2. Parameter Values and Data Used for Simulation

Base values of demand elasticities used in our simulations are reported in <Table 1>. Published estimates of demand and supply elasticities vary as a result of different levels of aggregation across time, products, and geography, as well as different econometric specifications. Many papers have estimated the own-price elasticity of U.S. retail demand for dairy products. Estimates of the own-price elasticity of U.S. retail demand for fluid milk range from -0.882 to -0.0431(Heien and Wessels; Huang; Kaiser(1999); Schmit and Kaiser(2002); Chouinard et al.). Estimates of the own-price elasticity of U.S. retail demand for cheese range from -0.773 to -0.146(Heien and Wessels; Huang; Kaiser (1999); Schmit and Kaiser(2002); Chouinard et al). Estimates of the own-price elasticity of U.S. demand for butter range from -0.410 to -0.2428(Huang; Chouinard et al.). Estimates of own-price elasticities of demand exist for frozen products(Huang, -0.0784; Chouinard et al. -0.803) and yogurt (Chouinard et al. -0.773). Based on the published estimates, I choose own-price elasticities that were calculated as average values: -0.463 for fluid milk, -0.460 for cheese, and -0.513 for other dairy products.

A few studies have also estimated cross-price elasticities of retail demand for dairy products. Estimates of the cross-price elasticity of demand between fluid milk and cheese range from -0.04 to 0.095(Heien and Wessels; Huang; Chouinardet al.). Estimates of the cross-price elasticity of demand between fluid milk and butter range from -0.032 to 0.021(Heien and Wessels; Huang; Chouinardet al.). Estimates of the cross-price elasticity of demand between fluid milk and frozen dairy product range from -0.1434 to -0.016 (Huang; Chouinard et al.). Thus the evidence on the sign and magnitude of cross-price elasticities is mixed. I proceed under the assumption that dairy products are likely to be substitutes at the level of aggregation relevant for national generic commodity advertising. This assertion is supported by many of the published estimates, and also by the recent 3-A-Day^{TM} dairy advertising campaign that encourages consumers to consume three servings of milk, cheese or yogurt a day(DMI (2006)). In fact, the average values of estimates in previous research were 0.028 as the cross-price elasticity of demand between fluid milk and cheese, and -0.043 as the cross-price elasticity between fluid milk and other dairy products, which were chosen for simulation analysis.

Own-advertising elasticities of demand are also drawn from the literature. Estimates of the U.S. own-price elasticity of demand for fluid milk range from 0.014(Liu et al.) to 0.057(Kaiser(1999)). Estimates of the own-price elasticity of demand for cheese range from 0.015 (Kaiser(1999)) to 0.039 (Kaiser and Schmit). Based on the estimates, I choose 0.036 as the own-advertising elasticity of demand for fluid milk, 0.027 as the own-advertising elasticity of demand for cheese, and 0.02 as the own-advertising elasticity of demand for other dairy products, which are the average values of estimates in previous research.

None of the research listed above estimates cross-advertising elasticities. Basmann showed that for a weakly separable group of n products, the advertising elasticities must satisfy $\sum_{i=1}^{n} B_i \alpha_{ij} = 0, j = 1, \ldots, n$, where B_i is the budget share for the i^{th} product. Intuitively, Basmann's adding up condition states that if advertising is effective at increasing demand for the advertised product, it must also decrease demand for some other products, which might be substitutes. Thus advertising has potentially important indirect effects on demand for non-advertised products(e.g., Alston, Freebairn, and James; Kinnucan and Myrland; Kinnucan and Miao). In the case of dairy advertising, under our maintained hypothesis that dairy products are substitutes, advertising for one product decreases demand for other dairy products. For the purpose of our simulations, I assumed that fluid milk and cheese are in the separated group, and derived -0.018 and -0.055 as cross-advertising elasticities between fluid milk and cheese.

