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*Price Formation and the Transmission of Prices Across Levels of Dairy Markets*

Andrew M. Novakovic

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Department of Agricultural Economics
Cornell University Agricultural Experiment Station
New York State College of Agriculture and Life Sciences
A Statutory College of the State University
Cornell University, Ithaca, New York, 14853

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# Price Formation and the Transmission of Prices Across Levels of Dairy Markets

Andrew M. Novakovic
Director, Program on Dairy Markets and Policy
Department of Agricultural Economics
Cornell University

The collapse of farm prices for milk during the last few months of 1990 is having serious effects on dairy farmers everywhere in the United States. Although manufacturer's wholesale prices of dairy products have also fallen, retail prices have not responded proportionately. To the extent that lower retail prices would stimulate sales of dairy products and thereby alleviate present surplus conditions, high retail margins may be a factor that adds to and prolongs the difficulties of dairy farmers.

In this testimony, I would like to discuss the factors that affect prices of milk and dairy products and the relationship between price changes across different market levels. The former may be termed price formation; the latter can be called price transmission. I will present evidence as to historical relationships, using public data from the last 20 years, and I will discuss in more detail the factors that I think have been particularly important in the last two years.

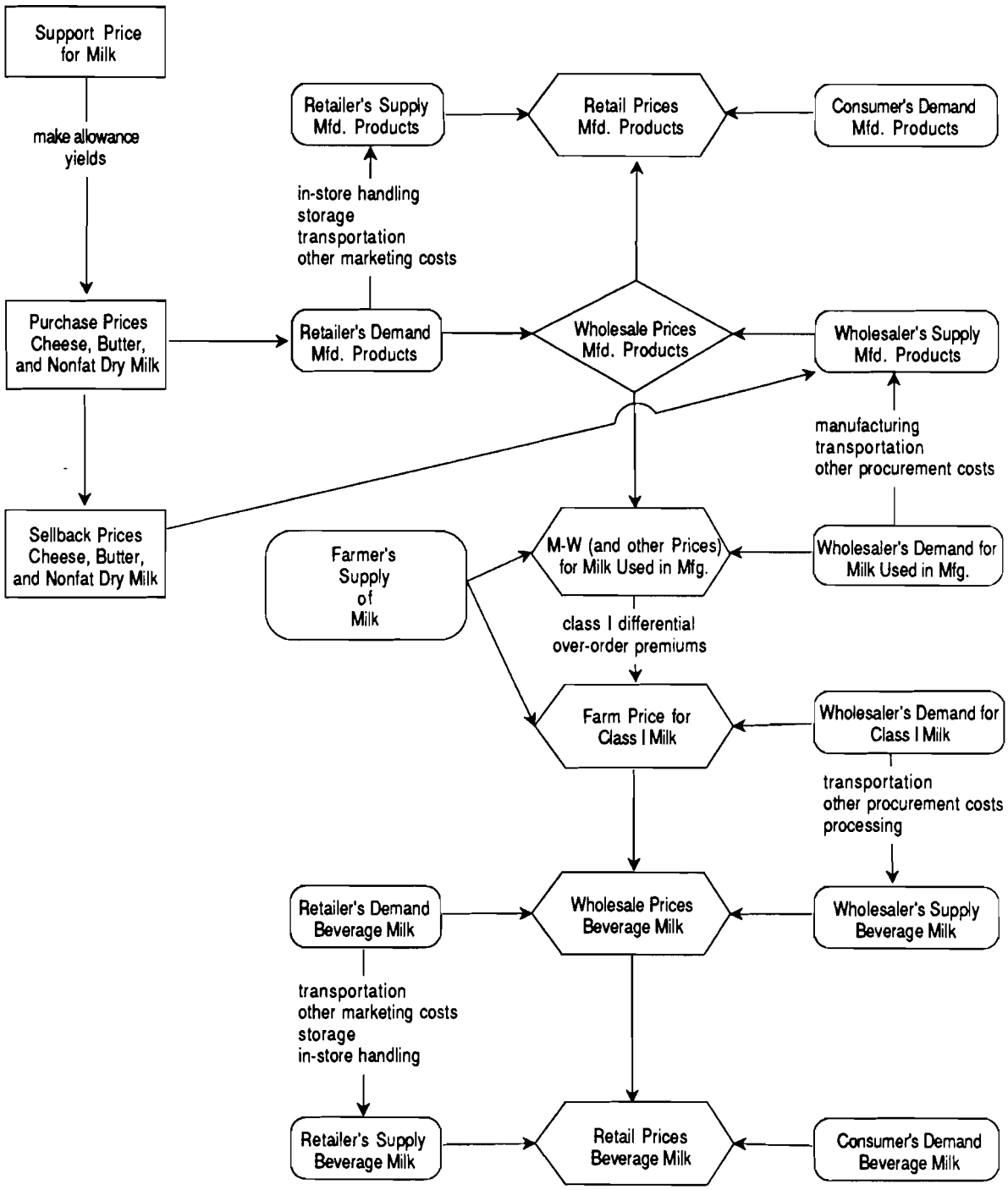
## How Are Prices Formed and Linked Across Dairy Markets

The economic concept of price formation simply refers to the process and factors that determine how and why the price of a good comes to be set at a particular level. More so than most products, dairy product prices are affected by regulatory factors, some of which deal with prices in a very direct way. However, like prices for any other product, dairy prices are also affected by a variety of market forces and conditions.

Many people incorrectly assume that the Dairy Price Support Program (DPSP) and Federal Milk Marketing Orders (FMMOs) result in a situation where the government sets the price of milk. While it is inescapably true that these federal programs can affect dairy market prices, it is no less true that other, more typical, economic factors also play a role.

A schematic description of the price formation process in dairy markets is provided in Figure 1. The diagram attempts to illustrate 1) the major factors affecting prices at different market levels; 2) the typical line of causality in price transmission, i.e. what price usually changes first and which price is next affected; and 3) the role played by the DPSP and FMMOs.

Figure 1. A Schematic Representation of Factors Affecting Price Formation in Dairy Product Markets



*Supply, Demand, and Cost Factors*

In Figure 1, the major economic factors affecting prices are simply referred to as supply, demand, and various marketing costs. The diagram tries to convey that supply factors and demand factors both affect price, but they come from different directions.

Supply and demand factors include such things as changes in population, demographics, prices of competing products, consumer income, technological change, labor productivity, and so on.

Marketing costs, such as transportation, storage, manufacturing, brokerage, and the like are shown as linkages across markets levels connected with firms who are buyers at one level and sellers at another level. For example, cheese processors are buyers of milk (farm level demand) and sellers of cheese (wholesale level supply). Manufacturing, milk assembly, and other such costs describe the cost factors that affect cheesemakers as they make the transition from being a buyer of milk to a seller of cheese.

*Market Levels*

Figure 1 describes three basic market levels--farm, wholesale, and retail. In this context the farm level refers to the interface between farmers as sellers of milk and processing plants as buyers of milk. The wholesale level refers to processors as sellers of dairy products and retailers as buyers of dairy products. The retailer and consumer interface is referred to as the retail level. In actuality, this is quite a simplification of both the people and firms involved across market levels and the channels of distribution.

For example, although some farmers sell their milk directly to processors, most of the milk produced in the U.S. is marketed through cooperatives. Cooperatives typically charge processors handling service charges and other competitive premiums which result in a spread between the price a farmer receives and the price that a processing plant actually pays. For that matter, many cooperatives play a dual role as processor and bargaining agent. The number of marketing agents that may be involved between the processor of a dairy product and the retail store can be much more complicated.

Fluid milk product markets are probably the simplest of all dairy markets. Typically, fluid milk processors make sales arrangements with the retailer and deliver their products directly to the store. Butter markets may work this way, but more often they will involve an intermediate stop at a warehouse and/or an intermediate marketing agent such as a broker or distributor. Cheese markets are usually much more complex. Few cheese manufacturers market their products directly to retailers. Many make cheese in bulk form, as 40 pound blocks, 640 pound blocks, 500 pound barrels, or other such intermediate product forms. These intermediate products will then be sold to another manufacturer for further processing or cutting and wrapping in consumer size packages. In most cases the firm which makes processed cheese doesn't make any natural cheese at all, or at least not in the same location. They buy barrel and other cheeses from someone else. Likewise, in many cases the cut and wrap operation does not manufacture cheese either.

Similar arrangements are often made for aging fine natural cheeses or shredding and other further processing. Thus, cheese markets will involve intermediate processors. Although some cheese is marketed to retailers directly by one of these intermediate processors, a large share is marketed by brokers and distributors. Of course, this discussion only scratches the surface of marketing practices in the dairy industry. Cheddar cheese, mozzarella, other natural cheeses, and processed cheeses all have their own special characteristics. Nonfat dry milk, whey products, ice cream, yogurt, cottage cheese, and so on also have their own unique set of marketing characteristics and complexities.

These market intermediaries are not detailed in Figure 1. For some purposes, this complication may not be particularly important; however any analysis of wholesale to retail price spreads and marketing margins must at least recognize the kinds of complications that exist and their extent. For example, later in this testimony I will discuss the spread between the National Cheese Exchange price and retail prices. There is a lot of marketing activity that occurs between this most basic manufacturer's price and the retail store. Public data do not exist to tell us precisely what happens at each step along the way between the primary manufacturer and the consumer.

The retail function is not as complex, but it bears noting that there are several types of retail outlets for dairy products. I don't think there is much information on how dairy product marketing and pricing differs across large chain store supermarkets, warehouse stores, independent chains and stores, convenience and dairy stores, and so on. The differences may be trivial or significant.

The different types of food retailing establishments leads to the next caveat about the complexity of dairy and other food markets, i.e. alternative channels of distribution. A large share of the dairy products made and consumed are not sold in grocery stores; they are sold to foodservice establishments and other food processors. The ultimate cost of a glass of milk or a slice of cheese is undoubtedly quite different depending on whether it is purchased in a grocery store, at a restaurant, or as part of a prepared meal or other food item.

*Causal Relationships and the Role of Government Programs*

"Causality" is the economic jargon for which-comes-first. Do changes in farm prices lead to changes in wholesale prices? Do price changes begin at the retail level? Or, does the leadership in price movement vary so much from time to time that there is no particular pattern?

Causal relationships in dairy product markets has not been well studied. Although I and some of my colleagues at Cornell have begun to do such a study, our work is not yet completed. The line of causality depicted in Figure 1 is based on what I believe to be the dominant pattern of relationships. It suggests that price formation tends to begin at the wholesale market level for manufactured products, principally cheese, butter, and nonfat dry milk. From this point, price relationships move forward to retail markets for

manufactured products and backward to farm prices for milk used in manufacturing and then back up the market chain for fluid milk products.

Contrary to the common popular impression, the wholesale market for manufactured products is also the level at which the DPSP has its direct impact on dairy markets. Although the support price for milk is often portrayed as a federally enforced minimum milk price, the process of the support program is more subtle. The support price may have a psychological effect on the formation of farm level prices, but its only direct effect is on the establishment of purchase prices for manufactured dairy products--cheese, butter, and nonfat dry milk. These are the prices which the CCC will pay for the specified dairy products. In this sense, the CCC becomes an alternative wholesale market level buyer of dairy products, thereby affecting the overall wholesale level demand for dairy products. The CCC prices do not dictate what wholesale market prices must be, but they do provide a floor below which market prices are unlikely to fall to any great extent. (If market prices fall below the purchase prices, it implies that a seller would prefer to sell to a commercial customer even at a lower price, or it may mean that the products sold commercially do not meet the USDA standards for program products.)

The CCC also establishes so-called sellback prices. If stocks are available, CCC will sell surplus products to anyone wishing to buy them at the sellback price or the prevailing market price, whichever is higher. In this sense, CCC stocks become an addition to overall wholesale supply. In recent years the CCC has pegged sellback prices at 110% of purchase prices. To the extent that stocks are available, sellback prices put a ceiling on wholesale market prices for cheese, butter, and nonfat dry milk. If a buyer pays a commercial supplier a higher price, it implies that the buyer does not find CCC stocks to be an acceptable substitute for commercial supplies. Government stocks of butter and nonfat dry milk are usually quite acceptable for commercial purposes. Government cheese is acceptable but somewhat less desirable when it is used for processing into processed cheese loaves. As a source for cut, natural cheese in consumer packages, government cheese is usually not a good substitute for bulk cheese manufactured for the consumer market.

