Testimony on Cost of Processing in Cheese, Whey, Butter and Nonfat Dry Milk Plants

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by

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Introduction

Judge Palmer and personnel of AMS Dairy Programs, I am appearing before you to offer a summary of a recent research project in which I collected data on and summarized the costs of processing in cheese, whey, butter and nonfat dry milk plants. I am not here to advocate for or against any particular policy action but rather to offer my insights into the current cost environment for dairy processors. This is a summary of my work and does not represent an official statement of Cornell University.

Cornell University has been conducting cost of processing studies in the dairy industry for more than 30 years. Over the past 20 years, work by the Cornell Program on Dairy Markets and Policy (CPDMP) included studies on the cost of processing cheese[1,2], whey[3], butter, nonfat dry milk powder[4,5], and fluid milk[6]. This project assesses the costs of processing in cheddar cheese, dry whey, butter and nonfat dry milk plants and builds

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[1] Mesa-Dishington, Jens K., Richard D. Aplin, and David M. Barbano., "Economic Performance of 11 Cheddar Cheese Manufacturing Plants in Northeast and North Central Regions, Part 1 of a Research Effort on Cheddar Cheese Manufacturing.", A.E. Res. 87-2, Dept. of Agr. Econ., Cornell Univ., January 1987.

[2] Mesa-Dishington, Jens K., David M. Barbano, and Richard D. Aplin., "Cheddar Cheese Manufacturing Costs, Economies of Size and Effects of Different Current Technologies, Part 2 of a Research Effort on Cheddar Cheese Manufacturing.", A.E.Res. 87-3, Dept. of Agr. Econ., Cornell Univ., January 1987.

[3] Hurst, Susan, Richard Aplin, and David Barbano., "Whey Powder and Whey Protein Concentrate Production Technology, Costs and Profitability, Part 4 of a Research Effort on Cheddar Cheese Manufacturing.", A.E.Res. 90-4, Dept. of Agr. Econ., Cornell Univ., April 1990.

[4] Stephenson, Mark W. and Andrew M. Novakovic., "Manufacturing Costs in Ten Butter/Powder Processing Plants.", A.E.Res. 89-19, Dept. of Agr. Econ., Cornell Univ., September 1989.

[5] Stephenson, Mark W. and Andrew M. Novakovic., "Determination of Butter/Powder Plant Manufacturing Costs Utilizing an Economic Engineering Approach.", A.E.Res. 90-6, Dept. of Agr. Econ., Cornell Univ., June 1990.

[6] Erba, Eric M., Richard D. Aplin, and Mark W. Stephenson., "Labor Productivities and Costs in 35 of the Best Fluid Milk Plants in the U.S.", E.B. 97-03, Dept. of Agr., Res., and Mgrl. Econ., Cornell Univ., March 1997.

on knowledge and background of these earlier efforts. Partial financial support for this project was provided by the Dairy Programs division of the Agricultural Marketing Service of the U.S. Department of Agriculture.

Two weeks ago on September 1, 2006, I published the initial summary results of this work on my web site[7]. I also sent an email announcement to about 250 people who work in the industry to let them know this working paper was available for download. The working paper describes the selection of plants involved in the study, the methodology used to collect and summarize the results. In the interest of brevity, I would ask that this working paper, which has been freely available and widely circulated, be accepted into the hearing record without reading its contents. I will summarize in my testimony what I consider to be the most important points with regard to methodology and the primary findings which include:

> 20 Cheese plants (outside of California) were selected from a draw, stratified by plant size whereby 5 plants were randomly selected from the largest 10 percent of plants in the country and 15 were selected from the remaining 90 percent of plants. Whey plants were a subset of the cheese plants selected. Butter and nonfat dry milk plants were selected by a non-stratified random draw.
>
> 16 completed surveys from cheddar cheese plants, 12 from plants drying whey, 8 plants producing nonfat dry milk powder, and 4 butter plants. Locations of these plants are regionally diverse.
>
> In addition to plants producing cheddar cheese and/or dry whey, nonfat dry milk and/or butter, plants had to produce these products in one or more of the package sizes that are surveyed in the National Agricultural Statistics Service (NASS) report on Dairy Product Prices. I.e., 40 lb. blocks of cheese, 500 lb. barrels of cheese, dry whey in bags, totes or bulk, butter in 68 lb. or 25 kg. boxes and nonfat dry milk in bags, totes or bulk.
>
> Plants were allowed to select the most recent twelve-month period which corresponds to their fiscal year. Because the plants have some latitude for time period, the results do not correspond to a calendar year or even to the same twelve-month period. The most common 12-month time period was from July 2004 through June 2005. These 12 months encompass about 63 percent of the observations. Another 21 percent of the observations were from earlier months and the remaining 16 percent were more recent.
>
> The methodology used to collect and summarize the data are very similar to the methodology used by the California Department of Food and Agriculture (CDFA) in their annual plant surveys. There are three primary differences from CDFA's results that bear mention: I do not have audit authority to collect data from plants, I do not calculate a current value of assets from schedules of economic deprecia-

[7] http://www.dairy.cornell.edu/CPDMP/Pages/Publications/Pubs/COP%20Working%20Paper.pdf

tion and, my sample of plants represent a smaller proportion of the population than California's annual survey.

Processing cost results published in the working paper show a simple average cost of $0.2065 and a sample weighted average cost of $0.1638 per pound of cheese. A simple average cost of $0.2282 and a sample weighted average cost of $0.1941 per pound of whey. A simple average cost of $0.1484 and a sample weighted average cost of $0.1410 per pound of nonfat dry milk [8]. And, a simple average cost of $0.1492 and a sample weighted average cost of $0.1108 per pound of butter.

Sample versus Population

The basic idea of statistics is that you want to extrapolate from the data you have collected to make general conclusions about the larger population from which the data sample was derived.

To do this, statisticians have developed methods based on a simple model: Assume that all your data are randomly sampled from an infinitely large, normally distributed population. Analyze this sample, and use the results to make inferences about the population.

This model is an accurate description of some situations but not the U.S. dairy industry. The CDFA data essentially sidesteps the issue as they collect data from very nearly all plants processing the products of interest in their state. This is the difference between a "sample statistic" — what I have collected — and a "population parameter" — what CDFA collects.

Previous processing studies, including my own, have shown very large economies of scale in these plants. As I was setting up the research methods for this study, I made 10 random draws of 20 plants from the population plant list that I had available. Doing this revealed that 17 to 18 of the 20 plants in such a draw would represent fairly small cheese plants mostly located in the Upper Midwest. Conducting the research on such a sample would provide excellent information on smaller plants located in one region of the country but would give sketchy evidence of processing costs in the plants processing the bulk of cheese in the country.

It was decided that I would conduct a stratified random draw whereby 5 plants were randomly selected from the largest 10 percent of plants in the country (outside of California) and 15 were selected from the remaining 90 percent of plants. Butter and nonfat dry milk plants were also selected by random draw but because the population of these plants is so much smaller and because I had no prior information on plant volumes, no

[8] One nonfat dry milk plant contacted me regarding the allocation of costs across products in their plant. Better information on cost allocation changes the simple average from $0.1484 to $0.1525 and the weighted average from $0.1410 to $0.1423. This change appears to be unique to this one plant.

stratification was done. The goal was to survey 8 nonfat dry milk plants and 10 butter operations.

When we calculate descriptive statistics on a sample, sometimes we are interested in just that sample, but more often we are interested in making inferences about the population parameters. I believe that to be the case here.

The Confidence Interval

The mean (average) you calculate from a sample is not likely to be exactly equal to the population mean. The size of the discrepancy depends on the size and variability of the sample. If the sample is small and variable, the sample mean may be quite far from the population mean. If your sample is large with little scatter, the sample mean will probably be very close to the population mean. Statistical calculations combine sample size and variability (standard deviation) to generate a confidence interval for the population mean. You can calculate intervals for any desired degree of confidence, but 95 percent confidence intervals are most common.

Using the cheese plants as an example, I have calculated the simple average (mean) of the 16 plants to be $0.2065 and the weighted average to be $0.1638 per pound of cheese. A 95 percent confidence interval around this is a range from $0.1502 to $0.2808. The literal interpretation of this is that I can be 95 percent confident that the population means falls between these two values.