Estimates of the elasticity of the U.S. milk supply range between 0.22 and 2.53, depending on the relevant time horizon and econometric specification(Chavas and Klemme, short-run elasticity of 0.22, long-run elasticity of 1.17; Cox and Chavas, 0.37; Helmberger and Chen, 0.583; Chen, Courtney, and Schmitz, 2.53). I use 1.375 as the value of the elasticity of supply for milk over a 1-year time horizon, which is the average value of estimates in previous research.

Shares and price ratios used in the model are calculated from data from the U.S. Departments of Agriculture and Labor, reflecting prices and quantities in the U.S. dairy markets in 2005(<Table 2>). The blend price (W) is the weighted average FMMO uniform price, and the net producer price (W_f) is calculated as the blend price less the check-off of \$0.15. The milk fat price (W_a) and milk protein price (W_b) are milk component values under FMMO classified pricing, and the price of milk fat for dairy product i (W_{ia}) and the price of milk protein for dairy product i (W_{ib}) are imputed from FMMO data. I calculate product-specific check-offs that are based on the 2003 Dairy Management Inc. annual report (DMI (2003)), which shows that a total of 68 percent DMI revenue was used for "marketing," which I take mean generic advertising: 23 percent of the DMI budget was used for fluid milk marketing, 35 percent for cheese marketing, 3 percent for dairy ingredient marketing, and 7 percent for school marketing. I allocate the 7 percent for school marketing to the other three categories based on each category's share of the DMI marketing budget, and multiply the result by the full check-off (\$.15/cwt) to calculate the product-specific check-off rates.

3. Simulated Effects of 40% Increases in Check-offs for Dairy Advertising

<Table 3> shows the effects of a 40 percent increase in the per unit check-off for fluid milk advertising under scenarios 1-4. Under all scenarios, fluid milk advertising increases the price and quantity of fluid milk, P_1 and X_1, which means that generic advertising has the positive impact on the price and quantity of the advertised product. In scenarios 1, 2 and 4, the direction of change in the prices of non-advertised products, cheese, and other dairy products is positive or negative. That makes sense because there are two factors affecting the price after advertising: (a) shift-down of demand of non-advertised products due to advertising, (b) increasing marginal cost, i.e., increase of advertising expenditure. Thus, the direction of change in the price of non-advertised products depends on these above factors. The quantities of non-advertised products decrease in scenarios 1 and 2, which means advertising shifts down the demand of non-advertised products. In scenario 3, assuming no horizontal demand and supply linkages, there is no change in prices and quantities of non-advertised products.

TABLE 3. Market Effects of a 40% Increase in the Per Unit Check-off for Fluid Milk Advertising