Between the purchase and sellback prices, the DPSP can have very important effects on the wholesale market prices of cheese, butter, and nonfat dry milk--products which represent almost one-half of the U.S. milk supply. Even so, there have been times when heavy surpluses have pushed market prices well below purchase price levels. There have also been times when tight market conditions have propelled market prices well above purchase price levels, and the lack of government stocks rendered the sellback price ineffective as a ceiling on market prices.

From the wholesale market for manufactured dairy products, price transmission effects tend to move in two directions. One moves in the direction of retail markets for manufactured products. The second moves in the direction of farm level prices for milk used in manufacturing. Although other basic supply and demand factors also affect these farm prices, changes in wholesale prices have historically been very closely correlated with the price of milk used in manufacturing. The most familiar example of this type of

farm price is the M-W price. Because it is used as the basic formula price in establishing minimum federal order class prices, the M-W is a particularly important price. Its use in setting class III and class II prices ensures that changes in the M-W will directly affect the prices of milk used in manufacturing throughout most of the U.S. In the case of the major exception, California manufacturing class prices are directly tied to wholesale prices for manufactured products; hence the relationship to product markets is even more direct there.

The federal order system also enters this diagram in how it affects the price of class I milk by enforcing the addition of minimum class I differentials on top of the M-W price. Market competition almost always results in additional over-order premiums on top of the FMMO minimum class I price. The resulting over-order class I price is the cost of milk for processors of beverage milk.

There is no public data on wholesale prices for beverage milk at the national level. Although the pricing practices of fluid processors is not well documented, it is my understanding that many handlers tie their wholesale price announcements and negotiations directly to changes in federal order minimum prices. In turn, retail prices of beverage milk will flow from wholesale prices and the marketing costs associated with moving packaged milk products and displaying them in grocery stores.

Current Status of National Dairy Markets and Prices

Since December 1983, when the U.S. government initiated the first of seven reductions in the federal support price for milk, farm prices for milk have shown increasing volatility. In the span of the last two years, milk prices have reached record heights and experienced record declines. Following the record high M-W price of $14.93 in December 1989, this national benchmark milk price fell to $12.02 in March 1990.[1] It recovered to $13.43 by July 1990 but has since fallen to $10.02 in March 1991, including a one month crash of $2.02 in October 1990. These data are illustrated in Figure 2, which compares the M-W price to the federal support price, both measured at 3.5% fat test. The historical data shown in Figure 2 make it clear that the volatility experienced since 1988 is unmatched since USDA began the M-W price series.

To understand the movements in farm prices, it is absolutely essential to understand changes in wholesale prices for dairy products and to appreciate that farm prices and wholesale prices ultimately affect one another. Although conditions can be such that either one can drive the other, most of the time farm prices follow wholesale prices of basic manufactured dairy commodities. Figure 3 illustrates the pattern of wholesale prices for cheddar cheese, comparing the National Cheese Exchange price for 40 pound blocks to the corresponding CCC purchase price. (Somewhat similar patterns exist for butter

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[1] Unless otherwise specified, all farm milk prices quoted herein are measured as dollars per cwt of milk testing 3.5% milkfat.

Figure 2. M-W and Support Prices for Manufacturing Grade Milk (3.5% bf), 1950-1991

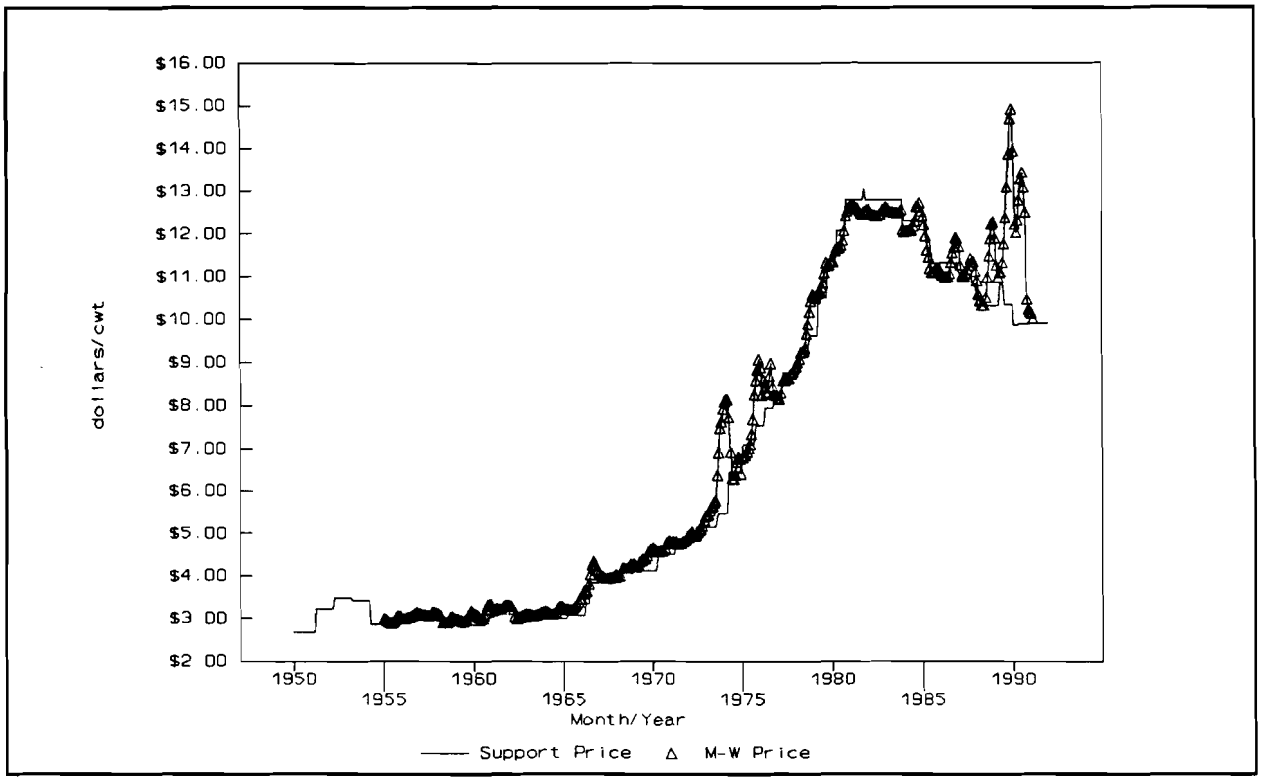
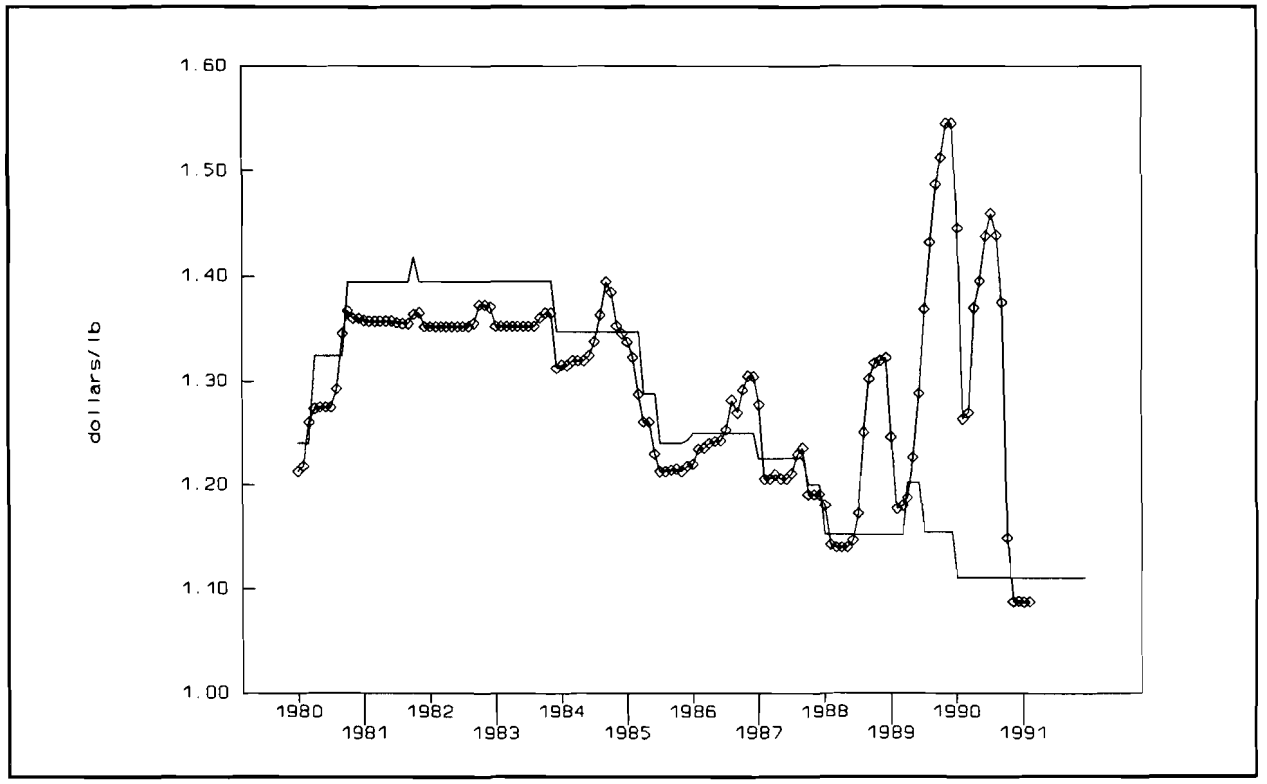



Figure 3. National Cheese Exchange and Purchase Prices for 40-Pound Block Cheddar, 1980-1991



and nonfat dry milk prices.) It can easily be seen that the M-W price follows closely the pattern of this cheese price, usually moving up and down about one month behind changes in the wholesale price.