The confidence interval for whey is a range of $0.1328 to $0.3237, for nonfat dry milk is a range from $0.1204 to $0.1846 and for butter a range from -$0.0921 to $0.3905. The large range on butter costs reflects relatively few observations and a fair amount of variability in the data.

A Better Approximation of the Cheddar Cheese Population

The variation that we observe between plants might be explained by many factors. Certainly one that is hypothesized is the size of the plant. Others might include product mix, seasonal operation, region of the country, management, etc. Some of these factors are readily measured but others, like management, are not.

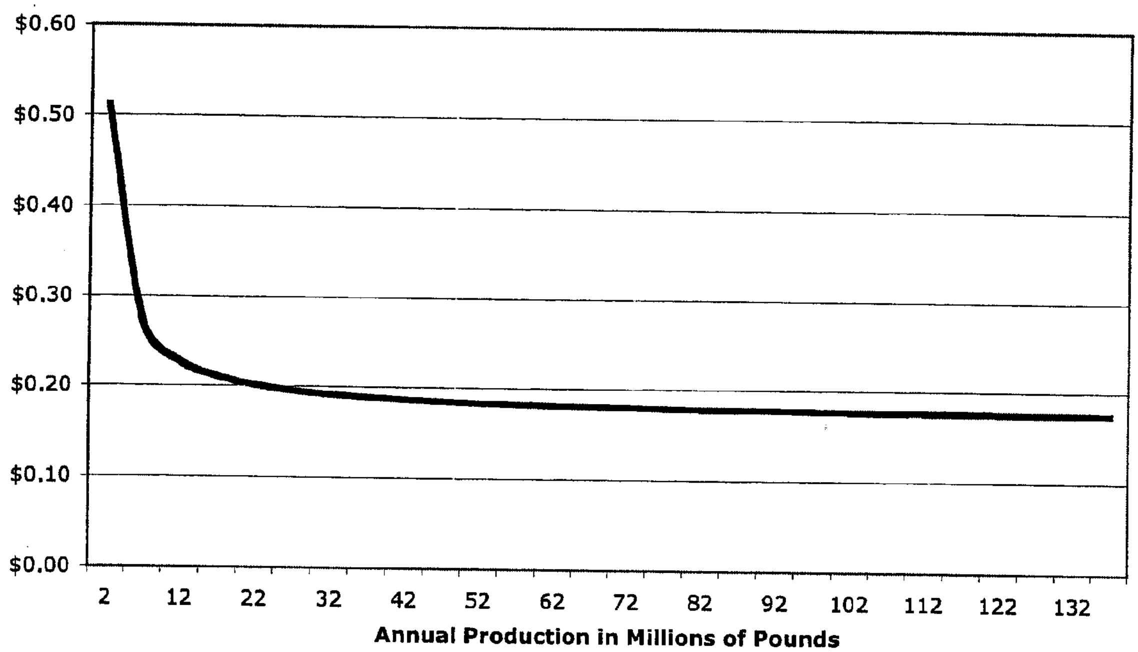
A cost function would include one or more of these factors and would give an approximation of plant costs that might differ from the mean as a result of the factors differing. Another statistical tool that is often used to model relationships between variables is regression analysis.

I have often observed that the relationship between plant size and costs of processing is not linear in the dairy industry. In other words, the economies of scale may be very large for doubling a fairly small plant but not so much for doubling a very large plant. Regression analysis was performed on the cost data from the cheese plants with a non-linear functional form using only pounds of cheese processed as the explanatory variable. The following formula is the result:

$$\text{Cost per pound} = 0.170026 + (683574 / \text{Pounds Processed})$$

The cheese plant cost as a function of pounds of cheese processed has an R-squared value of 88.7 percent. R-squared is a measure of fit and can be interpreted as 88.7 percent of the variability observed in cost of cheese processing can be explained by the volume of cheese processed annually. This is a very good statistical fit for a function like this and it allows further examination of the population of cheese plants. Figure 1 shows the cost curve as derived from the formula above.

