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MEASUREMENT OF GENERIC MILK PROMOTION EFFECTIVENESS USING AN IMPERFECT COMPETITION MODEL

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Abstract

An analytical model to evaluate milk promotion effectiveness incorporating the degree of competition is presented. The imperfect competition model allows for simultaneous movement of both price and quantity with an endogenous fluid milk premium. The model's usefulness is demonstrated using the Japanese generic milk promotion data. The results show that a conventional exogenous-price model will underestimate returns to milk promotion.

Key words: generic milk promotion, fluid milk premium, imperfect competition.

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Introduction

Although raw milk is essentially a homogeneous input into the production of fluid milk and manufactured dairy products, in many countries the fluid milk price is higher than the manufacturing milk price. Such price discrimination indicates that the fluid milk price and quantity are not competitively determined.

Changes in fluid milk promotion expenditures, in theory, will bring about changes in the fluid milk price as well as in the quantity of milk marketed as fluid milk products. Thus, effectiveness of the promotion program should be measured considering changes in both price and quantity. Price and quantity of fluid milk must be treated as endogenous. However, if the degree of competition is not incorporated in the model, one of the other must be treated as exogenous because imperfect competition exists in the milk market. This "trade off" problem can be solved by incorporating the degree of competition into the model.

In most studies of U.S. dairy markets, an exogenous fluid milk price (Thompson, Eiler, and Forker; Liu and Forker 1989, 1990; Ward and Dixon; Blisard, Sun, and Blaylock), or an exogenous fluid milk premium (Kaiser, Streeter, and Liu; Liu, et al.) is assumed. No models known to the authors have incorporated the degree of competition in U.S. dairy markets. However, considering that many dairy cooperatives in the U.S. exercise some market power (as is evidenced by the existence of over-order payments), an imperfect competition model should provide better estimates of dairy promotion effectiveness. In the Japanese market, the assumption of an exogenous fluid price or premium is even more inappropriate because fluid milk prices are determined in individual negotiations between prefectural milk marketing boards (designated dairy cooperatives) and the processors they supply. Given that the price for manufacturing milk is set by the Japanese government, market power wielded by the prefectural boards is pivotal in fluid milk price determination.

Moreover, in most models, promotion expenditures have been modeled as exogenous. Because generic promotion expenditures are collected by assessments on milk marketings, increases in assessments affect fluid milk quantity marketed, and in turn increased fluid quantity also increases the amount of assessments. This means promotion expenditures should be treated as endogenous as well.

In this paper, a framework to measure promotion effectiveness which incorporates the degree of market competition is proposed. The usefulness of the model is then demonstrated using Japanese national generic milk promotion data. We show a relationship between movements of the fluid milk price and quantity, and factors which affect their movements (including the degree of competition, and the degree of demand response to price and promotion). The paper also illustrates how the proposed model yields a more accurate estimate of the marginal rate of return to promotion than an exogenous price model would. This is the first attempt to evaluate returns to fluid milk promotion with simultaneous movements in price and quantity, endogenously determined fluid milk premium and promotion expenditures, and an explicit consideration of imperfect competition.

Although there are several criticisms of an approach that identifies the degree of market competitiveness, especially regarding a dynamic feedback game, its usefulness in empirical studies has been widely accepted in the literature (Appelbaum; Azzam and Pagoulatos; Azzam and Schroeter; Bresnahan; Chen and Lent; Dixit; Durham and Sexton; Holloway; Iwata; Karp and Perloff; Maier; Schroeter; Schroeter and Azzam; Sullivan; Suzuki, Lenz and Forker; Wann and Sexton).

