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STAFF PAPER

**GENERIC DAIRY PROMOTION
ECONOMIC RESEARCH:
*Past, Present, and Future***

by
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Generic Dairy Promotion Economic Research:
Past, Present, and Future

Olan D. Forker and Donald J. Liu¹

This presentation has three purposes. The first purpose is to provide an overview of the generic dairy promotion evaluation research conducted at Cornell. Second, we will provide an overview of similar research done elsewhere. Finally, we will discuss the future direction of our research. What should Cornell do to improve the understanding of the effectiveness of dairy promotion programs both in New York and in the U.S. as a whole. As a preamble, we would like to discuss how the research has been done. This will facilitate your understanding of the research and place results in an appropriate context.

For the time being, imagine that you are the chief engineer for a major airline company and your task is to simulate the performance of a newly designed aircraft under various weather conditions. How would you proceed with the analysis? There are four possible steps.

First, you would study the environment within which the airplane is to be operated. Second, you would set up a laboratory which is as similar to the real airspace environment as possible, given economic and technical constraints. Third, you would complete your simulation model by putting a model airplane in the laboratory. Finally, you would simulate different conditions in the laboratory and observe the performance of the airplane.

In the context of advertising evaluation research, the above four steps also apply. First, we study the environment within which people make consumption decisions. That is, we investigate the factors (such as income) that affect consumers' decisions in buying milk and dairy products. Second, we identify the most important factors to include in the analysis. Data are expensive to obtain and for some variables data are simply not available. Third, we complete our advertising evaluation model by estimating a sales-advertising equation(s) with the important factors included in the equation so as to account for the consumption impact of those factors. Finally, we simulate with the model by changing the level of advertising and observing the resulting sales.

Four Common Models

Depending on the focus of the analysis, there are several ways to specify the advertising evaluation model. Four common models have been used: (1) the single demand equation model, (2) the simultaneous demand and supply equation model, (3) the industry model, and (4) the demand system model.

¹ Olan D. Forker is a Professor and Donald J. Liu is a Research Associate, Department of Agricultural Economics, Cornell University. This paper is based on a presentation at the meeting of the New York State Milk Promotion and Advisory Board on September 8, 1989. Additional presentations have been made to the staff of ADA&DC, D'Arcy Masius Benton & Bowles, and the Economic Research Committee of the New York State Milk Promotion and Advisory Board.

Single Demand Equation

The single demand equation model considers only the forces that influence the demand for milk. As an example, in Figure 1 we show that the consumption of milk depends on advertising, consumer income, price of milk, price of competing products, and social and demographic factors. The demand equation in the box relates milk consumption to its underlying determining factors. Given data on milk consumption and its determining factors, the equation can be estimated by various statistical or econometric methods. Then, the impact of advertising can be simulated by changing the level of advertising and observing the resulting milk consumption.

The strength of the single demand equation approach is its simplicity. That is, since only a few variables are involved in the equation, efforts on data collection and statistical estimation are minimal. On the other hand, since the supply aspect of the picture is ignored, simplicity also represents a major weakness of the model. Specifically, with an increase in the advertising expenditures, the model predicts that milk consumption will increase by a certain amount, holding all other factors including milk price constant. However, to entice retail suppliers to supply more milk to meet the increased demand, the price of milk has to increase which, in turn, will depress the quantity demanded somewhat. Thus, not recognizing that the milk price will also change if demand changes may result in an over-prediction of the sales impact of advertising.

Simultaneous Demand and Supply Equations

To allow for the milk price impact of advertising, the supply side of the picture has to be included. Then, instead of a single demand equation model, we have simultaneous demand and supply equations. In Figure 2, the left hand side of the picture pertains to the demand considerations while the right hand side to the supply. As in Figure 1, the demand equation relates milk demand to its underlying determining factors. However, the price of milk is not included as one of the determining factors; it is to be decided within the model. The supply equation in the right hand side of the figure relates milk supply to its underlying determining factors such as wage rate, energy cost, and other suppliers' costs.

Through the interaction of the demand and supply equations, the equilibrium milk quantity and the equilibrium milk price are determined by the model (as indicated by the two bold arrow lines). The impact of promotion can be assessed by changing the level of advertising, allowing the price of milk to be determined within the model, and observing the resulting equilibrium milk consumption level. So now we have a more appropriate measure of the advertising impact on sales as we have accounted for the price effect of advertising.

The strength of the simultaneous equation model is that both demand and supply considerations are included. The cost of including the supply side of the story is that the model becomes more complicated and its data requirement is more demanding.

In addition, there is a common drawback pertaining to both the single demand equation model in Figure 1 and the simultaneous demand and supply equation model in Figure 2. The common drawback of the two models is that they still do not provide an estimate of the impact on farmer income. Since farmers pay for the generic dairy promotion, it is important to trace back the impact of the program from the retail level to the farm sector. To accomplish this, an industry model is needed.