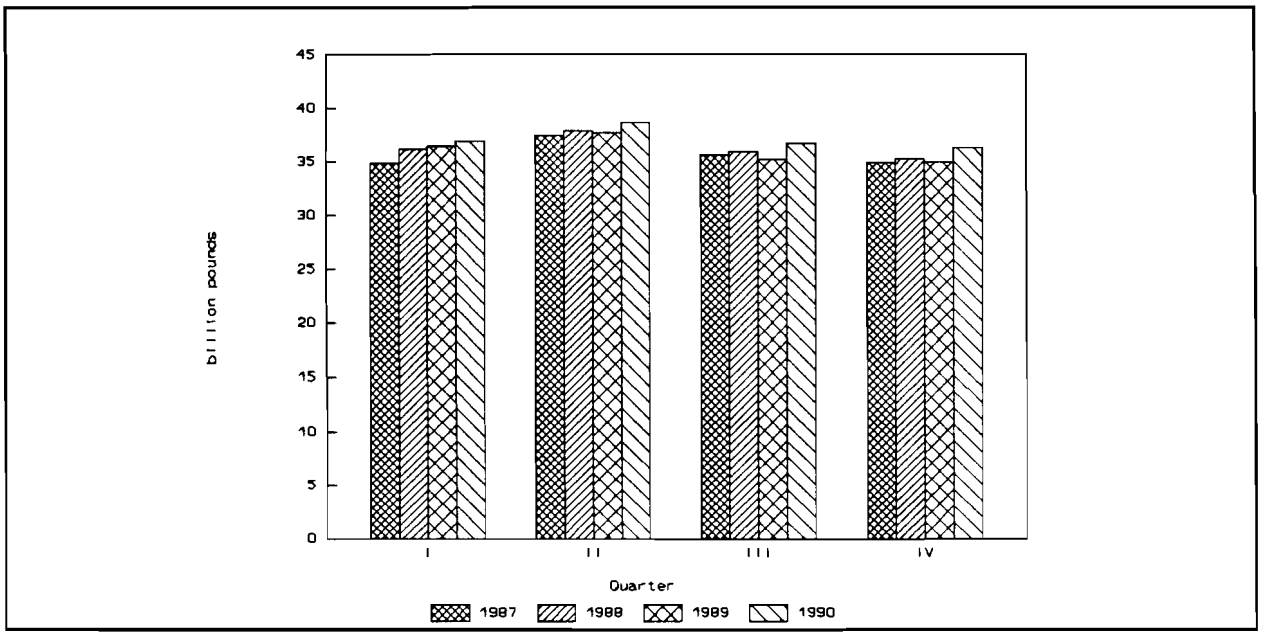
*Why Farm Prices Fell*

Basic market supply and demand conditions, combined with the decline in the federal support price from $12.80 in November 1983 to $9.88 in January 1990, have resulted in an unusually volatile pattern of milk prices over the last several years. Because of the large surpluses that existed in the early 1980s, the initial declines in the support price resulted in corresponding reductions in market prices. However, the Milk Diversion Program in 1984 and early 1985 helped strengthen milk prices then; as did the Dairy Termination Program in 1986 and 1987. Following the final implementation of sellouts under the DTP in late 1987, it appeared that milk prices would quickly tumble to the support price of $10.33 or even lower. Instead, serious drought conditions, especially in the Midwest, led to speculative increases in market prices in the second half of 1988. The M-W peaked at $12.27 in December. After buyers of farm milk realized that milk production was not seriously curtailed in 1988, market prices began to fall in early 1989; however, as often occurs with a drought, the effects of poor planting and growing conditions started to impact on milk production by the summer of 1989. Overall, annual national milk production declined only 0.4% in 1989 (on a daily average basis); yet this seemingly insignificant tightening of milk supplies resulted in competitive pressures that pushed the M-W price up to $14.93 in December 1989. Although milk production was still increasing slowly in early 1990, milk prices weakened from this peak, reflecting in part the fact that milk prices had probably attained a higher level than the market could bear and in part reflecting seasonal declines. During this period of rapid increases in milk prices, farm level conditions, or expectations about what might happen at the farm level, were probably the leading factors in moving prices. Corresponding changes were occurring at the wholesale level, but they were more the result of manufacturers' concerns about their sources of supply then any basic wholesale or retail demand factors.

In April 1990, the M-W price started doing something virtually unheard of; it started a Spring increase. In fact, the M-W rose $1.20 from March to July. This unusually early seasonal increase was driven by two key factors. First, milk production appeared to be growing only modestly in early 1990. This is illustrated in Figure 4 which shows quarterly national milk production data for 1987 to 1990.

Second, buyers of cheese were aggressively purchasing cheese, driving up cheese prices at a time of year when wholesale prices are usually weak. The National Cheese Exchange price for 40 pound blocks rose 19.6 cents/lb from February to July, which is approximately equal to a $1.94 rise in milk value. Thereafter, cheese markets began to soften, and then they collapsed in October. In retrospect, it appears that cheese buyers, after having seen cheese prices run up in late 1988 and then run up to a record high in late 1989, were determined not to get stung again in 1990. Hence, they purchased more than normal amounts early in 1990 and built precautionary stocks. The level of stocks built, coupled with what may have been a recession induced weakening in retail sales, not

Figure 4. Quarterly, U.S. Milk Production, 1987-1990




only kept cheese prices from rising in the Fall; they contributed to a very unusual, contraseasonal collapse in cheese markets. With butter prices already riding at support levels and no strength in nonfat dry milk markets, this meant there was no way to sustain milk prices. Moreover, with milk production apparently increasing by leaps and bounds in late 1990, processors were not worried about their ability to obtain adequate amounts of milk.

*Where Will Dairy Markets Go in the Near Term*

Virtually all dairy market forecasters agree that milk prices will be depressed throughout 1991. A certain amount of seasonal strengthening is expected for the Fall; however even then most forecasters seem doubtful that the M-W price will peak at much beyond $11.00. Opinions begin to diverge beyond 1992, although it would seem that a majority of forecasters foresee a continuation of low prices, with the M-W price averaging below $11.00 for the next couple of years.

Although experiences of the last three years teach us that milk prices can change rapidly, it does appear most likely that they will remain depressed throughout 1991. However, there are good reasons to believe that market prices should show more significant improvement in 1992. As alluded to above, three factors led to depressed milk prices: 1) increases in milk production; 2) the collapse of wholesale cheese prices; and 3) a federal policy that did not so much cause prices to decline as it failed to prevent a collapse. Federal policy may or may not be changed, but eventually market forces will reverse or correct the first two factors and lead to better prices for farmers.

Assuming no further motivation from federal policy, *when* farmers will see more favorable prices will depend on market conditions. More than adequate milk supplies and

the collapse of cheese markets in 1990 led to depressed milk prices. Thus, a tightening of supplies and a reinvigoration of cheese markets is essential to the improvement of milk prices. In my opinion, there are good reasons to believe that both will occur and that it won't take a particularly long period of time.

To the extent that cheese markets were depressed by an excessive buildup of precautionary stocks, it is literally just a matter of time before these stocks are worked off. Thereafter, changes in cheese prices will depend on the underlying strength of consumer demand. Many macroeconomic forecasters point to signs that the current recession is beginning to turn around. To the extent that the recession has held back the growth in cheese sales, this bodes well for the cheese industry. Although it is possible to be more pessimistic, overall the potential for a resumption of a strong cheese market seems good. It is of course difficult to predict precisely when this corner will be turned, but I would expect cheese markets to show significant signs of improvement before the end of 1991.

It also shouldn't take terribly long for milk supplies to tighten up. First, the magnitude of excess supplies in 1990 wasn't particularly great. Although annual rates of gain of four percent or so in the last half of 1990 looked impressive, they are as much a reflection of lower production in 1989 as they are an indication of longer term increases in 1990, as illustrated by the year to year changes shown in Figure 4. Thus, it seems to me that while a tightening of supplies is probably needed, the amount of change required is quite modest.

The second factor that leads me to think production will come into line with product sales fairly soon is simply the fact that farm prices are as low as they are. Even farms that have done very well over the last few years are or soon will be experiencing serious cash flow problems. Longer term profitability will be at best low and more likely negative for a large number of farms. As was true in the early 1950s, the mid-1960s, and the mid-1970s, the marketplace can correct itself when farm prices become unreasonably low. However, for some farmers these market induced corrections do not come fast enough.

On net, the bad news is that prices will not recover until enough farmers go out of business to tighten up milk supplies (assuming no change in federal support policies). In my opinion at least, the good news is that the reductions that are needed are not terribly large. A one to two percent reduction in production could have a substantial impact on milk prices. Which brings us back to where we started; milk prices cannot increase unless there is money at the wholesale level to support the higher farm price. Wholesale prices will have to increase as well; this should be possible, unless the demand for cheese is much weaker than I expect.

Historical Patterns in Price Relationships Across Market Levels

The relationships between the support price and the M-W price, and the purchase price of block cheddar cheese and the National Cheese Exchange price for block cheddar cheese has been illustrated in Figures 1 and 2. This section of the testimony focuses on relationships between market price variables. Statistical relationships have

been estimated using monthly dated reported since January 1971.[2] Unless otherwise indicated, the analyses reported below assume 1) the direction of causal relationships is as illustrated in Figure 1 and 2) that price transmission responses are asymmetric, i.e. price increases are transmitted differently than price decreases.

The econometric analysis uses ordinary least squares regression techniques and a procedure to estimate asymmetric responses developed by Wolffram and later refined by Houck. One limitation of our analysis is that we have not tested the statistical validity of our assumptions about causal relationships. Another is that this analysis is limited to testing the effects of a change in price from one month to another month; in other words, we do not explore the accumulated effects over a period of months. In my opinion, the assumptions about causality are fairly safe, but the other is a more serious limitation. Other studies, particularly that by Kinnucan and Forker, support the sensible assumption that complete effects of a price change are not transmitted across a market level in the period of one month. In fact, we should strongly expect that retailers consciously try to smooth out changes in wholesale prices over time, both on the up and the down side. Thus, the results presented below should be thought of as a first round analysis. I believe the indications of asymmetric responses that will be shown are very valid; however they undoubtedly do not reflect the full magnitude of responses to price increases or decreases that would be observed over a period of months.

The data used in the following analyses are as follows:

Wholesale Prices

- Monthly average of weekly National Cheese Exchange prices for barrel cheese, in ¢/lb (source: USDA, *Dairy Market News*)
- Monthly average of weekly Chicago Wholesale prices for Grade A butter, ¢/lb (source: USDA, *Dairy Market News*)

Farm Prices

- Monthly M-W price for manufacturing grade milk, in $/cwt (source: USDA, *Dairy Market News*)
- Monthly average price for class I milk in all federal order markets, in $/cwt (source: USDA, *Federal Milk Market Order Statistics*)
- Monthly average announced cooperative price for class I milk in selected cities, in $/cwt (source: USDA, *Dairy Market News*)

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[2] The analysis reported here was conducted in collaboration with Kevin Jack and Dr. Lois Willett, Department of Agricultural Economics, Cornell University. The results are from a preliminary study of price transmission relationships. Additional work to refine and extend this analysis is being done.

- Monthly modal price for class II milk in all federal order markets, in $/cwt (source: USDA, *Federal Milk Market Order Statistics*)

Retail Prices

- Monthly U.S. average retail price for fresh whole milk, in ¢/½ gal (source: USDL, as published in *Federal Milk Market Order Statistics*)

- Monthly U.S. average retail price for butter, in ¢/lb (source: USDL, as published in *Federal Milk Market Order Statistics*)

- Monthly U.S. average retail price for ice cream, in ¢/½ gal (source: USDL, as published in *Federal Milk Market Order Statistics*)

- Monthly U.S. average retail price for processed cheese, in ¢/lb (source: USDL, as published in *Dairy Market News*). Data are not reported from July 1978 to December 1983 and July to December 1989. Missing data were projected, based on the Consumer Price Index for cheese, as reported by USDL.

Wholesale Prices of Manufactured Products and the M-W Price

An equation specifying the M-W price in one month as a function of the National Cheese Exchange price for the previous month indicates an extremely strong relationship. Every 1¢/lb change in this wholesale cheese price results in a 9.5¢/cwt change in the M-W price one month later. (Assuming a conversion factor of 9.88, this change in farm value is equivalent to 0.96 ¢/lb of cheese.) Note that this relationship is symmetric, meaning prices move equally whether they are decreasing or increasing.

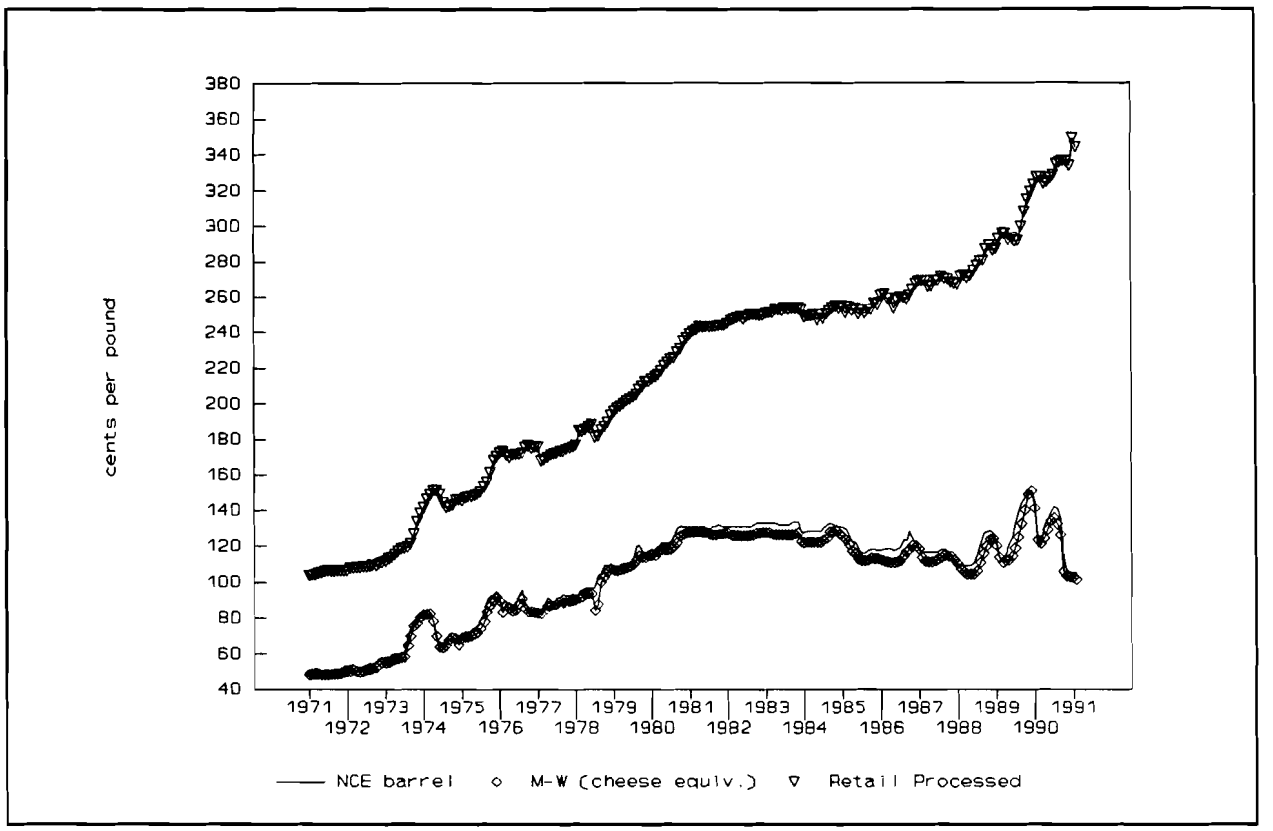
Similar analyses were also done with the wholesale price of butter and the butter and cheese prices in combination. The butter prices added virtually nothing to the statistical explanatory power of the cheese price alone. Future analyses will investigate the significance of butter and nonfat dry milk markets further, but this result is consistent with the general industry opinion that cheese markets usually drive the M-W.