The Japanese Milk Promotion System

The National Milk Promotion Association of Japan (NMPAJ), established in 1978, is the sole agency responsible for Japanese generic milk promotion. In addition to its donation to the NMPAJ, each prefectural milk marketing board also promotes its prefectural brand. In the present analysis, we consider only the NMPAJ's nationwide generic program.[1]

The NMPAJ's budget, prepared every fiscal year (April through March), was 8 billion yen ($61.5 million) for FY 1990. This revenue

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[1]While it would be desirable to analyze the total advertising program for fluid milk and manufactured dairy products, the proprietary nature of data pertaining to the prefectural boards' and dairy product manufacturers' branded advertising programs preclude their incorporation into our analysis. However, as with most brand advertising, these programs are primarily aimed at increasing the advertisers' market share. The NMPAJ generic program, on the other hand, is primarily a demand expansion program for fluid milk, and is the focus of our study.

came from three main sources: assessments (2.8 billion yen), government subsidies (4 billion yen), and carryover from FY 1989 (1.2 billion yen). Unlike the U.S., where dairy farmers pay mandatory promotion assessments, in Japan assessments, which are not obliged by law, are levied on retailers, manufacturers, and farmers, and the promotion fund is augmented by government subsidies. The voluntary assessments on farmers and manufacturers are 0.24 yen per kilogram (kg) (8.4¢/cwt) of fluid milk and 0.10 yen per kg (3.4¢/cwt) of manufacturing milk marketed. Assessments on farmers are collected through prefectural marketing boards. Retailers are assessed 0.24 yen per kg (8.4¢/cwt) of fluid milk purchased from manufacturers. NMPAJ's total assessment revenue is equal to: [0.24 × 3 × (fluid milk quantity marketed) + 0.10 × 2 × (manufacturing milk quantity marketed)] × [1 - (collection loss)]. With a mandatory program, assuming no collection losses, FY 1990 assessment revenue would have been 4.3 billion yen. After adjusting for a 34 percent collection loss due to assessments not being mandatory (i.e., a free rider problem exists), NMPAJ actually received 2.8 billion yen in assessment revenue in FY 1990.

NMPAJ's 8 billion yen FY 1990 budget was divided among three primary expenditure categories: promotions (6.4 billion yen), administration (0.4 billion yen), and carryover to 1991 (1.2 billion yen).[2] NMPAJ's promotion activities encompass media advertising, and a

[2]Carryover to next year = (actual expense) - (budget).

wide variety of non-advertising activities.[3] With the exception of a cheese fair, NMPAJ's promotional activities are primarily focused on expanding fluid milk consumption. After FY 1987, NMPAJ's funding increased sharply, primarily due to increases in government subsidies which have been allocated mostly to school milk promotion (See Appendix tables 1 and 2).

The weight of existing evidence indicates that, in most cases, an appropriate evaluation of generic milk promotion effectiveness requires monthly expenditure data. In addition to annual expenditure data, NMPAJ also provided us with a monthly data series.

The Model

An imperfect competition model to evaluate milk promotion effectiveness is developed using Japanese national milk promotion data. Because the interest of this paper is focussed on the boards' decision making, it is assumed that total milk supply is fixed and that each board allocates its raw milk supply to fluid and manufacturing uses to maximize its total milk sales revenues net of promotion assessments. The i^{th} board's maximization problem is[4]

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[3]The non-advertising activities encompass booklet distributions (on topics such as milk and health, cooking with milk, sports nutrition, guidelines for health professionals, and information for teachers and young children), special events (including a milk home-delivery campaign, a milk and dairy products fair, and a cooking contest), cooking classes, seminars for opinion leaders, research on market trends, and special projects for promoting milk consumption in schools.

[4]If $q^i - q_f^i < PQ^i$, the objective function is replaced by max $NR^i = P_f q_f^i + GP\cdot(q^i - q_f^i) - a^i$. This is not the case in our analyses.

$$\max NR^i = P_f q_f^i + GP \cdot PQ^i + SP \cdot (q^i - q_f^i - PQ^i) - a^i$$

s.t.