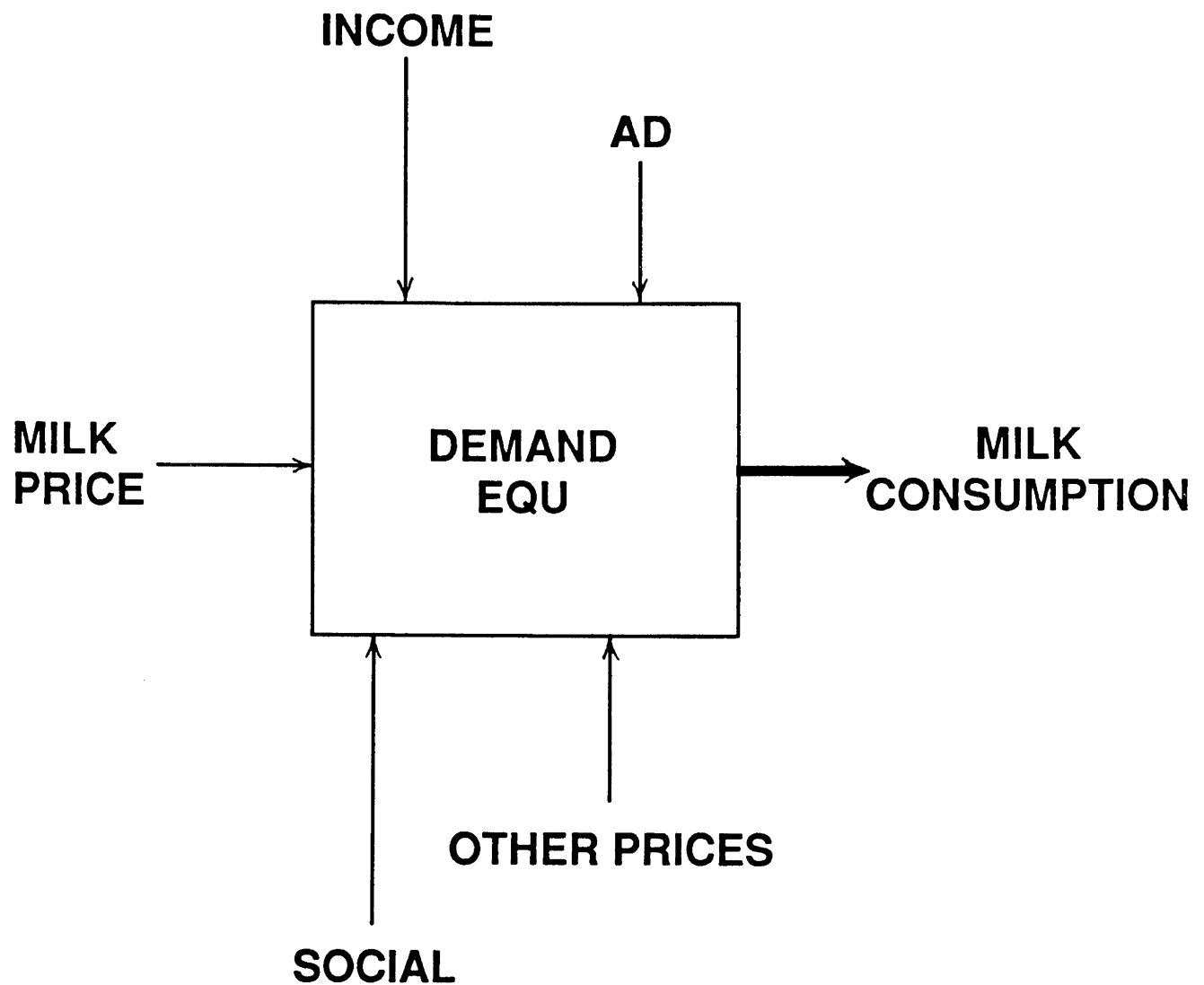


Figure 1:
SINGLE DEMAND EQUATION

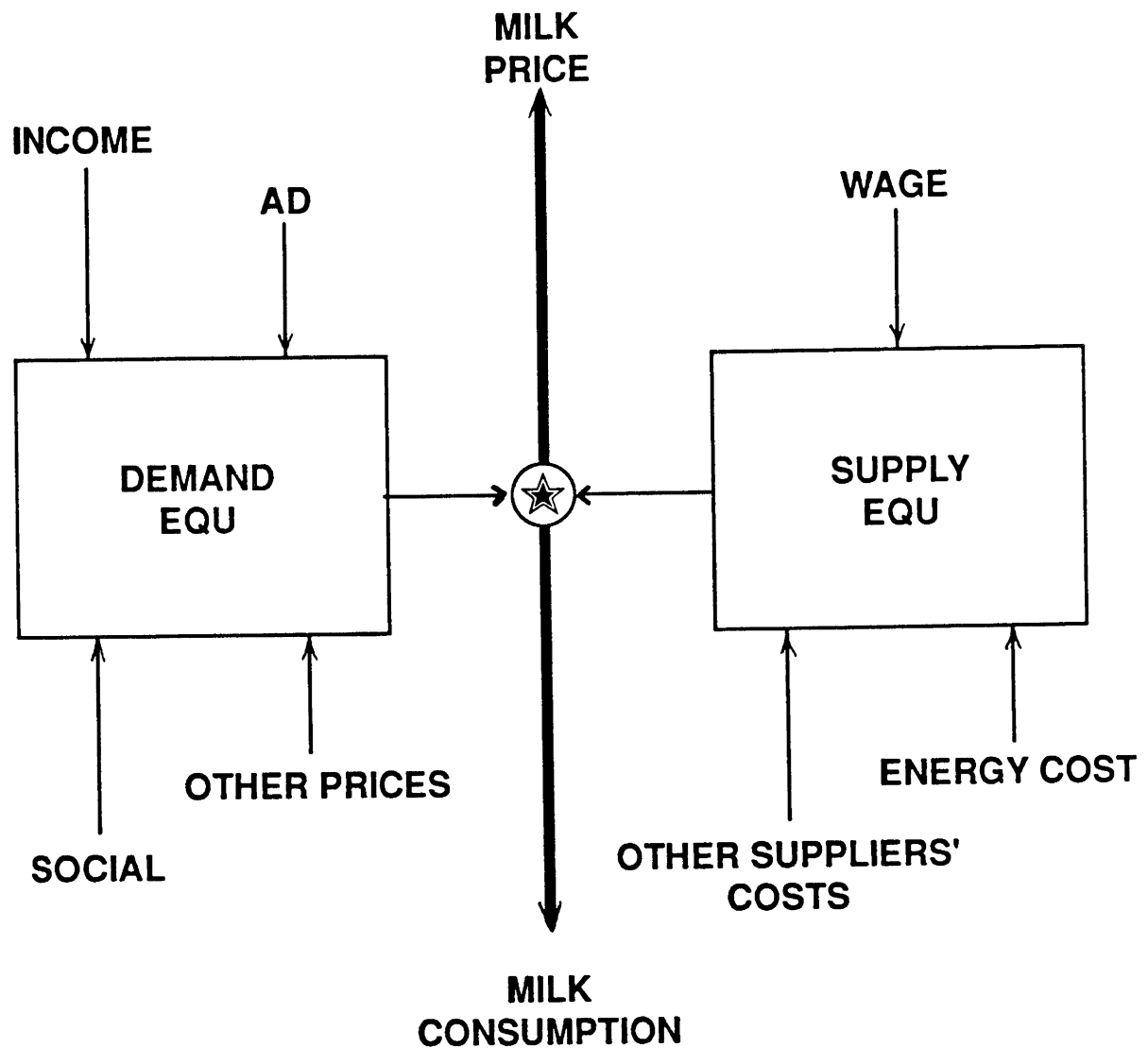


Figure 2:
SIMULTANEOUS SUPPLY/DEMAND EQUATIONS

Industry Models

The industry model presented in Figure 3 resembles the simultaneous demand and supply equation model in Figure 2, except that the structure of the dairy industry is also included. In the upper half of the figure, we show the demand and supply equations which simultaneously determine the equilibrium milk price and milk consumption, given a specific level of advertising. Then, the impact of advertising on dairy farmers can be determined by feeding the equilibrium milk consumption into the dairy industry equations in the lower half of the diagram while holding constant such underlying determining factors as feed costs, Class I differential, and government purchase prices.