The patterns of the M-W price and wholesale and retail prices of cheese since 1971 are illustrated in Figure 5.

*Wholesale and Retail Prices of Cheese*

Retail cheese price data are a bit problematic. Actual prices for processed cheese are available from January 1971 to June 1978, January 1984 to June 1989, and January and February 1991. Actual prices for natural cheeses are available from January 1984 to June 1989 and January and February 1991. An index of all cheese prices is available from December 1977 to the present. If possible, my preference would be for actual prices of cheddar cheese. None of the available variables are ideal for our analysis. Hence, I

Figure 5. M-W Price, National Cheese Exchange Price for Barrel Cheese, and the U.S. Average Retail Price of Processed Cheese, 1971-1991




chose the processed cheese price series because it was the most well defined product for which we had the longest time series of actual price data. We used the cheese price index to predict the missing values for the processed cheese price series. Given that we used processed cheese prices at the retail level, it is most appropriate to use the National Cheese Exchange price for barrel cheese as the measure of wholesale price. As indicated above, these prices are shown in Figure 5.

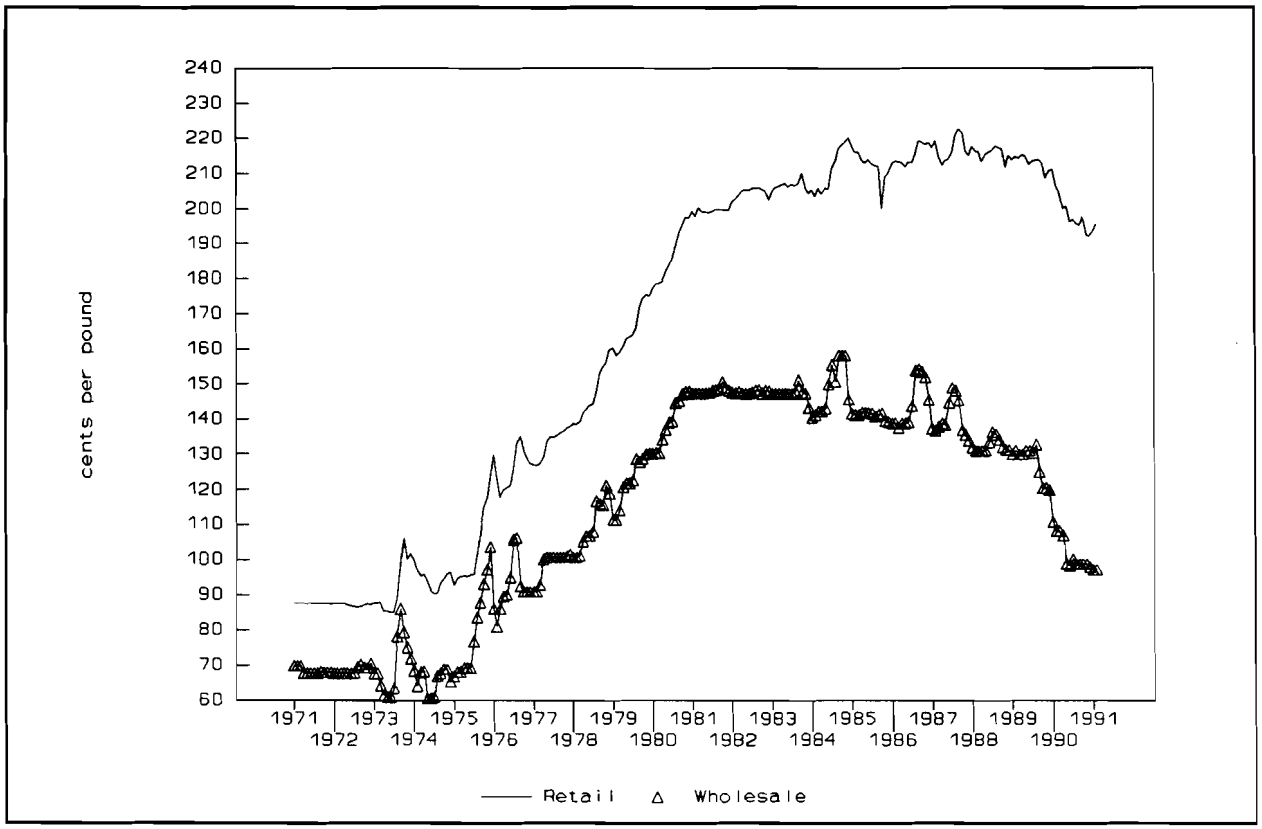
A strong statistical relationship was found between retail and wholesale prices. Moreover the relationship is strongly asymmetric. When the wholesale price increases 1¢/lb, the retail price has historically increased 0.7¢/lb two months later. When the wholesale price decreases 1¢/lb, the retail price decreases 0.1¢/lb two months later.

This indicates two things. First, retailers do not quickly pass along the full change in wholesale prices, whether prices are increasing or decreasing. Second, price increases are more fully reflected than price decreases. Both of these results are consistent with other studies of farm or wholesale to retail price transmission.

*Wholesale and Retail Prices of Butter*

Monthly Chicago Wholesale prices and U.S. average retail prices of butter are shown in Figure 6, beginning in 1971. A strong statistical relationship was found between retail and wholesale prices. However, the relationship is not as greatly asymmetric as in the

Figure 6. Chicago Wholesale and U.S. Average Retail Price of Butter, 1971-1991



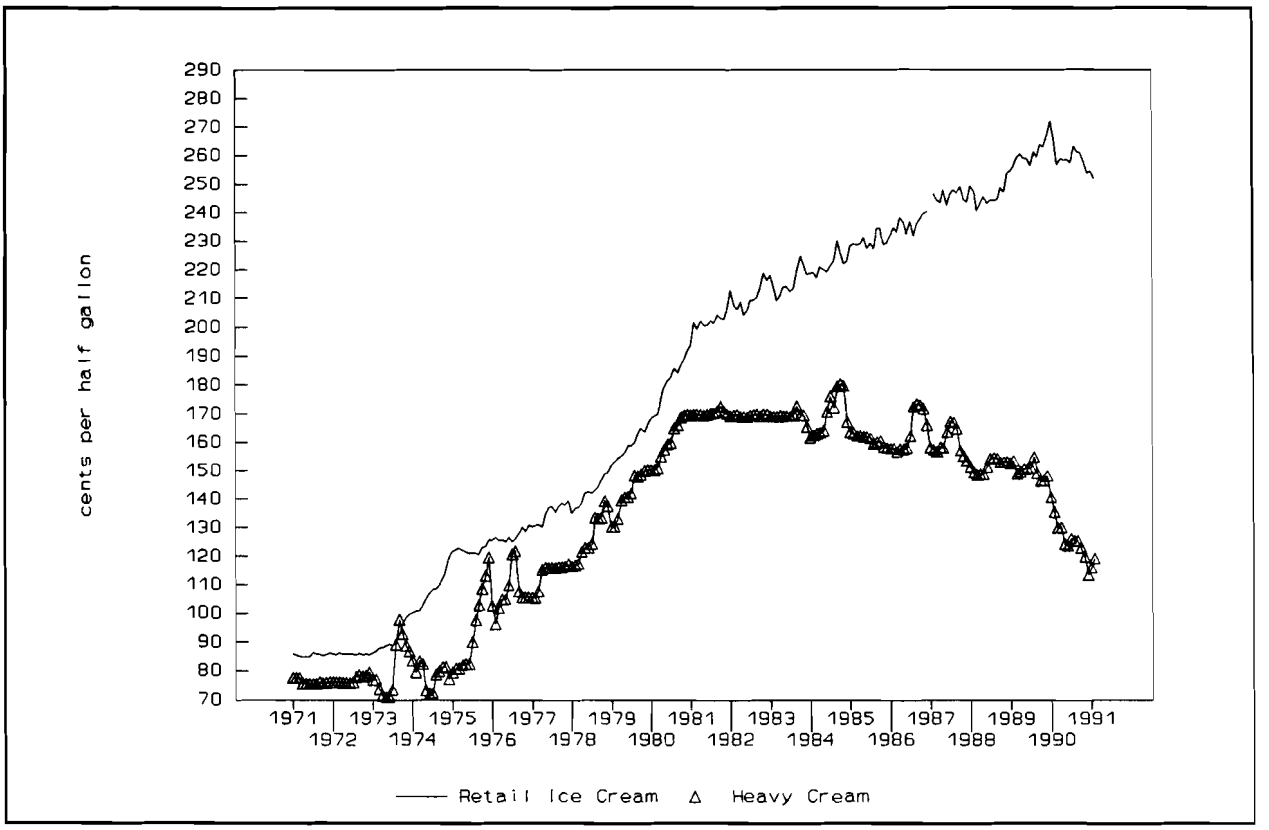

case of cheese. When the wholesale price increases 1¢/lb, the retail price has historically increased 0.92¢/lb two months later. When the wholesale price decreases 1¢/lb, the retail price decreases 0.88¢/lb two months later.

*Price Transmission for Ice Cream*

Like fluid milk, we do not have a wholesale price for ice cream. Moreover, ice cream is not made directly from farm milk; it is made from cream or ice cream mix. In fact, many ice cream makers buy cream or mix from other processors. We attempted to take a first cut at analyzing price transmission in ice cream markets by making some assumptions which need to be refined and revised in future analysis. Nonetheless, they provide a glimpse at what may occur in a market for a product that is very different from the others that have been analyzed here.

The modal class II price was adjusted to 40% fat using a butterfat differential formula based on the Chicago butter price and a differential factor of 0.115. This yields a rough estimate of the value of heavy cream used in class II, which corresponds approximately to how we would expect ice cream mix to be priced. My estimated value of class II heavy cream is compared to the U.S. average retail price of a half gallon of ice cream in Figure 7.

Figure 7. Estimated Wholesale Value of Class II Heavy Cream and the U.S. Average Retail Price of a Half Gallon of Ice Cream, 1971-1991




With these data, it was estimated that a $1 per cwt increase in the estimated price of heavy cream results two months later in an increase in the price of a half gallon of ice cream equal to 0.6¢. A $1 decrease is associated with a 1.1¢ decrease two months later. This implies an asymmetric relationship where the response to decreases is greater than the response to increases. In both cases, however, the response is quite a bit less than the corresponding full value of the change in the cream price. Converting to an ice cream yield equivalent, a $1 per cwt change in the price of heavy cream equals about 2.3 ¢/½ gal of ice cream. Hence it is significant that this equation also had the largest trend factor in it, wherein ice cream prices were estimated to increase 0.9¢/½ gal every month, independent of cream price changes.