Scenario	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
Prices	% change	Level change	% change	Level change	% change	Level change	% change	Level change
Net farm price of milk (W_f, cents per cwt)	0.073	1.09	0.470	7.01	0.384	5.73	0.453	6.76
Blend price of milk (W, cents per cwt)	0.176	2.64	0.568	8.56	0.483	7.28	0.551	8.31
Blend milk fat price (W_a, cents per cwt)	-1.847	-315.80	-0.393	-67.20	-0.018	-2.99	-0.359	-61.43
Milk fat price in fluid milk (W_{1a}, cents per cwt)	-1.818	-315.52	-0.387	-67.14	-0.106	-18.38	-0.354	-61.37
Milk fat price in cheese (W_{2a}, cents per cwt)	-1.851	-315.46	-0.394	-67.13	0.0	0.0	-0.360	-61.36
Milk fat price in other dairy products (W_{3a}, cents per cwt)	-1.851	-315.46	-0.394	-67.13	0.0	0.0	-0.360	-61.36
Blend milk protein price (W_b, cents per cwt)	1.915	471.09	1.486	365.65	0.996	245.15	1.423	350.19
Milk protein price in fluid milk (W_{1b}, cents per cwt)	1.898	471.01	1.473	365.60	3.163	785.14	1.411	350.13
Milk protein price in cheese (W_{2b}, cents per cwt)	1.923	471.14	1.492	365.70	0.0	0.0	1.429	350.23
Milk protein price in other dairy products (W_{3b}, cents per cwt)	1.923	471.14	1.492	365.70	0.0	0.0	1.429	350.23
Retail price of fluid milk (P_1, cents per gallon)	0.759	2.42	0.903	2.88	2.161	6.89	0.870	2.77
Retail price of cheese (P_2, cents per pound)	-0.777	-3.21	0.143	0.59	0.0	0.0	0.149	0.62
Retail price of other dairy products (P_3, cents per pound)	0.407	0.46	0.735	0.83	0.0	0.0	0.710	0.81
Quantities								
Farm supply of milk (M, mil. lbs. per year)	0.073	129.59	0.470	831.49	0.384	679.34	0.423	801.25
Milk fat supply (a, mil. lbs. per year)	0.073	4.74	0.470	30.43	0.384	24.86	0.453	29.33
Milk fat sold for fluid products (a_1, mil. lbs. per year)	4.550	47.82	4.069	42.77	2.369	24.90	4.006	42.10
Milk fat sold for cheese (a_2, mil. lbs. per year)	-1.667	-42.95	0.004	0.09	0.0	0.0	0.052	1.33
Milk fat sold for other dairy products (a_3, mil. lbs. per year)	-0.001	-0.04	-0.434	-12.36	0.0	0.0	-0.493	-14.04
Milk protein supply (b, mil. lbs. per year)	0.073	3.91	0.470	25.06	0.384	20.48	0.453	24.15
Milk protein sold for fluid products (b_1, mil. lbs. per year)	3.255	54.23	3.421	57.00	1.230	20.50	3.391	56.49
Milk protein sold for cheese(b_2, mil. lbs. per year)	-4.287	-30.87	-1.306	-9.41	0.0	0.0	-1.191	-8.58
Milk protein sold for other dairy products(b_3, mil. lbs. per year)	-0.658	-19.39	-0.762	-22.47	0.0	0.0	-0.804	-23.70
Retail quantity of fluid milk(X_1, mil. lbs. per year)	1.048	571.71	1.039	566.67	0.453	247.25	1.027	560.29
Retail quantity of cheese (X_2, mil. lbs. per year)	-0.347	-35.95	-0.053	-5.50	0.0	0.0	-0.044	-4.50
Retail quantity of other diary products (X_3, mil. lbs. per year)	-0.227	-42.22	-0.362	-67.51	0.0	0.0	-0.390	-72.72
Producer surplus (mil. dollars per year)		19.34		124.35		101.55		119.82

Now, focus on the change in price and quantity of milk. Under all scenarios, the price and quantity of milk increase after 40 percent increase in the per unit check-off for fluid milk advertising. That presents advertising increasing the price and quantity of milk, and thus a milk producer, who pays check-off for advertising, is better-off. Indeed, the change in producer surplus is positive in all scenarios in <Table 3>. Notice that the advertising is more powerful at increasing the price and quantity of milk, and producer surplus, when the horizontal linkages are ignored. Comparing simulation results in scenarios 2 and 3 to scenario 1 shows that the effect of advertising depends on horizontal demand and/or supply linkages. When there are no demand linkages across dairy product markets(scenario 2), fluid milk advertising is 6 times as effective at increasing the farm price and quantity of milk(a 0.470% increase compared to a 0.073% increase in scenario 1), and the net producer gain is 6 times as large($124 million compared to a $19 million). With no demand or supply linkages(scenario 3), fluid milk advertising is 5 times as powerful at increasing the farm price and quantity of milk(a 0.384% increase compared to a 0.073% increase in scenario 1), and the net producer gain is 5 times as large($102 million compared to a $19 million). Then, comparing scenario 4 to scenario 2 shows that when cross-price elasticities as well as cross-advertising elasticities are zero(Scenario 2), the advertising effect is 4% more powerful than when only cross-advertising elasticities are zero(Scenario 4). Thus, when the cross-effects of advertising are ignored, the advertising effects are more powerful without linkages through markets.[5] Simulation results show that the effectiveness of advertising and benefit from advertising will be overestimated when the horizontal linkages are ignored, like previous research evaluating the effect of generic dairy advertising.