Since both the demand-supply and the farm sector considerations are included, a major problem for the industry model approach is that the model can be very complicated. Both excellent knowledge of the dairy industry and good data from retail to farm level are essential in the process of model development.

Demand Systems

Finally, there is the alternative of demand system model. Notice that all the three models discussed above deal with only one commodity -- milk. Since consumers face a limited income and the size of their stomachs is finite, it might be desirable to consider several major commodities simultaneously when investigating how the consumption of milk is affected. The demand system approach is especially appropriate when viewing the milk consumption as a function of not only milk advertising but also of the advertising of competing industries.

Figure 4 presents an example of the demand system model which includes three commodities -- milk, orange juice and cola. The demand for each of the three commodities depends on the prices and advertising of the three commodities, consumer income, other prices, and social and demographic factors. With the model, the impact of milk advertising on milk consumption can be assessed by changing its advertising level while holding constant other factors including competitive advertising. In addition, one could determine the impact of orange juice advertising on milk sales which, in turn, would influence the appropriate level of milk advertising.

Like the industry model, the major problem for the demand system approach is its complexity, as several commodities are considered simultaneously. Also, the model does not incorporate supply and farm sector considerations. Presumably, one could develop a multiple-industry supply-demand model which includes all the desirable features of the different models discussed. However, this would make the resulting model extremely complicated and expensive.

To conclude, since different models have different strengths and weaknesses, the appropriate approach for the problem at hand must depend on the focus of the analysis, the availability of the data, and the industry knowledge of the researcher. In general, a more complicated model gives more detailed insight to the impact of advertising. However, a more complicated model also tends to be more sensitive to modeling and data errors and hence the results are more subject to error and incorrect interpretation.

Simulation/Optimization

The estimated sales-advertising models can be used to assess the sales impact of advertising by changing the level of advertising expenditures in the model. Given the estimated sales-advertising model, there are two methods to determine the optimal expenditure level -- simulation and optimal control. Either approach has its strengths and weaknesses.