(1) $Q_f = f(P_f, M)$

(2) $Q_f = q_f^i + \sum_{j \neq i} q_f^j$

(3) $\sum_{j \neq i} q_f^j = g(q_f^i)$

(4) $M = A/c$

(5) $A = a^i + \{0.24 \cdot \sum_{j \neq i} q_f^j + 0.10 \cdot (\sum_{j \neq i} q^j - \sum_{j \neq i} q_f^j) + 0.24 \cdot 2 \cdot Q_f$
$+ 0.10 \cdot (Q - Q_f)\} \cdot L + S$

(6) $a^i = \{0.24 \cdot q_f^i + 0.10 \cdot (q^i - q_f^i)\} \cdot L$

where NR is total revenue net of promotion costs, P_f is fluid milk price, q_f^i is the ith board's fluid milk supply, GP is the guaranteed price for manufacturing milk, PQ^i is the ith board's payment quota, SP is the standard purchase price for over-payment-quota manufacturing milk,[5] q^i is the ith board's total milk supply, and a^i is the ith board's assessment expenditures. Q_f is total fluid milk supply, M is total promotion messages, A is total promotion expenditures, and c is the unit

[5]The Japanese federal government operates a deficiency payment system for manufacturing milk. Through their prefectural marketing board, farmers receive the standard purchase price for manufacturing milk from manufacturers for within payment quotas. The federal government pays farmers the difference between the standard purchase price and the guaranteed price, again within payment quotas. The federal government sets the guaranteed and standard prices and payment quotas. Although manufacturers are not obligated to pay the standard purchase price for over-payment-quota milk, they usually do so because this price is determined based on market prices of dairy products and manufacturer's processing and selling costs (Suzuki, Lenz and Forker).

price of promotion messages (the Consumer Price Index is used as a proxy for c in our empirical model). Q is total milk production, L is the collection ratio (the ratio of actual to expected assessments), and S is government subsidies. Equation (1) is the aggregate fluid milk demand function (f implies causality), and (3) is the i^{th} board's conjecture of the other boards' aggregate reaction function (g implies causality). In (5) and (6), 0.24 (yen) and 0.10 (yen) imply per kg assessments from fluid and manufacturing milk, respectively. The term, $\{0.24\cdot q_f^i + 0.10\cdot(q^i - q_f^i)\}$, is the i^{th} board's assessment, and the term, $\{0.24\cdot\sum_{j\neq i} q_f^j + 0.10\cdot(\sum_{j\neq i} q^j - \sum_{j\neq i} q_f^j)\}$, is the other boards' assessment, while the term, $\{0.24\cdot 2\cdot Q_f + 0.10\cdot(Q - Q_f)\}$, is manufacturers' and retailers' assessments. The product of 0.24·2 means that 0.24 yen (fluid milk assessment) is collected from both manufacturers and retailers, while 0.10 yen (manufacturing milk assessment) is not collected from retailers. With aggregate collection losses ranging from 32 to 55 percent during the years 1981-90, the collection ratio, L, must be included in (5) and (6) to avoid overstating assessment income. Although L should be endogenous, L is treated exogenous in this model because it is difficult to incorporate the factors which affects collection loss into the model.

The first order condition obtained by solving the maximization problem for (P_f, Q_f, q_f^i, a^i, M, $\sum_{j\neq i} q_f^j$, A), taking (q^i, PQ^i, GP, SP, c, Q, L, S) as given, is[6]

$$(7)\quad P_f - 0.24\cdot L + [1 - 0.52\cdot L\cdot(\partial Q_f/\partial M)/c]\cdot[1 + \partial(\sum_{j\neq i} q_f^j)/\partial q_f^i]\cdot q_f^i\cdot(\partial P_f/\partial Q_f)$$
$$= SP - 0.10\cdot L$$

where 0.52 is derived from [0.24×3 - 0.10×2]. Equation (7) expresses equality across markets of perceived marginal revenue net of perceived marginal assessments. Equation (7) can be expressed in elasticity terms as:

$$(8)\quad P_f - 0.24\cdot L - (1 - 0.52\cdot L\cdot\eta\cdot Q_f/A)\cdot P_f\cdot\theta^i/\epsilon = SP - 0.10\cdot L,$$

where $\epsilon = |(\partial Q_f/\partial P_f)\cdot(P_f/Q_f)|$, which is the absolute value of the fluid milk own-price elasticity, $\eta = (\partial Q_f/\partial M)\cdot(M/Q_f)$, which is the fluid milk promotion elasticity, and $\theta^i = (\partial Q_f/\partial q_f^{\,i})\cdot(q_f^{\,i}/Q_f)$, which is conjectural elasticity (Appelbaum) or Tsujimura's λ (Suzuki, Lenz and Forker). By definition of conjectural elasticity, $\theta = 1$ implies monopoly or collusion because $q_f^{\,i} = Q_f$ in monopoly and $\theta = 0$ implies price-taking