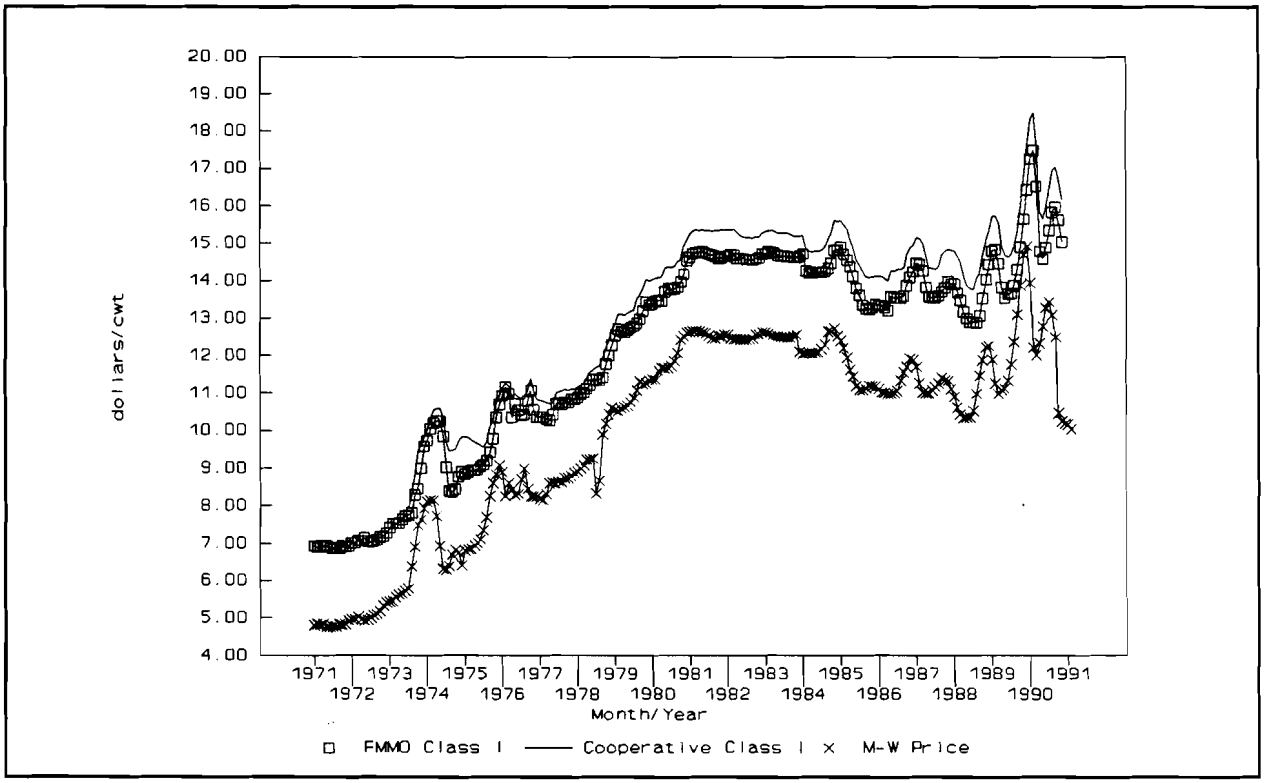
*The M-W Price and Class I Prices*

Two measures of class I prices were used in our analysis of the relationship between the M-W price and the prices paid for class I milk. The federal order average class I price was calculated as a function of the M-W price of two months prior and a similar function was calculated using the so-called announced cooperative class I price. The latter price series gives an indication of over-order premiums charged by cooperatives; however it overstates premiums as it is an asking price not the actual price finally negotiated for class I milk. The statistical analysis of announced cooperative prices was also slightly

different inasmuch as the data series we used started in 1973, rather than 1971, which is the starting point for all other data we used.

The M-W price and minimum federal order and announced cooperative class I prices are compared in Figure 8. Since 1971, the average federal order minimum class I price has equaled 93.8% of the M-W price from two months prior plus $2.36, with an additional 0.4¢/cwt added each month since January 1971. The latter may be interpreted as a factor representing changes in the weighted average class I differential over time. This equation does not attempt to pick up specific changes in class I differentials, such as occurred in 1986; however it does show a very strong correlation over the 20 year time period.

Figure 8. M-W, Average Federal Order Class I, and Announced Cooperative Class I Prices, 1971-1991



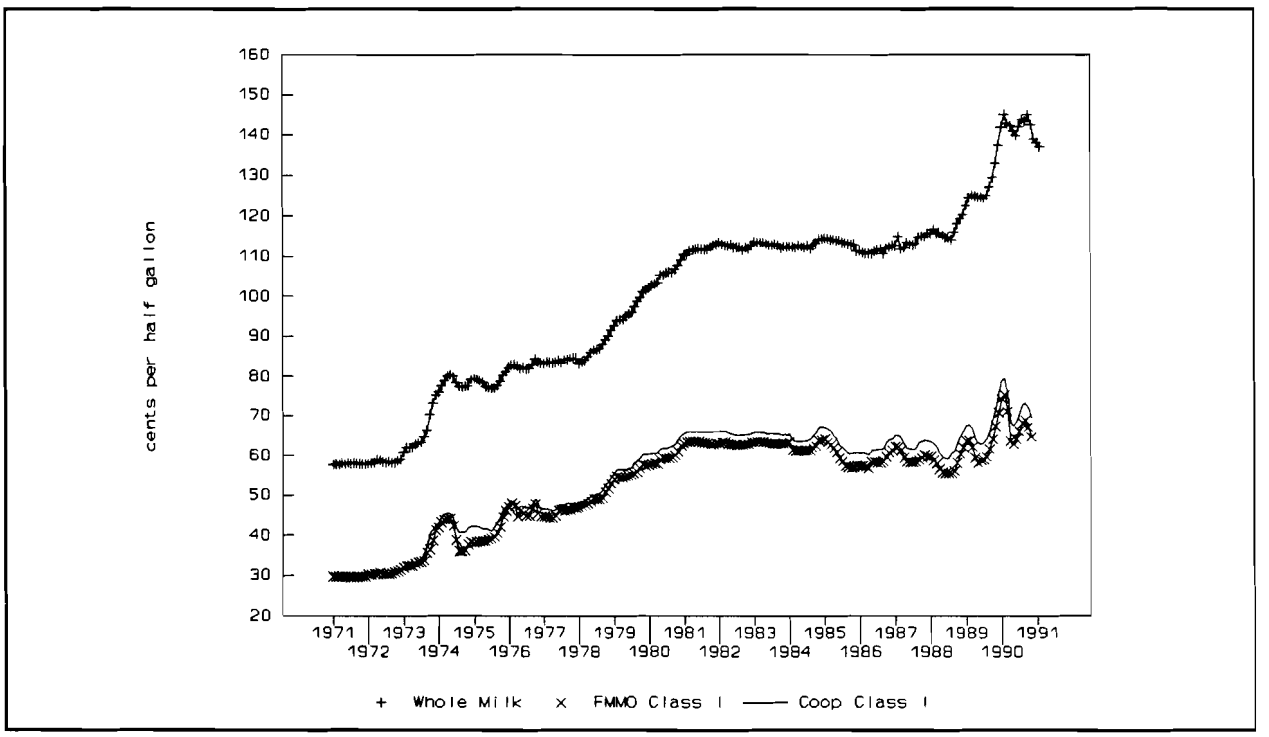

The announced cooperative class I price also is strongly related to the M-W price of two months prior. For monthly data from 1973 to 1991, we estimated that the response was symmetric, as follows. When the M-W price changes 10¢/cwt, the announced cooperative price changes 8.8¢/cwt two months later plus $3.05, with an additional 0.8¢/cwt added each month since January 1973.

*Class I Prices and the Retail Price of Whole Milk*

Both the average federal order minimum class I price and the announced cooperative class I price are compared to retail prices for whole milk in Figure 9. Statistically strong

relationships are found in both cases. When using federal order minimum prices, we found that the strongest effect was contemporaneous, that is retail prices were affected by changes in the same month that the class I price changed. This is perhaps no surprise because class I prices are announced and known about one month before a sale is actually made. In the case of the announced cooperative price, a one month lag produced the larger effect, although there was a significant effect in the contemporaneous month as well.

Figure 9. Average Federal Order Class I, Announced Cooperative Class I, and U.S. Average Retail Whole Milk Prices, 1971-1991




Every $1/cwt (11.6¢/gal) increase in the minimum class I price results in a 4.9¢/½ gal increase in the retail price in the same month. A $1/cwt decrease in the minimum class I price results in a 2.3¢/½ gal decrease in the same month.

An increase of $1/cwt in the announced class I price results in an increase of 5.7¢/½ gal one month later, whereas the same decrease results in 2.7¢ decrease in the price of a half gallon of milk, one month later.

## Profitabilities at Various Levels in Dairy Markets

The price transmission analyses presented so far provide some insights into how farm milk and dairy product prices have moved together over time; however this analysis says nothing about the implications of these prices for the profitability of dairy farms, dairy processors, or food retailers. One cannot look up firm profits in government periodicals,

but there are some indicators of profitability that can be studied. In the sections below, I will present information on the indications of profits implied by changes in price spreads or gross market margins and report the results of studies of profitability in cheese manufacturing and dairy product retailing. Within this framework, one probably should also ask about the profitability of dairy farms. Suffice it to say for now that farm profits were excellent when the M-W was $14, but they are poor or negative when the M-W is $10.

*Indications Provided by Price Spreads*

Gross margins or price spreads are simply the arithmetic difference between a price at one market level and the price at another market level, expressed in equivalent units. For example, the difference between the Chicago Wholesale butter price and the national average retail price of butter could be called the wholesale to retail price spread on butter. Price spread or gross margin relationships for major products are illustrated below.

National Price Spreads on Cheese, Butter, and Fluid Milk

Gross margins for manufacturers of block cheese and butter/nonfat dry milk are illustrated in Figures 10 and 11, for data beginning in 1980. The graphs clearly indicate that in any month margins can range from atrocious to wonderful; moreover the volatility of these margins has been increasing since 1987.

Figure 10. National Cheese Exchange Price for Block Cheddar Minus the M-W Price Vs. the CCC Make Allowance on Cheese, 1980-1991