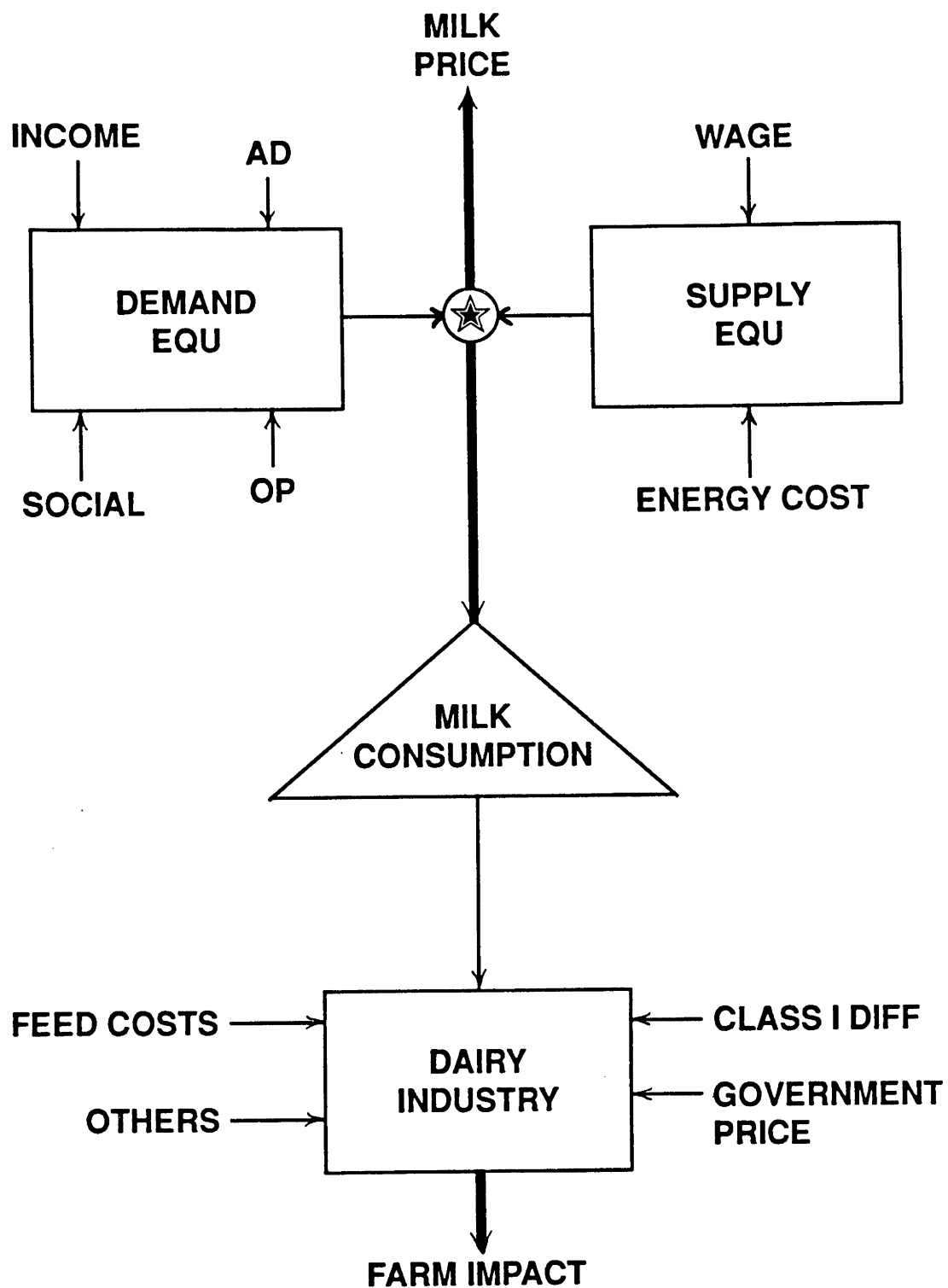


Figure 3:
INDUSTRY MODEL

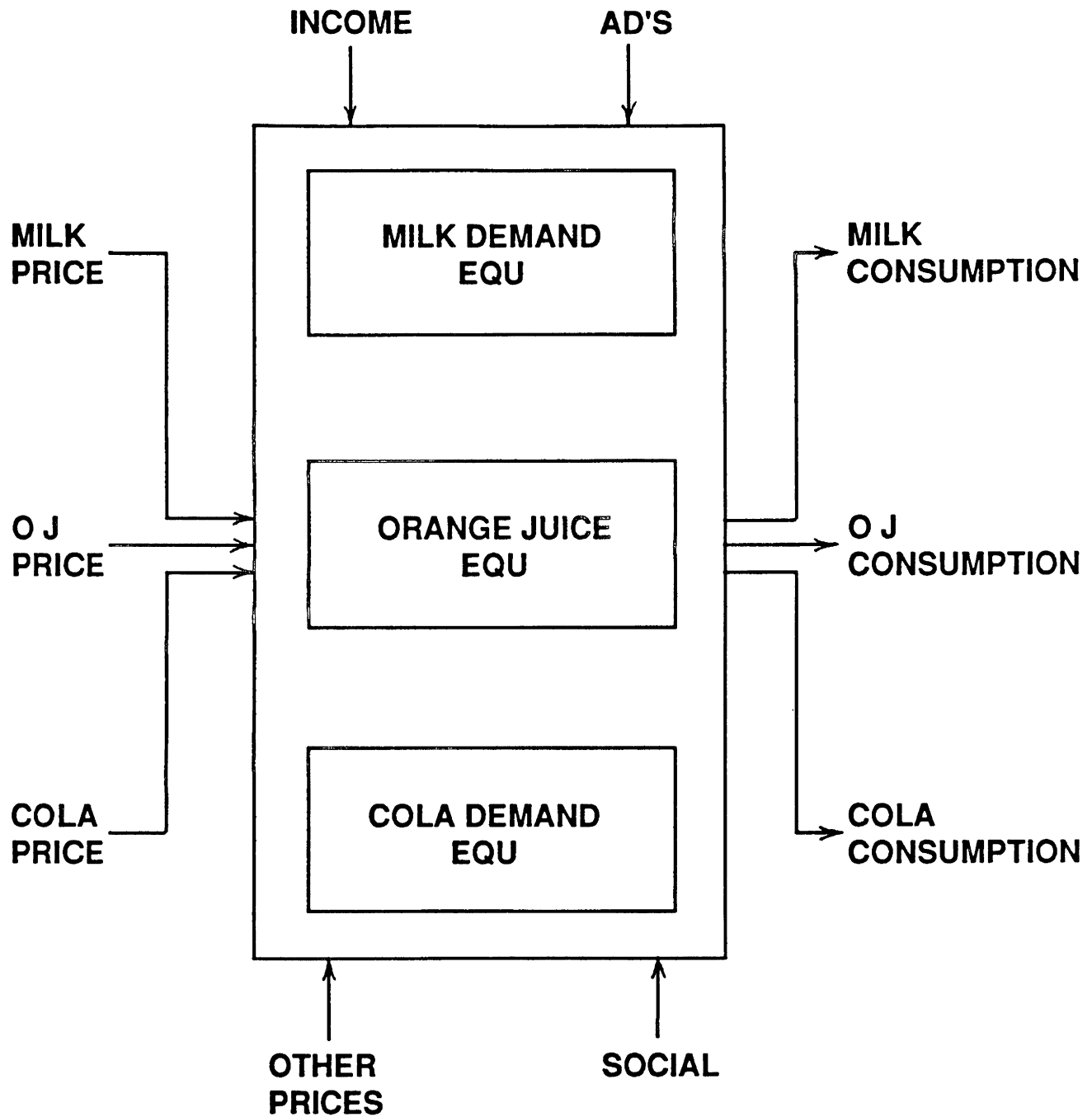


Figure 4:
DEMAND SYSTEM

The simulation approach is to simulate the sales impacts under a range of advertising expenditure levels. The optimal level is the one with the maximum impact. The advantage of the simulation approach is that it is easy to conduct. However, since it is impossible to exhaust all possible expenditure levels in the simulation (especially when there exists an optimal seasonal advertising pattern), a major drawback of the approach is that the true optimal solution might be missed. Rather than through ad hoc simulations, the optimal control approach solves for the true optimal solution. However, the problem is that the optimal control procedure is very complicated and may require considerable human and computer time.

The Existing Literature

In this section we briefly describe some of the dairy evaluation research conducted at Cornell and elsewhere during the past 5 years. Specific research results will be discussed in the next section.²

Research at Cornell

(1) Kinnucan and Forker (AJAE, 1986):

The authors use the single demand equation approach to estimate the fluid milk demand for New York City. The model is used to simulate the optimal advertising spending pattern. The results are published in the American Journal of Agricultural Economics (1986) and has provided a basic framework for the ensuing research conducted at Cornell and elsewhere.

(2) Liu and Forker (AJAE, 1988):

The authors use the demand and supply equation approach to extend and update Kinnucan and Forker's New York City fluid study. The model is used to simulate the optimal advertising level with the farm supply response being taken into account. The results are published in the American Journal of Agricultural Economics (1988).

(3) Liu and Forker (WP, 88-5):

The authors review the optimal advertising control literature in the fields of economics and operational research and outline some optimal advertising policies under various economic conditions. The results are published as a departmental working paper (1988).

(4) Liu and Forker (WP, 89-4):

The authors use demand and supply equation approach to estimate the fluid demand equations for the markets of New York City, Syracuse and Albany, and the farm milk supply equation for New York State. Then they develop an optimal control model to determine the optimal advertising levels for the three markets considered. The results are originally published as a departmental working paper (1989). The model is then subsequently updated with the prorated national fluid expenditures included in the equations. The results from the updated model are contained in another paper now under review by the American Journal of Agricultural Economics.

² Notice that the studies introduced in this section represent only a part of the existing literature and for a more detailed listing of Cornell research, see Appendix A.