Figure 1. Annual Production Versus Cost per Pound of Cheddar Cheese



An Estimation of the Population Costs for Cheddar Cheese

I have a recent snapshot of monthly volume data for non-California cheddar cheese plants. This was the list used to take the random draws for plant selection. This list includes 138 plants in the country with volumes from large to quite small. When NASS collects weekly dairy product prices for cheddar cheese plants, only plants producing

1,000,000 pounds or more of product annually are included in the survey. One million pounds of cheddar cheese production would, on average, process four 50,000 tanker loads of milk per week. Plants smaller than this are probably producing a specialty cheese and not commodity cheddar. If I make one million pounds of cheese the cutoff for inclusion in the population of commercial plants, then, of the 138 plants that I have data for, 53 plants remain in the list. Figure 2 displays the cumulative percent of plants, ranked from large volume to smaller, and shows the estimated cost of processing in the 53 plants.

Figure 2. Cumulative Percent of Plants Versus Cost per Pound of Cheddar Cheese (In 53 Plants)

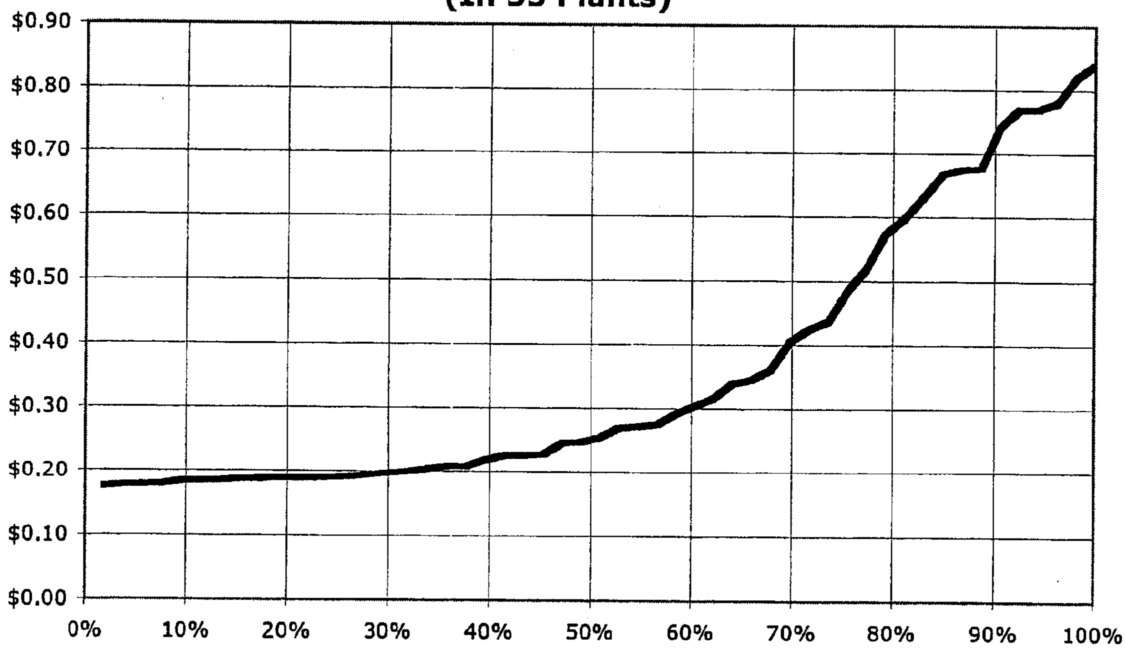
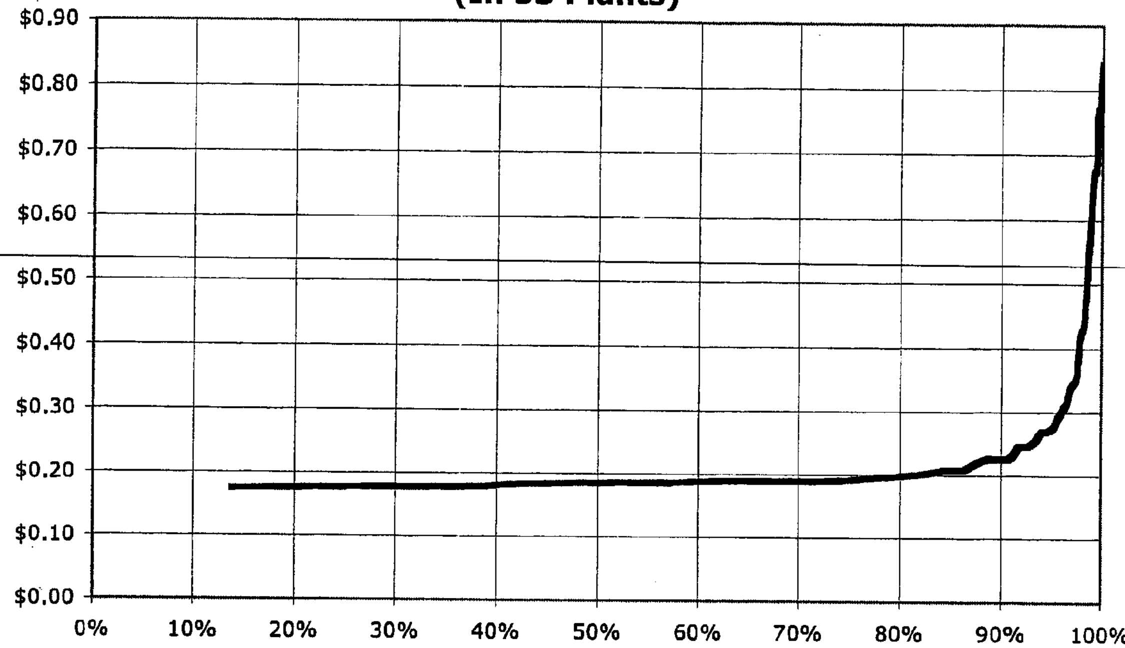