Let's move on to the change in the price and quantity of milk components. After 40 percent increase in the per unit check-off for fluid milk advertising, the quantities of milk components used in fluid milk, a_1 and b_1, increase. Thus, expanding advertising expenditure raises the quantity of milk components for advertised product. One thing notable is the change in the

[5] We also know that the linkages through markets still work without cross-advertising effects (zero cross-advertising elasticities), which was discussed in the previous chapter by comparing scenario 4 to scenario 1.

price of milk components due to the increase in per unit check-off. After 40 percent increase in the per unit check-off for fluid milk advertising under all scenarios, all milk fat prices (W_a and W_{ia}) decrease, while all milk protein prices (W_b and W_{ib}) increase. These results verify the economic implication that advertising for a protein-intensive product, fluid milk, will increase the derived demand for milk protein relative to milk fat, which raises milk protein price. Since cows produce additional milk in fixed proportions, the quantities of milk protein and milk fat will increase at the same rate. Finally, milk fat price decreases due to over-supply. However, blend price of milk (W), which is weighted average of blend milk fat price and blend milk protein price, is raised by increasing per unit check-off for fluid milk advertising. One thing interesting is that horizontal demand(and/or supply linkages) makes larger the change in the price of milk components due to advertising. When there are demand and supply linkages, fluid milk advertising is more effective at decreasing milk fat price(a 1.847% decrease compared to a 0.018%~0.393% decrease in other scenarios), and at raising milk protein price(a 1.915% increase compared to a 0.996%~1.486% increase in other scenarios).

4. Optimal Advertising Expenditure for Dairy Products

In <Table 4>, I report the optimal check-offs and advertising expenditures for fluid milk for each of the four scenarios. From equations (43) and (44), the optimal check-off and optimal expenditure are proportional to EW/Et_l, the elasticity of the blend price of milk with respect to the check-off for the advertised product. The results mirror those of the simulations reported in <Tables 3> and discussed above. Optimal advertising expenditure for fluid

Table 4. Optimal Advertising Expenditure under Alternative Model Assumptions

Scenarios		With linkages	With no perfect linkages		
		Scenario 1	Scenario 2	Scenario 3	Scenario 4
EW/Et_l		0.0044	0.0142	0.0121	0.0138
Optimal check-off	cents per cwt	6.6	21.4	18.2	20.8
Optimal expenditure	mil. dol.	117.0	378.8	322.1	367.5

milk under the assumption that no horizontal relationships exist between dairy product markets is greater than optimal expenditure under the more general model.

IV. Conclusion

This paper provides theoretical and empirical evidence that the horizontal demand and supply linkages have an important role in the effectiveness of generic advertising on the market. The results of simulation present that evaluation of the impact of generic advertising should consider the horizontal linkages. The previous literature, which ignores these linkages, reports inaccurate measurement of the effect of advertising and the returns to dairy advertising, and thus producers are misled to pay more money for generic advertising.

In Korea, the generic advertising program for dairy products was started in 1999, but there are only a few economic studies evaluating the effect of generic promotion. The paper, basically, agrees with the results of Korea's previous research that presents the positive returns to generic promotion. However, this paper also showcases the possibility of over- or underestimation estimation of the effectiveness of generic advertising.

The concepts and models developed in this paper are applicable to the economics of promotion in industries where a single commodity is allocated to multiple downstream markets. Examples include the allocation of a farm commodity in alternative processed markets, processed vs. fresh markets, or foreign vs. domestic markets. The paper also has implications for further empirical research on generic advertising. For example, this research will offer a basic concept to develop a model to understand the generic promotion of milk, pork, beef or any other agricultural products in Korea.

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