(5) Kaiser, Streeter and Liu (AJAE, 1988):

The authors develop a U.S. dairy industry model including retail fluid and manufactured markets and a farm market to investigate the welfare impact of a mandatory supply control program. The results are published in the American Journal of Agricultural Economics (1988). Also see Western Journal of Agricultural Economics (1988) and Journal of Dairy Science (1988). Though the model does not include advertising variable in the retail demand equations, it serves as a precursor for a more comprehensive industry model to be discussed.

(6) Liu, Kaiser, Mount, and Forker (WP, 88-11):

The authors extend Kaiser, Streeter and Liu's U.S. dairy industry study to include in the model (1) advertising variables in the retail fluid and manufactured demand equations and (2) the wholesale fluid and manufactured sectors. Basically, this paper deals with the econometric problem of how to estimate a dairy industry model when government purchase price is binding in some periods and not binding in others. The results are originally published as a departmental working paper (1988). The model is then subsequently updated with the population figure included in the demand equations. The results from the updated model are contained in another paper now under review by the American Journal of Agricultural Economics.

(7) Liu, Kaiser, Mount, and Forker (WP, 89-??):

The authors use the U.S. dairy industry model developed in (6) to conduct advertising policy simulations with both fluid and manufactured advertising variables simultaneously considered. The results will be published as a departmental working paper (1989).

(8) Forker, Liu and Hurst (AE-RES, 87-25):

The authors identify and discuss the necessary data for a comprehensive dairy promotion evaluation research. This is a project conducted in cooperation with the National Dairy Board. The results are published as a departmental research paper (1987).

(9) Forker and Liu (AE-EXT, 88-3):

The authors identify and discuss the important issues involved in generic promotion evaluation research. This is a project conducted in cooperation with NEC-63 Advertising Committee. The paper is published as a departmental extension paper (1988).

(10) Forker and Liu (Choices, 1989):

The authors identify and discuss the important issues involved in the economic analysis of generic promotion. The paper is published in Choices magazine (1989).

Research Elsewhere

(1) Ward and Dixon (AJAE, 1989):

The authors use the single demand equation approach to estimate the fluid milk demand equation for a 12-region market. Special focus is placed on the impact of the national promotion program on the overall effectiveness of the 12 regions' fluid advertising. The results are published in the American Journal of Agricultural Economics (1989) and in the 1988 USDA Report to Congress.

(2) Blaylock and Blisard (USDA, 1988):

The authors use the single equation approach to estimate the U.S. at-home natural cheese and processed cheese demand equations. A comparison between the relative effectiveness of the natural cheese and processed cheese advertising is made. The results are published as a technical bulletin of the United States Department of Agriculture (1988).

(3) Goddard and Amuah (AJAE, 1989):

The authors use the demand system approach to investigate the impact of the Canadian butter advertising program. The research allows for the measurement of cross advertising effects such as the impact of margarine advertising on the sales of butter and vice versa. The results are published in the American Journal of Agricultural Economics (1989).

Empirical Results

This section presents the important empirical findings of the literature. The results are grouped on a market basis.

New York City Fluid Market

The single demand equation approach in Kinnucan and Forker (1986) produces a significant fluid milk advertising coefficient with an estimated advertising elasticity of 0.056.³ This advertising elasticity is the highest of any of the studies. This study is based on data pertaining to the earlier phase of the program when expenditures were relatively low. The maximum impact of advertising is found to occur at the second month after the expenditures are incurred.

Simulation indicates that it was easy to justify substantial increases in advertising expenditures for the fluid market. The results also indicate that an optimal seasonal spending pattern exists. The results suggest more intensive advertising during the months of January through March and less intensive advertising during July to September. The rate of return in New York City would have been 9 percent higher if the advertising budget had followed the optimal seasonal pattern.

The demand and supply equation model used by Liu and Forker (1988) covers a later time period and yields a significant but smaller fluid advertising coefficient of 0.003. The advertising time lag is the same; that is, the maximum impact occurs at the second month. Also, the impact of advertising is found to last for about six months.

The simulation results indicate that the rate of return for New York City fluid milk advertising from 1980 to 1984 is about \$1.50. Although this was enough to justify expenditures at the then current level, marginal analysis indicates that actual spending was probably 35 percent higher than economic optimum.

New York City, Syracuse and Albany Fluid Markets

A simultaneous study of the three markets is conducted by Liu and Forker (1989) covering a later time period (1984-1987). The fluid milk advertising coefficients are

³ The word "significant" means that sales impact of advertising is positive and statistically different from zero. Also, an advertising elasticity of x means that sales will increase by x percent if the level of advertising expenditures increases by one percent.

significant for New York City and Syracuse, but not significant for Albany. The estimated advertising elasticities are 0.025 for New York City, 0.036 for Syracuse, and 0.014 for Albany.⁴ This New York City elasticity is higher than Liu and Forker's previous study but lower than that in Kinnucan and Forker. As to the advertising time lag, the maximum impact occurs at the second month for New York City, and at the first month for Syracuse and Albany.

In this study, the prorated national fluid advertising expenditures are included to also account for the sales impact of the national program. Thus, the advertising coefficients indicate the combined effect of both the NDB and the ADA&DC sponsored advertising. The optimal control model solution indicates that the actual advertising expenditures by the New York State promotional unit from 1984 through 1987 was about on target in New York City and Albany (only 8 percent and 11 percent above optimum, respectively).⁵ However, the actual spending level for Syracuse could be increased by three times to reach optimum.

Due to the relative large expenditure level in New York City, however, the optimal solutions suggest only a reallocation of the existing total expenditures across the three markets considered. With the reallocation, the average monthly sales for Syracuse would have increased by 887.8 thousand pounds which is more than enough to outweigh the corresponding combined sales decrease in New York City of 594.6 thousand pounds and Albany of 71.2 thousand pounds.