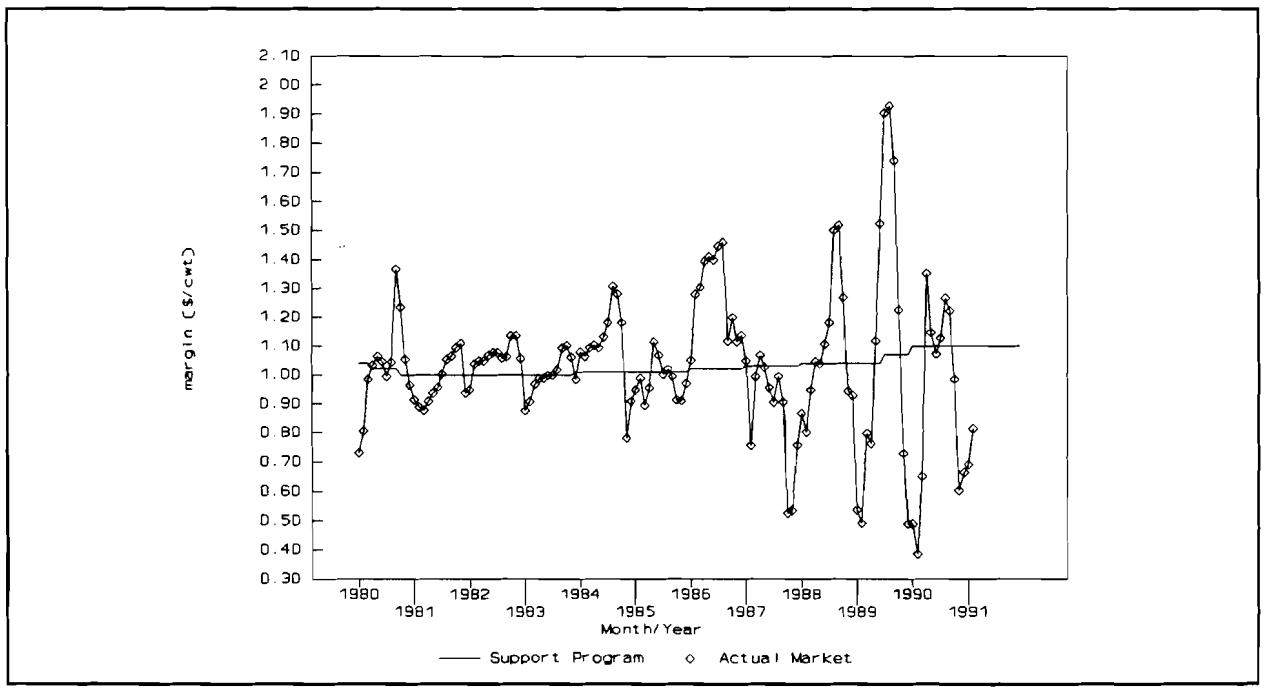
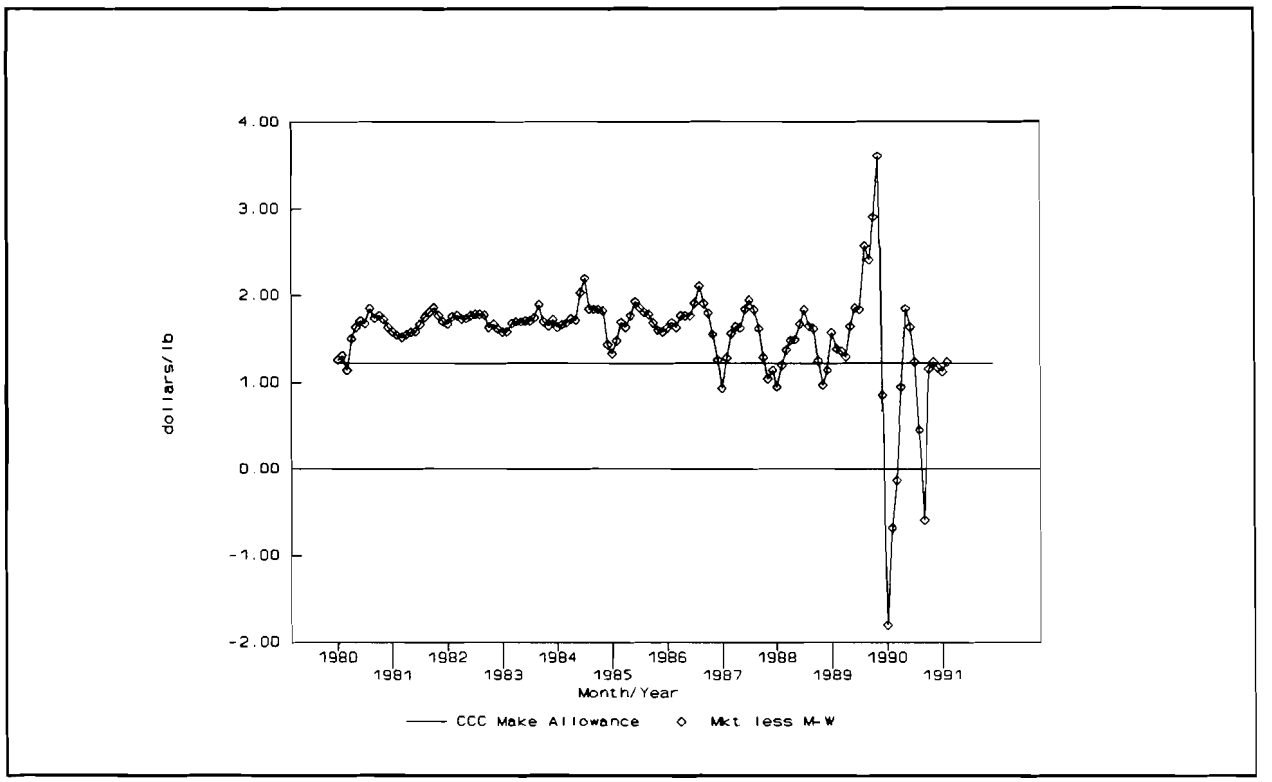


Figure 11. Chicago Wholesale Butter Plus Central States Nonfat Dry Milk Prices Minus the M-W Price Vs. the CCC Make Allowance for Butter and Powder, 1980-1991




Margins for butter/nonfat dry milk processors were especially volatile when nonfat dry milk prices soared to record highs and then fell back to more normal levels in 1989. Nonfat dry milk prices led the M-W price on the way up, contributing to extremely large margins. However, nonfat dry milk prices fell back to more normal wholesale price levels while the M-W price was peaking. Under these conditions gross margins became seriously negative; meaning that butter/nonfat dry milk makers not only could not cover their manufacturing costs, they couldn't afford to pay for the milk they bought. Butter/nonfat dry milk margins have since settled down and today are running just a little below what I estimate are the levels necessary to adequately cover their long run costs.

The gross margin for processors of cheese did not experience the same severe short term fluctuations; however they have been increasingly volatile since 1987. At times, these margins indicate favorable returns to cheese making, but there are many months when the margin is less than necessary for cheese makers to cover their long run manufacturing costs.

The spread between wholesale and retail prices of cheese and butter are illustrated in Figures 12 and 13. Two things stand out immediately. First, the gross margins at this level are much larger. Second, they are, relatively, less volatile.

Figure 12. Wholesale to Retail Price Spread for Processed Cheese, 1971-1991

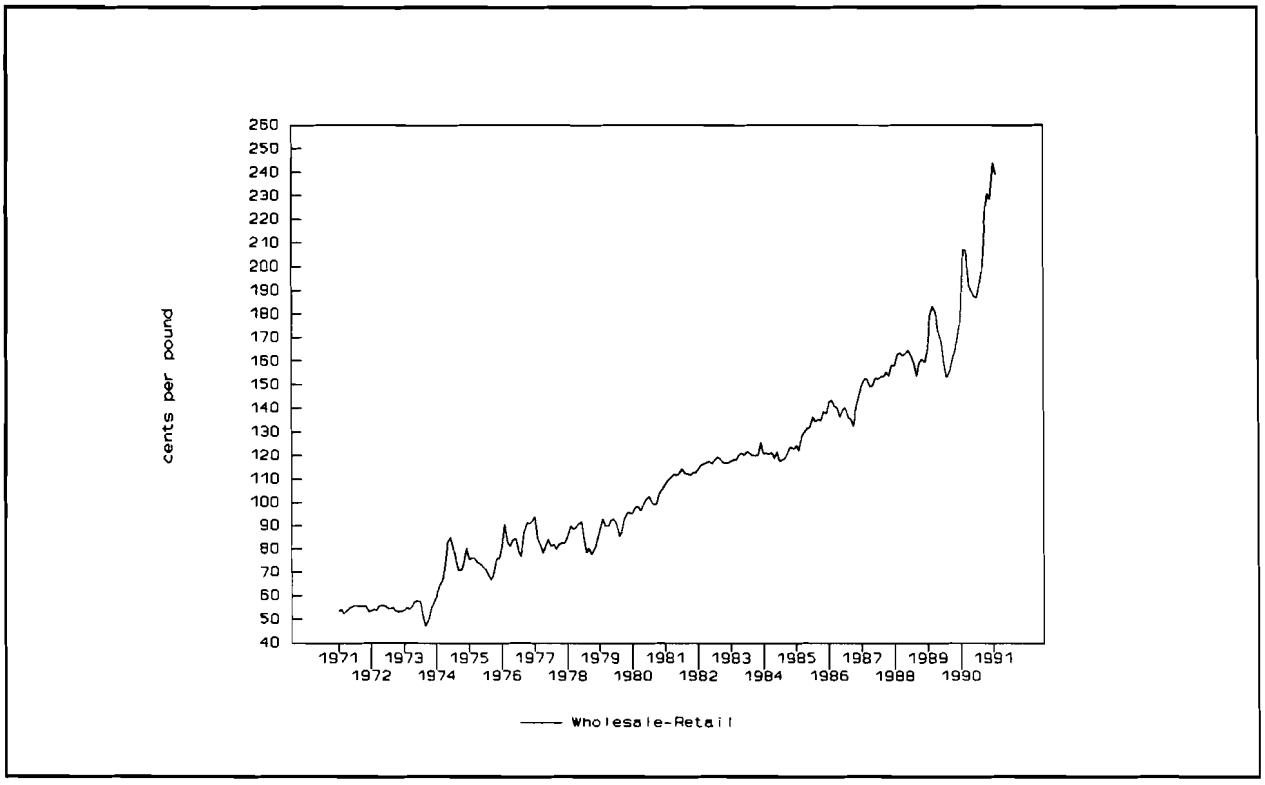
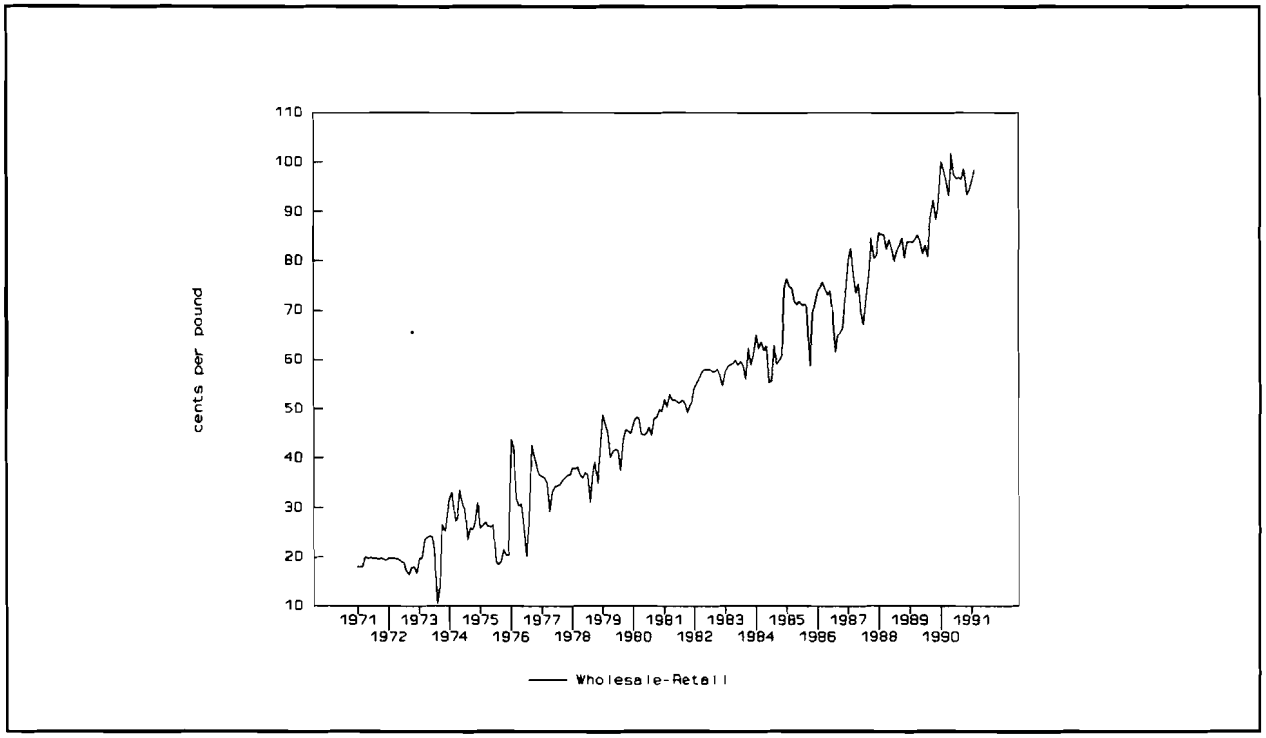