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[6]The first order condition is derived by solving the following Lagrangian;

$$\begin{aligned}\Phi = {} & [P_f q_f^i + GP\cdot PQ^i + SP\cdot(q^i - q_f^i - PQ^i) - a^i] \\ & + \delta[Q_f - f(P_f, M)] \\ & + \zeta[Q_f - (q_f^i + \sum_{j\neq i} q_f^j)] \\ & + \mu[\sum_{j\neq i} q_f^j - g(q_f^i)] \\ & + \xi[M - A/c] \\ & + \pi[A - \{a^i + \{0.24\cdot\sum_{j\neq i} q_f^j + 0.10\cdot(\sum_{j\neq i} q^j - \sum_{j\neq i} q_f^j) + 0.24\cdot 2\cdot Q_f \\ & \qquad + 0.10\cdot(Q - Q_f)\}\cdot L + S\}] \\ & + \rho[a^i - \{0.24\cdot q_f^i + 0.10\cdot(q^i - q_f^i)\}\cdot L]\end{aligned}$$

behavior because $q_f^i/Q_f \doteq 0$ under perfect competition. The term, c, is lost in equation (8) because

$$(9)\quad (\partial Q_f/\partial M)/c = [(\partial Q_f/\partial M)\cdot(M/Q_f)]\cdot Q_f/(M\cdot c) = \eta\cdot Q_f/A \quad \because M\cdot c = A.$$

Because P_f and ϵ are common to all boards, assuming that milk is a homogeneous product, equation (8) requires that θ^i is the same for all boards if all boards realize the condition expressed by (8) (Holloway). We consider $\theta^i \equiv \theta$ with the assumption that the boards approximately realize the condition expressed by (8). Consequently, θ should be simply referred as a "market response elasticity" (Tsujimura) rather than conjectural elasticity.

Because θ is not derived from demand or costs, but rather depends on behavior (Helpman and Krugman), θ is difficult to directly estimate as a function of some explanatory variables. Instead, with the assumption that θ is constant in each time period, and given actual observations on (P_f, SP, L, Q_f, A) and estimates of ϵ and η, one may solve for θ using equation (8), i.e.:

$$(10)\quad \theta = (P_f - SP - 0.14\cdot L)\cdot\epsilon/[(1 - 0.52\cdot L\cdot\eta\cdot Q_f/A)\cdot P_f],$$

where 0.14 is derived from [0.24-0.10]. One can consider that θ is independent from P_f, SP, L, Q_f, and A, because θ depends on behavior (Helpman and Krugman). It allows us to introduce the derived time-specific constant θ into our model (as Dixit; Suzuki, Lenz and Forker did). The full model is thus:

Fluid milk demand:

(11) $Q_f = f(P_f, M)$

Milk sales maximizing allocation:

(12) $P_f - 0.24\cdot L + [1 - 0.52\cdot L\cdot(\partial Q_f/\partial M)/c]\cdot\theta\cdot Q_f/(\partial Q_f/\partial P_f)$

$= SP - 0.10\cdot L$

Milk promotion messages:

(13) $M = A/c$

Total milk promotion expenditures:

(14) $A = AS + S$

Total assessments:

(15) $AS = \{0.24\cdot 3\cdot Q_f + 0.10\cdot 2\cdot(Q - Q_f)\}\cdot L$

Milk sales revenue:

(16) $GR = P_f Q_f + GP\cdot PQ + SP\cdot(Q - Q_f - PQ)$

where AS is total assessments and GR is milk sales revenue, with all other variables as previously defined. From this model we can obtain equilibrium values of (Q_f, P_f, M, A, AS, GR) conditional on (L, c, θ, S, Q, GP, SP).