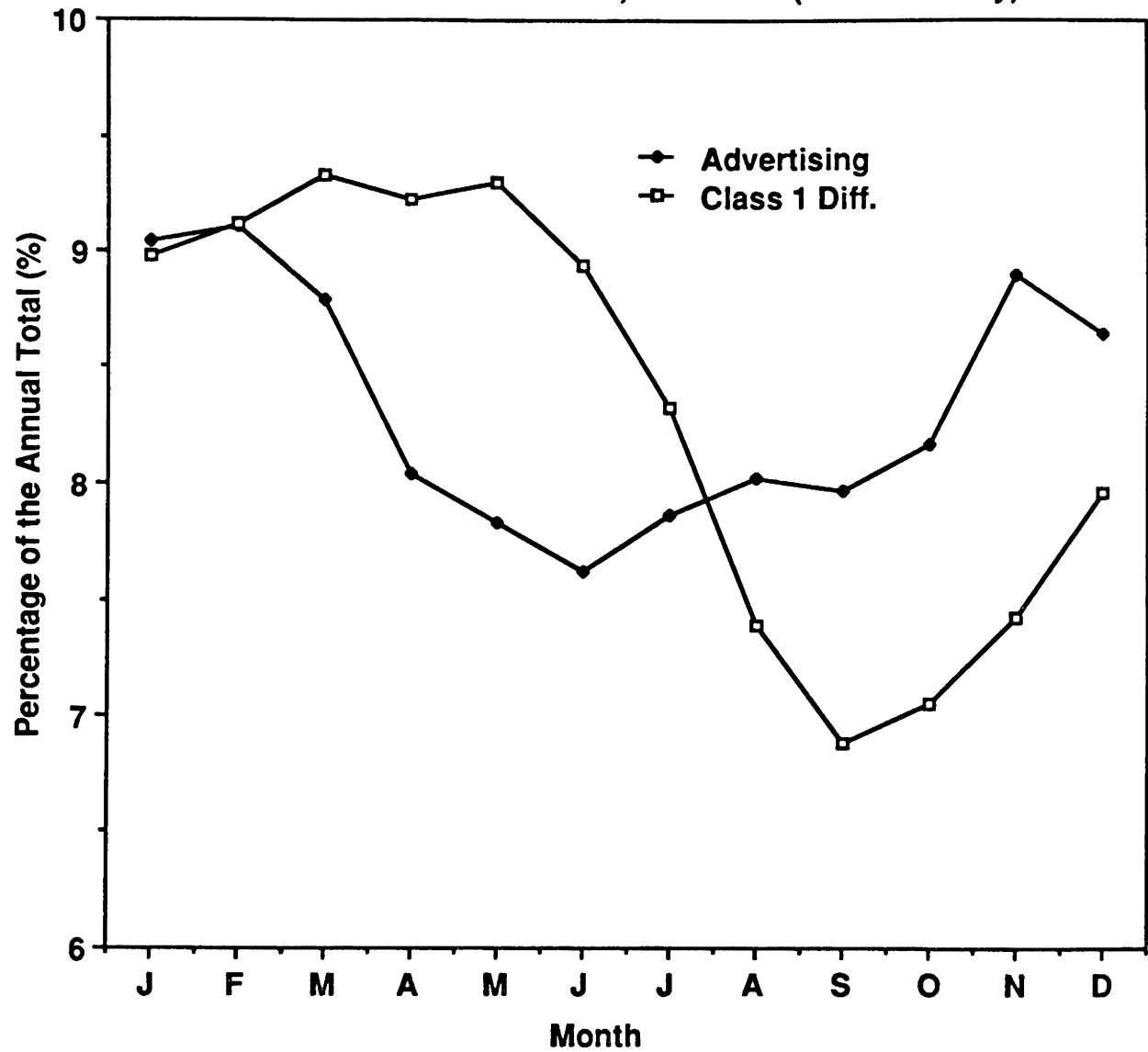
The analysis also yields an optimal seasonal pattern in allocating advertising funds. This pattern is consistent with the simulation result obtained by Kinnucan and Forker. The optimal pattern of this model is presented in Figure 5. The optimal expenditures pattern pertains to all advertising, both the NDB and the ADA&DC expenditures. Again, this study indicates that it is optimal to advertise more heavily during the winter season and less heavily during late spring and early summer.

Since the benefit of the fluid advertising is in part a function of the Class I differential, the Class I differential is also plotted in Figure 5. Keep in mind that the maximum impact of advertising in New York City occurs at the second month after the expenditures have been incurred. It is evident that the optimum seasonal distribution is in large part a result of the seasonal variation in the Class I differential.

⁴ The advertising elasticity of Albany is the smallest among the three markets. This can be explained by a higher media cost in the Albany market. Since the population is older in that city, it is more expensive to reach the target group aged between 18 and 45. The cost per thousand point is \$15.38 in Albany, comparing to \$13.20 and \$13.28 in New York City and Syracuse, respectively.

⁵ In Liu and Forker's previous study, it was found that the spending level for New York City from 1980 through 1984 should be reduced by 35 percent to achieve economic optimum. The near optimal spending level for New York City during 1984 through 1987 found in this study can be attributed to the following three reasons. First, as was found in Ward and Dixon, there has been an upward shift in the advertising effectiveness since the inception of the national dairy promotion program. Second, the Class I differential in New York State has increased from a monthly average of \$2.20/cwt. in 1984 to \$2.66/cwt. in 1987. Thus, the benefit of fluid advertising has increased. Finally, since the current study allows the seasonal advertising pattern to deviate from the observed one, the opportunity set in the optimization problem is enlarged and, hence, a higher solution found.

Figure 5: Optimal Seasonal Advertising Pattern and the
Class 1 Differential, 1984-1987 (New York City)



However, the optimal seasonal pattern in Figure 5 cannot be used as the prescribed policy for the New York State promotion unit because we need to first remove the seasonal pattern of the NDB spending. After accounting for the actual seasonal spending pattern of the national program, the optimal seasonal policy for the New York unit is quite different from the overall optimum. In Figure 6, the pattern labeled exclude NDB is the optimal seasonal pattern for the New York State promotion unit, given the observed pattern of the national spending. For comparison purposes, the observed seasonal pattern of the ADA&DC is presented in Figure 7.

The analysis reveals a very important point. Since both the optimal spending level and seasonal pattern of the state promotional unit depends critically on the expenditure level of the national program, coordination between the two units is essential to maximize the effectiveness of dairy farmers' promotional monies.

Twelve-Region Fluid Market

Using a single demand equation approach, Ward and Dixon find a significant fluid advertising coefficient for the 12 regions considered. The estimated advertising elasticity is 0.01. An important finding of this study is an upward shift in the effectiveness of fluid advertising since the inception of the national dairy promotion program in 1984. The authors attribute this increase to the scale economy of the national program. The largest increase in advertising effectiveness occurred between the first and second years of the program. The additional impact between the second and third years is very modest. This implies that a plateau of advertising effectiveness might have been reached.