Figure 2 demonstrates, for example, that if we wanted to cover the processing costs of 60 percent of the commercial cheddar cheese plants in this country, we would need to have a make allowance of about $0.30.

We can also plot the cumulative percent of volume of cheddar cheese produced in the plants. This is done in Figure 3 which shows, for example, that if we wanted to cover the processing costs of 80 percent of the cheddar cheese produced outside of California, then we would need a make allowance of about $0.20.

Figure 3. Cumulative Percent of Volume Versus Cost per Pound of Cheddar Cheese (In 53 Plants)



An Estimation of the Weighted Average Processing Costs for Cheddar Cheese

If we define the commercial population of cheddar cheese plants as the 53 plants that I have observations for, then we can calculate a weighted average estimate for the population rather than the weighted average value of the sample provided earlier in this paper ($0.1638 per pound). The weighted average estimate of the population is $0.2028. This is a value that would cover about 82 percent of the volume of cheddar cheese made in the country and the processing costs of about 33 percent of the plants.

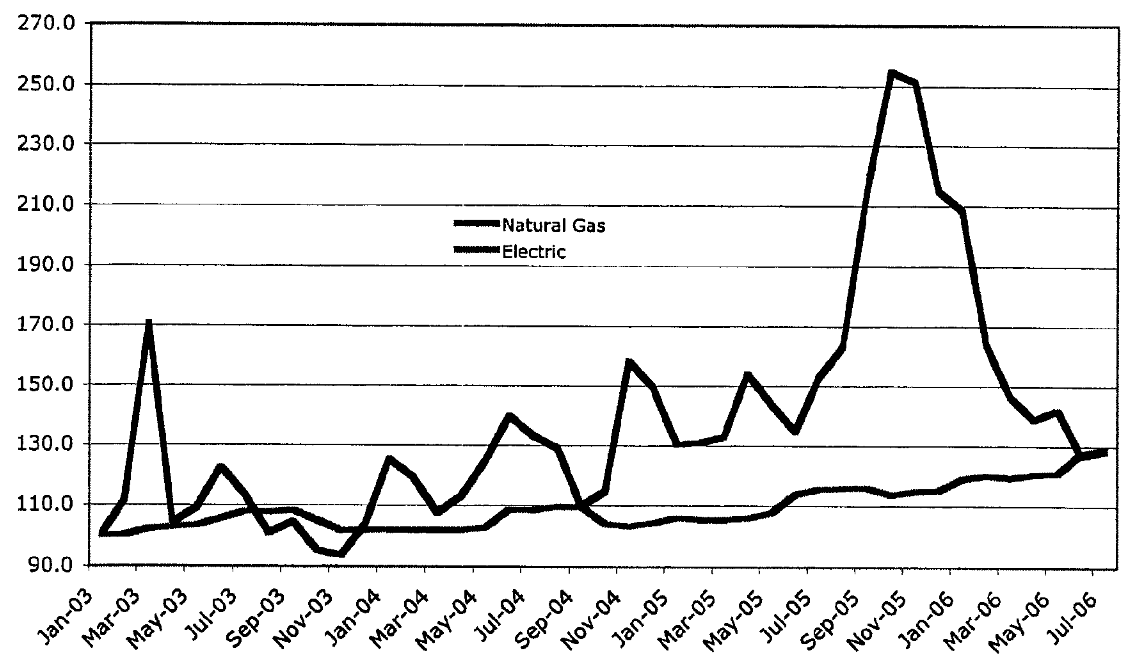
Estimating Population Costs of Whey, Nonfat Dry Milk and Butter