Figure 13. Wholesale to Retail Price Spread for Butter, 1971-1991

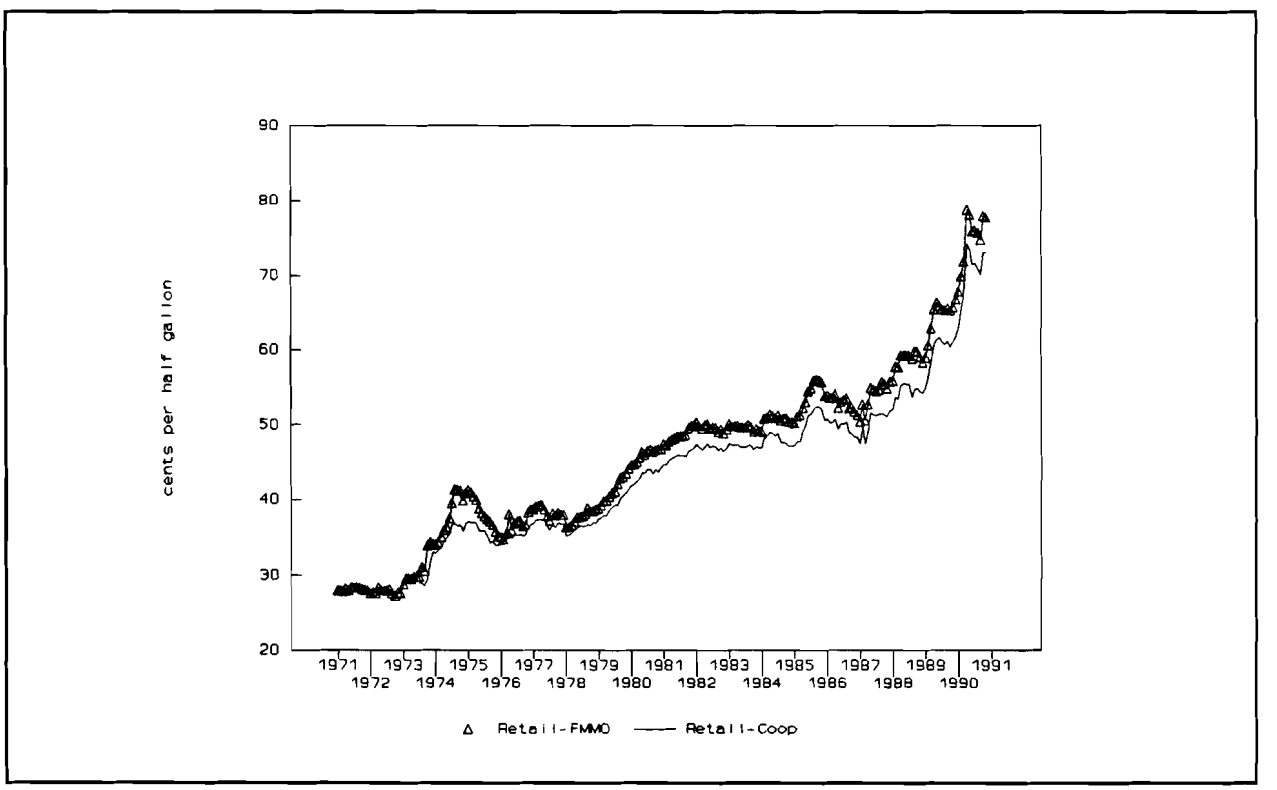


It is interesting to observe that although retail butter prices have clearly responded to the large declines in manufacturer's wholesale prices, the margin has steadily widened since 1971. In 1971, the wholesale price represented about three-fourths of the retail price. Today it represents about half.

A similar pattern is observed for processed cheese. In 1971, the price of barrel cheese represented about half of the retail price of processed cheese. In early 1991, the wholesale price accounts for less than 30% of the retail price.

Because there are no national data on wholesale prices of fluid milk products, we can only look at farm to retail price spreads on fluid milk. The pattern since 1971 is illustrated in Figure 14. What stands out clearly in this diagram is the impact of large increases in farm prices that occurred in 1974, 1988, and 1989. Although the farm to retail price spread widens generally over the last 20 years, each time there has been a particularly large increase in farm prices, the retail price seems to be propelled upward to a new plateau. Once at this new level, retail prices will fluctuate up and down somewhat, but the price spread widens. This is particularly evident in the last three years. Prior to the run up in class I prices in late 1988, the farm to retail price spread was running about 50 to 55¢/½ gal. In 1989 they moved above 60¢; after 1989 they moved up another 5¢. Today they are in the neighborhood of 75¢/½ gal.

Figure 14. Farm to Retail Price Spreads for Fluid Milk, 1971-1991

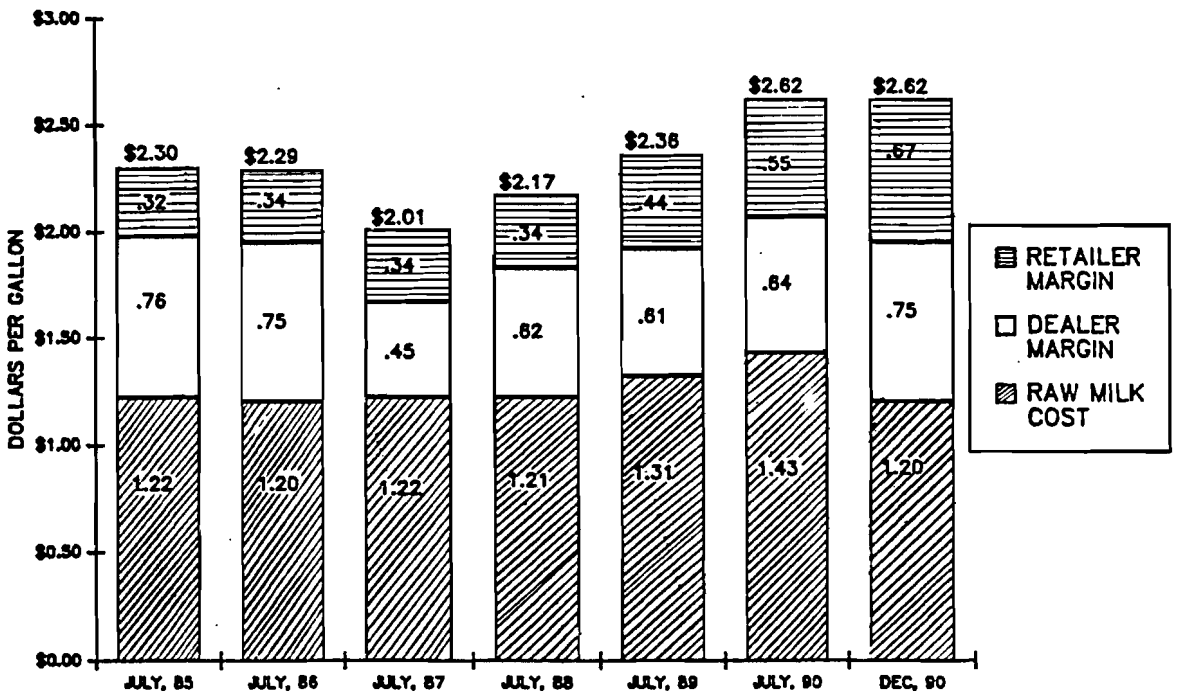


New York Data on Fluid Milk Prices

As indicated earlier, there are no national data on wholesale prices of beverage or packaged milk. The New York State Department of Agriculture and Markets collects detailed information on retail prices of a variety of beverage milk products for various locations around the state and by different types of retail outlets. For the last several years, they have also surveyed the invoice prices for beverage milk products and calculated gross margins for processors and retailers.

Preliminary review and analyses of these data have been conducted by my Cornell colleague Dr. Richard Aplin. A sample of the results for plastic gallons of milk sold in the metropolitan New York City area is shown in Figure 15. For example, for December 1990,

Figure 15. Retail Price, Raw Milk Cost, Dealer & Retailer Margin, Supermarkets, Plastic Gallon of Milk, 1985-1990, Metro New York




Source: Division of Dairy Industry Services, New York State Department of Agriculture & Markets.

the cost of the class I milk purchased was equal to $1.20 per gallon. The gross margin for the processor/dealer was 75¢/gal and the retailers' gross margin was 67¢/gal. Since 1985 the processor margin has declined and then returned to 1985 levels. The decline is in large part due to a change in New York economic regulations which temporarily resulted in unsustainably low processor margins. The retailer margin was stable through 1988 and has been growing since then. The overall farm to retail price spread pattern is similar to that shown in Figure 14 for national data. These New York data indicate that most of the widening spread can be attributed to retail margins. From July 1988 to

December 1990, the processor margin increased 13¢ in New York while the retailer margin increased 33¢/gal.

*Indications Provided by Profitability Analysis*

Estimated Profitability of Cheese Manufacturers

As I stated earlier, gross margins or price spreads provide only a rudimentary indication of the changes in profitabilities associated with firms and farms in the marketplace. Figure 10, for example, gives an indication that cheese makers have experienced ups and downs in their margins, but one cannot determine whether cheese makers were generating adequate profits at any of these margins, or all, or none. Recently two of my Cornell colleagues--Dr. Richard Aplin and Dr. David Barbano--have completed estimates of the profitability of Cheddar cheese and dry whey powder manufacturing in Wisconsin and New York. This analysis combines their previous studies of manufacturing costs for hypothetical but realistic cheese plants with very recent estimates of the costs of milk and selling prices of cheddar cheese in the two states. The price estimates are based primarily on phone surveys of selected cheese makers in Wisconsin and New York.

A sample of the results of this analysis is given in Table 1. These estimates are for a large but not uncommon sized plant of equal size in both states. The picture it paints for cheese manufacturers is grim. In the last 26 months, only two have been profitable (on a cash basis) for the hypothetical Wisconsin cheese plant; 24 were profitable for the New York plant. The basis for the better performance of the New York plant is due primarily to higher prices for New York Cheddar cheese suitable for aging, which more than offset the cost benefits of higher yields in Wisconsin. The differences in manufacturing costs between the two states are estimated to be negligible. The cost of milk was about 29¢/cwt higher in Wisconsin in 1989, but only 4¢ higher in 1989. Large plants would generate better returns, but even the large plants show fairly poor results. Manufacturing whey protein concentrate instead of dry whey powder also improves results very substantially. Many Wisconsin cheese plants produce WPC, but this is very uncommon in New York. Aplin's estimates for 1987 and 1988 indicate much better profitability for cheese makers in those two years.

Estimates of Profitability in Fluid Milk

Aplin has also participated in studies of processing, distributing, and retailing fluid milk products in the New York metropolitan area. It is estimated that in 1991, the cost of processing plastic gallons and making a 75 case drop is about 75¢/gallon, whereas the supermarket's cost of in-store handling is about 18¢. Comparing these estimates to Figure 15 leads one to suspect that the gross processor margins in New York are in line with costs, but the retailer margins are well in excess of their costs.

Table 1. Estimated Profitability of Cheddar and Whey Powder Manufactured in Wisconsin and New York, for a Hypothetical Plant Having a Capacity of 960 Thousand Pounds of Milk Per Day.

| Location | 1989 Annual | 1990 Annual | 1991 Annual |
|---|---|---|---|
| | Number of Months Profitable or Break Even | | |
| Wisconsin | | | |
| Cash Basis[a] | 2 | 0 | 0 |
| with Capital Charge[b] | 0 | 0 | 0 |
| New York | | | |
| Cash Basis | 12 | 10 | 2 |
| with Capital Charge | 9 | 2 | 0 |
| | Average Profit (Loss), in $/cwt. | | |
| Wisconsin | | | |
| Cash Basis | (.35) | (.64) | (.51) |
| with Capital Charge | (.92) | (1.23) | (1.09) |
| New York | | | |
| Cash Basis | .77 | .22 | .33 |
| with Capital Charge | .20 | (.37) | (.26) |

[a] Profitable even after a full charge for capital investment is made to account for depreciation and capital costs, assuming new facilities and using 1988 costs for building and equipment.

[b] Profitable if no charges for depreciation and capital costs are made. In other words, cheese and whey powder manufacturing is making a contribution to committed costs but not necessarily a profit in a total sense.

Source: Dr. Richard Aplin, Department of Agricultural Economics, Cornell University.

Thus, the available data on profitability for all dairy product processors seems to suggest that their profits have not been exorbitant. Indeed, they may well have been rather skimpy or poor in the last two years. Overall, supermarkets show returns on investment that are about average for U.S. industry. The results for specific parts of the grocery store are discussed below.

Direct Product Profitability in Supermarkets

Food retailers have relied on percent gross margins to measure the profit performance of the individual items they sell or the departments they operate. This is simply their gross margin (retail price minus invoice cost) as a percent of the retail price. Margins for the entire store will vary somewhat from year to year, but a percent gross margin of 22% might be considered normal. A study of 1989 supermarket margins is summarized in Table 2. By this measure, items sold in the dairy case (which includes products not made from milk) had a percent gross margin slightly below average. For that same year, the compounded annual growth rate in supermarket sales over the last five years was 5.2% on all items and 2.1% on dairy products. By these standard measures, dairy products do not look like a particularly exciting or profitable item.