From simulation results, it is concluded that the increase in consumption from advertising is more a function of a national campaign (as opposed to regional efforts), than an increase in the total advertising expenditures. This finding of "large is effective" can be used as evidence in favor of a further consolidation of the northeast promotional units, assuming the national result holds at the regional level as well.

U.S. At-Home Cheese Study

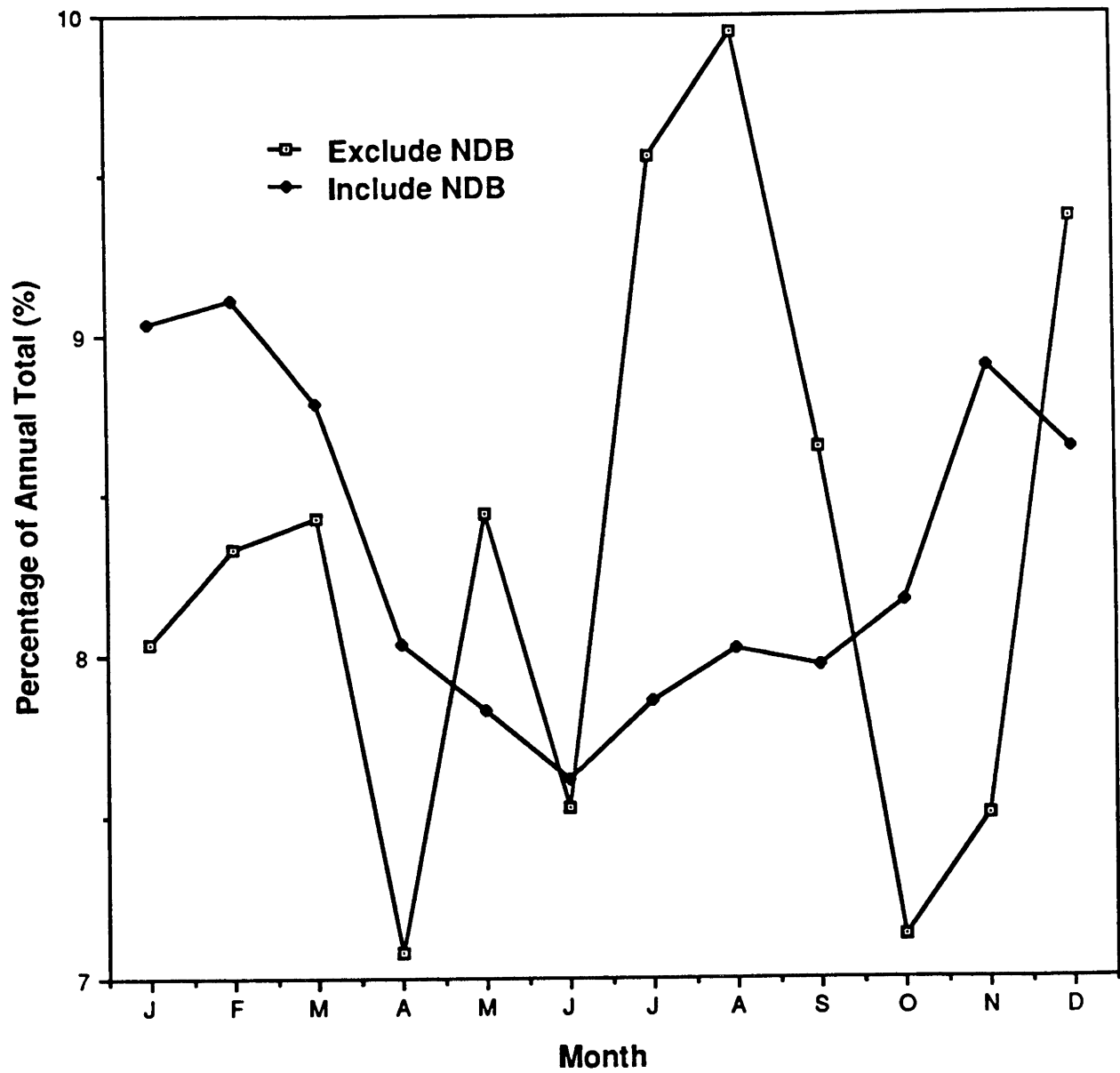
Using the single demand equation approach, Blaylock and Blisard estimate demand equations for natural cheese and processed cheese individually.

For natural cheese a significant generic advertising coefficient is found. But the brand advertising coefficient is not significant. The insignificant brand advertising coefficient probably is due to the fact that brand advertisements are geared toward increasing the market shares of individual firms (rather than the total sales of the industry). The impact of natural cheese advertising is found to last for only one month.