I would like to make the same mapping from sample statistics to population estimates for the other three products surveyed. However, population data on production volumes for these products are not in my possession. It is possible that the National Agricultural Statistics Service (NASS) could provide this data from their monthly Dairy Products survey. I was in contact with NASS to see if I might obtain plant-level data without plant identification but they had concerns with their confidentially agreements and with the comparability of populations.

Impact of Energy

As mentioned earlier in my testimony, the majority of plant observations came from a time period of July 2004 through June 2005. Some observations were earlier than that and some more recent. Over this time period, energy costs in particular have increased. The Bureau of Labor Statistics calculates an index of producer prices (PPI) for industrial electric power and natural gas. Over the entire 26 month time period, the PPI for electric power had increased about 13 percent and natural gas had increased by somewhat more than 100 percent. Applying the PPI indices to the monthly plant values, average electric expenditures would have increased 4 percent from the average values listed and gas costs would be increased by 28 percent. Figure 4 shows the PPI for electricity and natural gas indexed from January 2003 through July 2006.

Figure 4. Indices of Natural Gas and Electric rates



When this change in the indices are applied to bring the cheese cost of processing forward to the 2005 calendar year for all plants, the average cost per pound of cheese would be increased by about $0.0034 per pound. This is observation is offered with the caution that only utility rates are changed and not the other costs of processing.

The impact on nonfat dry milk and whey is nearly double the cheese values as utilities are a greater portion of total costs. Indexing electric and gas rates forward to the 2005 calendar year increases the average cost per pound of powder by $0.0070 and whey by

$0.0076 in the plants surveyed. Again, only fuel and electric rates are changed in this calculation. Butter processors would only see their utility costs increase by about $0.0029.

Concluding Comments

Plant participation in the study has been good. Although these plant data are not audited, comparison with the audited data from CDFA demonstrates comparability and I have no reason to question the integrity of participants.

Butter plant participation was not as strong as hoped for and the confidence interval around the mean estimates shows that there was more variability around the mean of the plants who did provide data.

Care must be taken to understand the difference between the sample means and the population parameter. I have good data to make an estimate of the population parameter for cheese plants but am unable to do so for lack of data with whey, nonfat dry milk and butter operations.

Data were collected from plants which covered a 26 month period. However, 63 percent of observations were during the 12 month time period from July 2004 through June 2005. Another 21 percent of the observations were from earlier months and the remaining 16 percent were more recent.

Energy costs have increased dramatically over the past couple of years, in particular, natural gas costs at the end of 2005. Although they have retreated from those highs, utility costs have become a focal point for many people in the make allowance debate.

This study shows that utility costs are about 10 percent of cheese processing costs and about 20 percent of whey, butter and nonfat dry milk processing costs. When these costs increase at levels approaching 100 percent, total processing costs are impacted by significant amounts.

If you have any questions, I would be glad to try and answer them without divulging any confidential data.