The Fluid Milk Demand Function

We initially included fluid milk price, consumption expenditures, milk promotion expenditures, temperature, the ratio of persons 0 to 14 years old to the total population, price of soft drinks, and 11 seasonal indicators as explanatory variables in the demand function (equation (11)). Contrary to *a priori* expectations, neither the price of soft drinks, nor the ratio of persons 0 to 14 years old to the total population were statistically significant explanatory variables. Consequently, these variables were dropped from the model.

Table 1 contains the estimated parameters and data sources for the estimated fluid demand function. This function was estimated with monthly data from April, 1981 through December, 1990, in a linear form, using the Two-Stage-Least-Squares (TSLS) because the fluid milk price and quantity, and promotion expenditures are all endogenous in our model. To overcome significant first-order autocorrelation in the disturbance term, the Cochrance-Orcutt procedure was employed.

Existing theory suggests that at some level of promotion expenditures, diminishing marginal returns should become evident. In an attempt to incorporate this effect in the model, the demand function was estimated using several forms with diminishing marginal promotion effects (linear expenditure system, double-log, semi-log, log-inverse, inverse). In terms of statistical significance and R^2, the linear form yielded the best results. In addition, each of the other forms resulted in negative marginal revenue estimates and were thus rejected because negative fluid milk marginal revenue precludes discussion of the collusion case (Suzuki, Lenz, and Forker). Although a linear form may overstate absolute rates of return to promotion, our analysis in this paper focuses on showing the relative differences of results between the imperfect competition model and an exogenous price model. Moreover, having equation (11) in linear form provides one with a clear-cut understanding of the meaning of the simulation analysis.

As a proxy for M in equation (11), milk promotion expenditures, deflated by the Consumer Price Index (CPI), are used. To account for lagged promotion effects, a polynomial distributed lag is used. Consumers need to hear and absorb promotion messages before acting on them, i.e., the current promotion effect is close to zero (Liu and Forker 1990). Previous empirical studies also indicate that the reactions to promotion messages are typically larger in later periods due to accumulated effects (i.e., the lag structure has the inverted U-shape), and then the effects decay as consumers are satiated with the messages (i.e., the effect in the last period is close to zero) (Thompson, Eiler, and Forker; Ward and Dixon; Liu, et al.). Therefore, a second degree polynomial distributed lag specification with both endpoints restricted to be close to zero seems reasonable. After trying many sets of degree of polynomial, endpoint restrictions, and the lag length, a second degree polynomial with both endpoints restricted close to zero and a 14 month lag yielded the most significant results.

In contrast with results from some U.S. studies in which carryover effects of fluid milk advertising were estimated to last approximately six months (Kinnucan, 1982, 1983; Thompson, Eiler, and Forker), the results of this paper indicate that the carryover effects of Japanese fluid milk promotion are on the order of 14 months. Longer carryover effects may have some relation with the fact that our promotion measure includes not only media advertising but also a variety of other promotional activities.

Calculated at mean data points, the own-price elasticity of fluid demand is -0.697, the expenditure elasticity is 0.319, and the long-run promotion elasticity is 0.058. Of the 27 U.S., U.K., and Canadian studies reviewed by the International Dairy Federation (IDF), only six reported a fluid advertising elasticity greater than 0.06 (IDF, p.21). Thus, compared to results from previous fluid milk studies, our estimated promotion response for Japan appears large. Japan's relatively short history of milk consumption, compared to other countries, may be contributing to the relatively large estimated promotion response. Per capita milk consumption in Japan is only about 40 percent of the U.S. level.