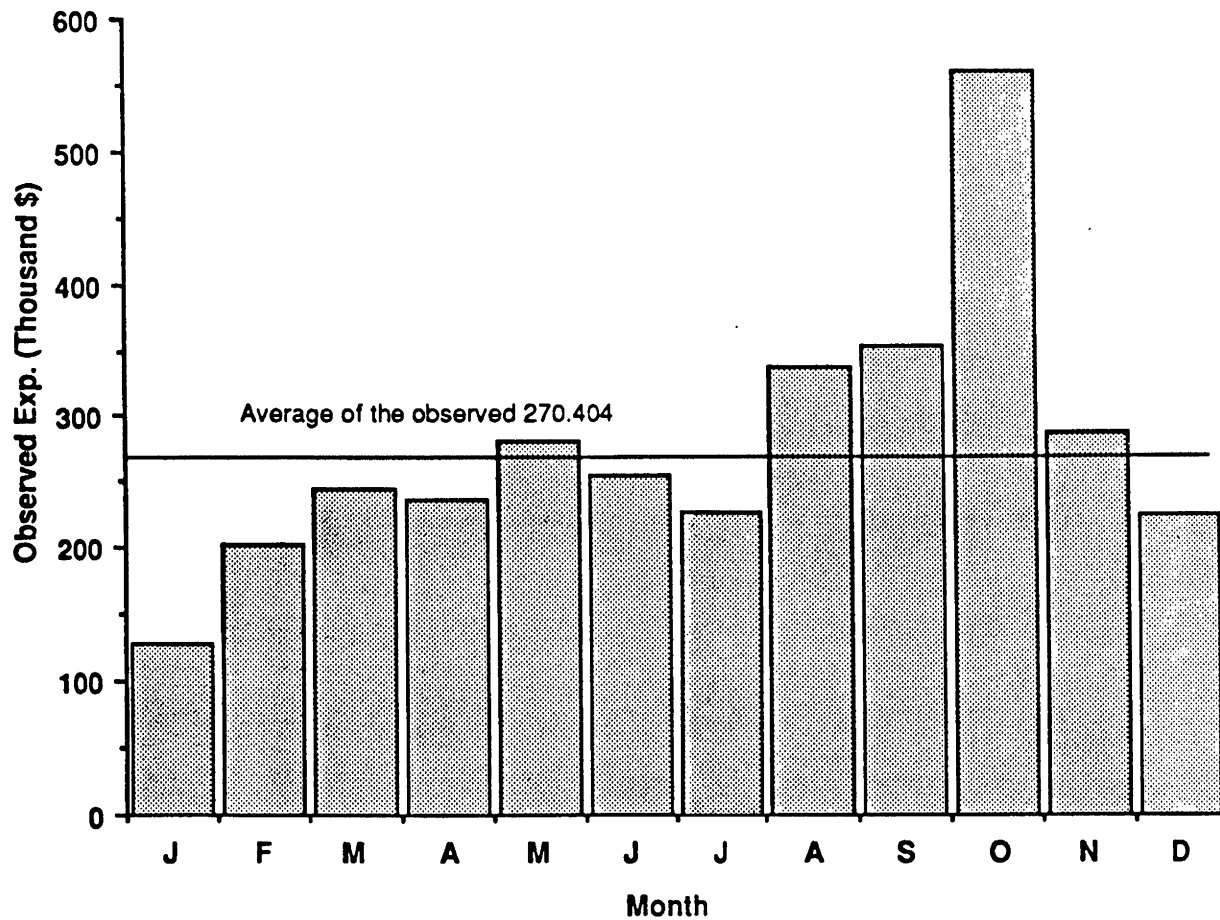
For the processed cheese, the authors find insignificant generic and brand advertising coefficients when treated as separate variables. Upon combining the two advertising expenditures, however, the coefficient is significant. Also, the impact of combined advertising is found to last for about twelve months.

The simulation results indicate that processed cheese advertising is more effective in increasing aggregate consumption than natural cheese advertising. The authors attribute this finding to the relative short carryover effect of the natural cheese (that is, one month vs. twelve months).

Figure 6: Optimal Seasonal Advertising Pattern, With and Without National Expenditures, 1984-1987 (New York City)



**Figure 7: Actual Seasonal Advertising Pattern of
ADA&DC, 1984-1987 (New York City)**



U.S. Fluid and Manufactured Markets

The industry model developed in Liu, Kaiser, Forker, and Mount (1989) yields significant fluid and manufactured dairy products advertising coefficients for the total U.S. market. The advertising elasticities are 0.018 for the fluid market and 0.006 for the manufactured market. The above fluid advertising elasticity is within the range of those found in other studies.

The simulation results over the period of 1984 through 1987 indicate that the farm level rate of return for the U.S. fluid advertising is at about \$7.04 for every dollar spent. The rate of return for manufactured advertising is zero because manufactured advertising results in only a replacement of the government purchases with the increased private consumption.⁶ With both fluid and manufactured advertising, the overall rate of return is \$4.77. Compared to no advertising, it is estimated that fluid and manufactured advertising reduces government purchases by 18.7 percent, which amounts to an average savings in government costs of the dairy price support program of \$153,708 per quarter in 1967 dollars.⁷

Canadian Butter Study

Using the demand system approach, Goddard and Amuah estimate sales equations for Canadian fats and oils including butter and margarine. The butter advertising coefficient is insignificant. But the following cross advertising impacts are found. On the one hand, a 1 percent increase in (brand) margarine advertising expenditures causes a 0.05 percent decrease in butter sales. On the other hand, a 1 percent increase in (generic) butter advertising expenditures causes a 0.30 percent decrease in margarine sales. However, the authors fail to provide any intuition as to why there exists such a big difference in the cross advertising impacts of butter and margarine. Finally, the simulation results indicate that the rates of return are \$1.11 for butter advertising and \$1.31 for margarine advertising.

Future Direction

The research findings at Cornell and elsewhere in general suggest that generic dairy promotion has a positive effect on sales of milk and dairy products. They also imply that the income of dairy farmers is improved under the program. However, since the effectiveness of advertising depends on a number of continuously changing economic and social factors, continued efforts in program evaluation are essential to help assure the optimal use of dairy farmers' promotion monies.

In terms of the New York State markets, it is important to refine the single equation models to include other relevant variables, to determine the time-varying nature of the advertising coefficient, and to assess the robustness of the model in predicting sales. It also important to develop further the question of optimality through more comprehensive simulation procedures and more detailed control optimization schemes.

⁶ However, this essentially ignores the fact that political goodwill may accrue when advertising efforts increase demand and thereby reduce government expenditures on the dairy support program. In light of the 1985 Food Security Act, which gives the Secretary of Agriculture the power to adjust dairy support prices in response to surplus levels, the potential for political goodwill is of increasing importance to dairy farmers.

⁷ Government costs are computed by multiplying the aggregate purchase price by government purchases. This is actually a gross estimate because it does not consider storage, transportation, and other costs of the dairy price support program.

For the national model, it is essential to improve the existing data base both for advertising and sales. The current advertising and sales data for the national model are at best proxies. It might also be useful to refine the national model to include regional disaggregation. A national model with regional disaggregation would enable researchers and program managers to assess the differential impact of the national and regional programs on various regions. This would enable them to identify program areas that need more attention or need to be changed and help them determine an optimal expenditure pattern across regions.

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Appendix A:
List of Publications on Economics of Dairy Product
Consumption by Faculty and Staff of the Department of
Agricultural Economics at Cornell University
January 1973 to Date

(Listed chronologically according to date of publication)

1. EILER, D. A., and FORKER, O. D. 1973. Limited Controlled Experimentation - The Timeliness, Executability, Quality Compromise. Measurement of Sales Response to Generic Promotion of Food Products: Seminar Proceedings. October. pp. 81-86.
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