Table 2. Supermarket Percent Gross Margins, 1989.

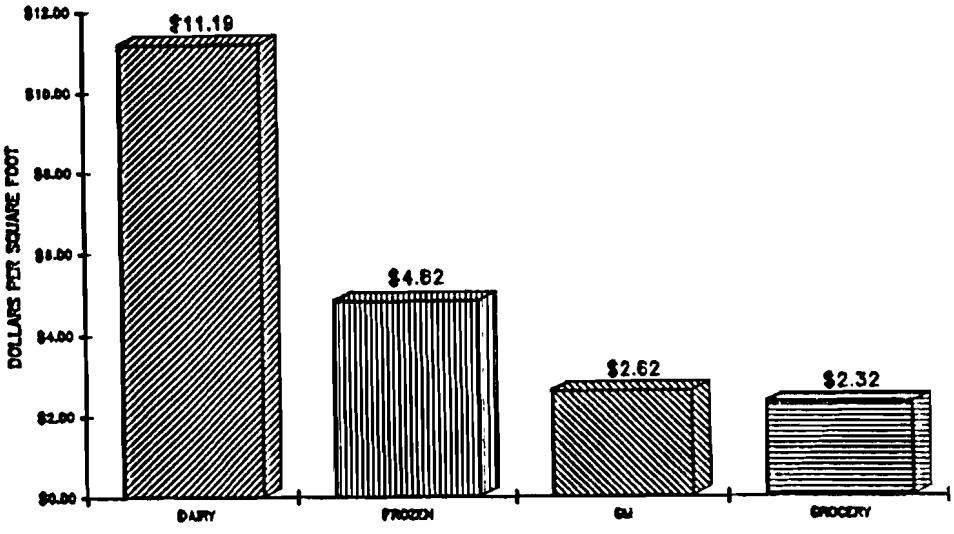
| Category | Gross Margin % |
|---|---|
| General Merchandise | 31.10 |
| Health and Beauty Care | 26.20 |
| Perishable | 25.20 |
| Dairy | 21.40 |
| Dry Grocery | 20.10 |
| Unclassified | 18.60 |
| Non-Edible | 17.30 |
| Store Average | 22.84 |

Source: Dr. Edward McLaughlin, Department of Agricultural Economics, Cornell University.

In the last few years, an alternative measurement of the profitability of individual products or departments has been developed--direct product profitability or DPP. The measurement simply recognizes that percent gross margin calculations ignore the very real possibility that in-store handling costs vary considerably from one product to the next. Another very important factor missed by the gross margin relationship is that many if not most dairy product have a very high rate of turnover--many units are sold over a period of time. Hence a 22% gross margin may be more than adequate to cover the retailing costs of one product and totally insufficient to cover the costs of another. DPP simply adds the cost of retailing to the equation. The first study to apply DPP concepts to dairy products was done by Richard Aplin and Gene German at Cornell for 1984 prices in selected New York markets. Dr. Bill Bishop, of Willard Bishop Consulting, Ltd., completed a more comprehensive study of national markets in 1989. Some key results of his study are summarized in Figures 16 and 17.

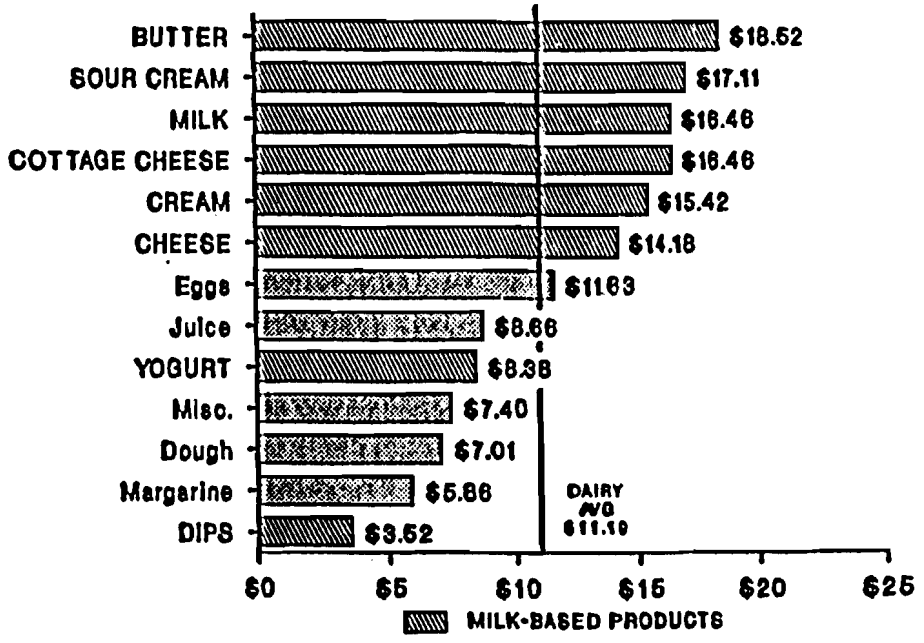
Figure 16. Supermarket Department Performance, Direct Product Profit, $/square foot

DIRECT PRODUCT PROFIT = Store Gross Margin Less Direct Costs (e.g. direct labor, display case and energy costs)




Source: Willard Bishop Consulting, Ltd.

Figure 17. Dairy Category Performance, DPP $/square foot




Source: Willard Bishop Consulting, Ltd.

Figure 16 shows an analysis of direct product profitability by typical supermarket departments. It indicates that the dairy case has substantially higher profits per square foot of display space than other major departments, including frozen foods, general merchandise, and dry groceries. It should be remembered that the dairy case includes products not made from milk, such as margarine, eggs, and other refrigerated products. In addition, many dairy products are sold in other departments. For example, ice cream products are part of frozen foods, and many cheeses are sold in the deli case. Nevertheless, this is a strong indication that the profitability of the dairy case and dairy products in particular is substantially better than the more conventional percent gross margin analysis suggests.

This is even more evident in Figure 17, which shows the DPP for specific products in the dairy case, as estimated by Dr. Bishop. From this chart, it is clear that dairy products are the reason for high DPP in the dairy department.

The recent study by Dr. Bishop is corroborated by an earlier study conducted by Touche-Ross for Texas markets in 1987 and the Aplin and German study of fluid milk in New York for 1984.

Implications of Retail Profitability[3]

These last tables may be the smoking gun for which critics of current retail prices have been looking, but I would caution against jumping to conclusions. Critics can point to various prices spreads and gross margins, but these do not in and of themselves indicate profitability levels. The DPP analysis provides a good measure of profitability at the retail level, but it is not the way the retailers typically evaluate themselves.

While DPP is clearly a superior way to evaluate the profitability of departments and products in supermarkets, it is seldom used by food store managers. Although the DPP concept is generally known, it is still considered a somewhat academic tool. Only a few food retailers even calculate DPP's for their store. Only a very few actually make management decisions based on DPP. Far and away the standard measurement tool and indicator is percent gross margin. As I indicated earlier, even though dairy products look exceptionally good based on DPP, they look rather average based on gross margins. We should not be surprised to find that retailers have a different perception of the profitability of dairy products than dairy marketing analysts who look just at price spreads.

This not withstanding, our conversations with retailers suggest that they do recognize that the dairy case is an area of growing profitability for them and that the profits on individual dairy products have become increasingly attractive. Whereas critics of high retail prices seem to want retail prices to come down, retailers have a different perspective

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[3] Much of my thinking in this section is influenced by conversations with my colleague, Dr. Edward McLaughlin, associate professor and co-director of the Food Industry Management Program in the Department of Agricultural Economics at Cornell University.

on what to do. Retailers indicate to us that they recognized the pattern of growing returns to the dairy case, and they are responding to it by enlarging their dairy cases and display areas and increasing the facings of dairy products in the refrigerated case. Because it is difficult, in some stores impossible, to enlarge the refrigerated case display along the wall of a store, the primary way that dairy cases are being enlarged occurs when new stores are built. Indeed data indicates that new stores do include increasingly large refrigerated dairy cases and that the dairy department is garnering prime locations in the store. The benefits of this are, of course, that the added space allows retailers to display an added variety of dairy products and present them in a more appealing way to consumers. Over time, this should increase the sales of dairy products, benefitting both retailers and the dairy industry broadly.

Other ways that retailers appear to be using the profits on dairy products to enhance sales is through store coupons, front page specials in newspaper inserts, and special in-store displays. While some people in the dairy industry may question the value of such activities compared to cutting prices, food retailers view these as very legitimate and desirable ways to increase sales. A recent analysis of alternative marketing techniques illustrates the principle involved.

A study of the impact on sales of alternative price reductions and promotional activities for a mature brand in the canned grocery category is summarized in Table 3. This study indicates that when price cuts alone are used, a 20% cut price in resulted in a doubling of unit sales. However, leaving price unchanged and either featuring the product in an advertisement or putting the product in a special display had the same effect. Using both an ad and display quadrupled sales, even with no change in price. Obviously, there is a cost associated with advertising and setting up special displays, but it is unlikely that these costs exceed the lost income from a 20% reduction in price. Moreover a reduction in price will very directly reduce percent gross margins, but use of an ad or display doesn't change the gross margins at all. (Any one of the three affects DPP.) Thus, when we consider the expectation of impacts on sales and the performance criterion by which most supermarket department heads are judged, it is small wonder that retailers look for ways to enhance their sales other than lowering prices. To the extent that they are successful in increasing dairy product sales, these retail strategies do benefit dairy product processors and farmers. In fact, it may be that strategies other than lowering prices are far more successful in increasing sales, although it is premature to come to that conclusion without further evidence or research.

Even if we accept this basic point, at some level we may judge the retail returns on dairy products to be exorbitant. If so, two additional observations might be made. First, if retailers continue to proceed with plans to enlarge the dairy case and offer more facings on dairy products, it is inevitable that the DPP on dairy products, which is measured per square foot of display space, will decline. The economic principle of decreasing marginal returns will apply. Stores will sell more dairy products and earn more total revenue, but the average profitability of dairy products will decline to more average levels.

Table 3. Sales Index Associated with Price and Promotion Combinations for a Mature Brand in Canned Grocery Category, Chicago Market.

| Promotion Condition | Price Index (1) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 100 | 95 | 90 | 85 | 80 | 75 | 70 |
| | Sales Index | | | | | | |
| Non-Promoted | 100 | 118 | 142 | 171 | 209 | 258 | 324 |
| Ad Only | 198 | 234 | 281 | 338 | 414 | 511 | 641 |
| Display Only | 213 | 251 | 302 | 364 | 445 | 550 | 690 |
| Display and Ad | 395 | 466 | 561 | 675 | 825 | 1019 | 1280 |

(1) 100 = undiscounted, everyday normal price

Source: Dr. Edward McLaughlin, Department of Agricultural Economics, Cornell University

Secondly, if retail margins are very high, it would not be surprising to see some strong price competition. Retailers view fluid milk as a key item for price competition. That doesn't necessarily mean that prices will always be low or lean relative to invoice costs, but it does mean that stores will respond if a competitor lowers price. In this case, competition may come from a peer store or it may come from a different type of store, such as a smaller, independent supermarket, a convenience store, or one of the several other types of food retailers. As illustrated in Figure 14, when milk prices rose in 1973 and 1974, retail margins on fluid milk widened considerably in 1974 and 1975. By 1976, gross margins had eroded from their peak, but remained well above where they had been prior to 1974. The latter may simply be due to increases in marketing costs from 1973 to 1976. Although farm prices fell in 1974, by 1976 they had recovered and from there on stayed above the peak in early 1974. The situation in the 1990s is likely to be somewhat different. Although milk prices should recover from their current depressed levels, it is hard to see when they will return to the levels witnessed in late 1989 and early 1990. If farm prices continue to stay well below the amount that propelled retail prices to their current plateau, we may yet see price competition become a more important factor at the retail level. To the extent that this helps to boost sales, it will be welcomed by dairy farmers. Yet I think everyone would agree that in the long term profitability must be maintained at all levels of the market place, farmers, processors, and retailers included.

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