Table 1. Estimated Monthly Fluid Milk Demand Function

Variable[a]	Estimated Coefficient (t-value)
Intercept	3.444 (6.31)
P_f/CPIF	-1.004 (-5.18)
FEXP/CPIF	4.524 (2.56)
TEMP	0.015 (3.45)
D1	0.388 (1.81)
D2	0.459 (2.17)
D3	0.394 (2.37)
D4	0.418 (2.32)
D5	0.570 (3.46)
D6	0.606 (3.39)
D7	0.470 (3.06)
D8	0.252 (1.67)
D9	0.609 (3.35)
D10	0.571 (3.36)
D11	0.478 (2.66)
$(U^{Qf/N})_{t-1}$	0.825 (10.84)
Estimated promotion carryover:	
$(A/N/CPI)_t$	0.224 (1.91)
$(A/N/CPI)_{t-1}$	0.418 (1.91)
$(A/N/CPI)_{t-2}$	0.583 (1.91)
$(A/N/CPI)_{t-3}$	0.717 (1.91)
$(A/N/CPI)_{t-4}$	0.822 (1.91)
$(A/N/CPI)_{t-5}$	0.896 (1.91)
$(A/N/CPI)_{t-6}$	0.941 (1.91)
$(A/N/CPI)_{t-7}$	0.956 (1.91)
$(A/N/CPI)_{t-8}$	0.941 (1.91)
$(A/N/CPI)_{t-9}$	0.896 (1.91)
$(A/N/CPI)_{t-10}$	0.822 (1.91)
$(A/N/CPI)_{t-11}$	0.717 (1.91)
$(A/N/CPI)_{t-12}$	0.583 (1.91)
$(A/N/CPI)_{t-13}$	0.418 (1.91)
$(A/N/CPI)_{t-14}$	0.224 (1.91)
Sum of promotion coefficients	10.157
Adjusted R^2	0.970
D.W.	2.447

[a]Dependent variable is per capita fluid milk demand (kg), Q_f/N, where Q_f is total fluid milk demand (1,000 metric tons, Milk and Milk Products Statistics, Ministry of Agriculture, Forestry and Fisheries), and N is population (million persons, Japan Statistical Monthly Report, Prime Minister's Office (PMO)). P_f is the retail fluid milk price (yen/kg, Household Survey, PMO); CPIF is the consumer price index for food (1985=100, PMO); FEXP is average per capita food expenditures (1,000

yen, Household Survey, PMO); TEMP is average temperature in Tokyo (°C, Meteorological Agency); A is generic fluid milk promotion expenditure (million yen, estimated from annual data provided by National Milk Promotion Association of Japan); CPI is the consumer price index for all commodities (1985=100, PMO); D1 (through D11) are indicator variables equalling 1 for January (through November) and 0 for the other months. $(U^{Qf/N})_{t-1}$ is lagged residual.

Simulations

The Japanese boards actually make promotion decisions on an annual basis rather than a monthly basis. Because the fluid demand function was estimated using monthly data, the equation needed to be translated into an annual equation. The current estimated monthly demand equation can be expressed as:

$$(17) \quad \underline{Q}_f = \alpha + \beta \cdot \underline{P}_f + \gamma \cdot \underline{M}$$

where the underlined variables refer to monthly average levels. To obtain an annual demand function, simply multiply (17) by 12,

$$(18) \quad \underline{Q}_f \times 12 = \alpha \times 12 + (\beta \times 12) \cdot \underline{P}_f + \gamma \cdot \underline{M} \times 12$$

The terms, $\underline{Q}_f \times 12$ and $\underline{M} \times 12$, generate annual values of fluid milk quantity demanded and promotion messages, respectively, while the monthly average $\underline{P}_f$ is the same as the annual average. Therefore, the coefficient for promotion (γ) and the coefficient for price multiplied by 12 ($\beta \times 12$) can be used in the annual equation.

Although we would have preferred to use wholesale prices the boards receive from manufacturers, retail prices were used in estimating the monthly demand equation due to data availability. We make the simplifying assumption that the wholesale price parameter is equal to the retail price parameter. For the aggregated annual model, the distributed lag coefficients for promotion are summed into a single, long-run promotion-response coefficient. While other considerations, such as optimal timing of promotion expenditures, would dictate a more detailed analysis of carryover effects and discounted present values of net returns to promotion, such considerations are beyond the scope of our present analysis. Some previous studies also used the sum of advertising coefficients and did not considered discounted present values (Thompson, Eiler and Forker; Thompson and Eiler). Relevant to present considerations, Case and Shamblin have shown that the optimal advertising level remains surprisingly constant over a wide range of advertising carryover. The above assumptions are not crucial restrictions on our simulation analysis because our analysis in this paper focuses on showing the relative differences of results between the imperfect competition model and an exogenous price model.

Using (10) our derived annual market response elasticity (θ) declines monotonically from 0.16 for 1981 to 0.10 for 1989 (the last column of table 2). As explained earlier, θ = 1 implies monopoly or collusion and θ = 0 implies price-taking behavior. Based on our estimates, it appears that the Japanese milk market is far from collusion, and has been becoming more competitive over time, which is consistent with Suzuki, Lenz and Forker.

Table 2. Marginal Rate of Return to Promotion, $\partial P_f/\partial L$, and θ

Fiscal Year	Marginal Rate of Return		$\partial P_f/\partial L$	θ
	Imperfect Competition Model	Exogenous-Price Model		
1981	6.04	4.66	1.41	0.16
1982	6.13	4.71	1.44	0.16
1983	5.68	4.31	1.39	0.15
1984	5.26	3.96	1.30	0.13
1985	5.17	3.87	1.31	0.13
1986	4.46	3.30	1.13	0.11
1987	3.87	2.85	0.98	0.09
1988	4.22	3.12	1.05	0.10
1989	4.33	3.19	1.10	0.10

Marginal Rates of Return to Promotion

To estimate marginal rates of return to promotion, equations (11) through (16) were solved for annual equilibrium values of Q_f, P_f, and A, with the collection ratio, L, increased one percent above actual values. Because promotion expenditures are endogenous in the model, an exogenous shock was applied to increase promotion expenditures using L. Marginal rates of return reported in table 2 are calculated as the increase in wholesale fluid milk revenues divided by the increase in promotion expenditures. Since total milk supply is given, and only the allocations to fluid and manufacturing uses are in question, the only costs associated with the increased wholesale-level revenues are the increased promotion expenditures.

The second column of table 2 contains estimated marginal rates of return to promotion for 1981 through 1989 using our imperfect competition model with market response elasticities. For example, a figure of 6.04 means that one extra dollar devoted to promotion will return $6.04 more in net revenue. As the market became more competitive, the marginal rate of return to promotion declined from 6.04 in 1981 to 4.33 in 1989. These estimates suggest that under the current degree of competition, substantial opportunities may exist for revenue enhancement through increased promotion expenditures.

Instead of using the imperfect competition model, the third column of table 2 contains estimated marginal rates of return to promotion assuming an exogenous fluid milk premium, and thus an exogenous fluid milk price because we assume an exogenous manufacturing milk price. Because the fluid milk price has been declining over time, estimated rates of return to fluid milk promotion generally decline from 4.66 in 1981 to 3.19 in 1989. Estimated exogenous-price marginal rates of return range from 73 to 77 percent of the model estimates with market response elasticities.

In the imperfect competition model, a promotion-induced outward demand shift increases both price and quantity, whereas in the exogenous-price model the shift only increases quantity. As long as fluid demand is price-inelastic, sales values necessarily increase more in the imperfect competition model than in the exogenous-price model.

The following relationship is derived from equations (11) through (15) to show the relationship between fluid price changes and the factors which move the price.

$$(19)\quad \partial P_f/\partial L = [0.14 - 0.2\cdot\theta\cdot(\partial Q_f/\partial M)/c/(\partial Q_f/\partial P_f)\cdot Q]/(1 + \theta),$$

where 0.14 means [fluid assessment per kg (0.24) - manufacturing assessment per kg (0.10)], and 0.2 means [manufacturing assessment per kg (0.10) × 2]. $\partial P_f/\partial L$ indicates marginal changes in the fluid milk price associated with marginal changes in promotion expenditures caused by marginal changes in the collection ratio. Values of $\partial P_f/\partial L$ in the model are reported in the fourth column of table 2. They have been becoming smaller over time as the milk market has been more competitive. Because usually $0 \leq \theta \leq 1$, $(\partial Q_f/\partial M) \geq 0$, and $(\partial Q_f/\partial P_f) < 0$, the right hand side of (19) is positive, which indicates the fluid milk price will always increase in response to increases in promotion expenditures in the model. Because the fluid assessment per kg (0.24) is larger than the manufacturing one (0.10) in Japan, $\partial P_f/\partial L = 0.14$ even when $\theta = 0$ (price-taking behavior). If the fluid assessment per kg is the same as the manufacturing one, $\partial P_f/\partial L = 0$ when $\theta = 0$. Equation (19) also shows that increases in the fluid milk price is larger, as θ and $(\partial Q_f/\partial M)$ get larger and $(\partial Q_f/\partial P_f)$ gets smaller. These results indicate that the conventional exogenous-price model will underestimate returns to promotion.

Conclusions

In this paper we proposed a first framework to evaluate milk promotion effectiveness incorporating the degree of competition. Using the Japanese generic milk promotion data, we demonstrated how our framework improves the estimates over a conventional exogenous-price model. In Japan estimated marginal rates of return with the exogenous-price model are 23 to 27 percent smaller than those with our imperfect competition model.

We also derived an equation to show how increases in the fluid milk price associated with increases in promotion expenditures get larger, as the degree of market imperfection and the promotion elasticity of fluid demand get larger, and as the price elasticity of fluid demand gets smaller.

Our results indicate that analyses with an exogenous-price or premium model has a possibility of underestimating returns to milk promotion, when imperfect competition exists.

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Appendix

Table 1. NMPAJ's Annual Revenues[a]

Fiscal Year	Assessment (1)	Government Subsidies (2)	Carryover and Others (3)	Total Revenue (4)=(1)+(2)+(3)	Expected Assessment[b] (5)	Losses 1-(1)/(5)
	Million Yen					Percent
1981	1,999	1,172	480	3,651	3,440	42
1982	2,021	1,124	35	3,180	3,550	43
1983	2,043	1,094	14	3,151	3,616	44
1984	1,840	1,065	39	2,944	3,669	50
1985	1,653	1,031	12	2,696	3,704	55
1986	2,021	1,319	18	3,358	3,693	45
1987	2,629	3,025	123	5,777	3,842	32
1988	2,746	3,277	535	6,558	4,026	32
1989	2,711	3,509	865	7,085	4,179	35
1990	2,824	4,012	1,205	8,041	4,263	34

[a]Reported by NMPAJ.

[b]Calculated by the following definition:

[0.24 × 3 × (fluid milk quantity marketed) + 0.10 × 2 × (manufacturing milk quantity marketed)]

Table 2. NMPAJ's Promotion Expenditures[a] and Fluid Milk Demand

Fiscal Year	Media Advertising and Booklets Distribution			Events (Campaigns, Fairs, and Contests)	Promotion of Group Drinking[b]	Total Expen-ditures	Fluid Milk Demand
	TV	Radio	Total				
			Million Yen				1,000 ton
1981	167	79	699	538	1,475	3,494	4,140
1982	308	84	790	302	1,415	3,043	4,247
1983	299	75	741	333	647	2,986	4,271
1984	300	80	743	324	630	2,813	4,328
1985	251	52	489	456	653	2,575	4,307
1986	345	50	862	539	790	3,217	4,342
1987	338	25	946	678	2,454	5,226	4,598
1988	390	24	1,036	718	2,681	5,583	4,821
1989	321	13	931	628	2,804	5,783	4,956
1990	323	28	1,005	623	3,268	6,357	5,091

[a]Reported by NMPAJ.

[b]Special projects for promoting milk consumption in schools, kindergartens, and facilities for aged people.

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