Study to Support Growth and Competitiveness of the Pennsylvania Dairy Industry

Combined Final Report

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Executive Summary

This study was begun early in 2017 after discussions with leadership of the Pennsylvania Department of Agriculture and the Center for Dairy Excellence[1]. The overall objective was to assess the factors that limit growth and competitiveness of Pennsylvania's dairy industry and to suggest actions by industry and state government that could better support growth. Phase I of the study reviewed existing data to assess historical performance of the state's industry, often with comparisons to other key dairy states with similar agronomic resources (Michigan, New York, and Wisconsin). Subsequent phases assessed the potential for additional dairy processing capacity, compared farm-level financial performance in Pennsylvania to other states, summarized stakeholder opinions about what limits growth and what might be done to better support it, assessed the economic impact of the state's dairy industry, evaluated the potential of the Port of Philadelphia to support dairy exports from Pennsylvania, projected prices, farm incomes and exports through 2025 to understand potential market opportunities and the context for future growth, and evaluated the impacts of the Pennsylvania Milk Marketing Board on milk sales and fluid milk processing in the state.

Below is a summary of key findings from each of the study components.

Phase I Diagnostic Study

- Milk production in Pennsylvania has grown little in the past decade, with slower growth in milk per cow than in comparison states with similar agronomic resources (NY, MI, WI). The southeastern and central regions of the state have seen growth in milk production since 2007;
- A survey of nearly 1000 dairy producers by the Center for Dairy Excellence indicated that 14% expect to exit the industry in the next five years, with a 18% overall reduction in cow numbers based on current intentions. Surveyed producers placed less emphasis on increasing herd size or milk per cow than on obtaining higher and more stable prices to improve future business performance;
- Available published data on dairy processing in Pennsylvania are limited and do not allow a comprehensive assessment of state-level processing performance. NDM and butter plants

[1] The authors gratefully acknowledge the support of Russell Redding, Secretary of Agriculture, and Jayne Sebright of the Center for Dairy Excellence.

processed volumes above the overall US average in 2015, but volumes per plant for many products are small compared to the overall US average for other products.

Incentives for Additional Processing Capacity

- Substantial incentives appear to exist for additional processing capacity in Pennsylvania – especially for other" cheese (non-American types, including Italian and specialty cheese) plants—based on their potential to reduce overall supply chain costs given 2016 milk production and dairy product demands;
- Significant economic benefits would accrue to the state because additional processing capacity would markedly increase processing of milk in Pennsylvania that is now shipped out-of-state;
- Investment in two "other" cheese (non-American types, including Italian and specialty cheese) plants processing volumes of 4 million lbs of milk per day in the areas near State College and Reading would result in the largest reduction in supply chain costs, and thus indicate the strongest incentives for new processing capacity;

Comparative Farm Financial Performance

- Pennsylvania farms tended to have lower Return on Assets, higher Debt-to-Asset Ratios and lower Current Ratios than analyzed farms in other states. These differences exist both for overall average values during 2011 to 2016 and many of the individual years, and when considering farm size and milk per cow;
- Overall, these measures suggest that larger and more productive Pennsylvania farms may be less resilient in the face of economic stress than similar types of farms in other states;
- The analysis does not directly indicate the underlying causes of these differences and their practical management or programmatic implications. Additional analyses of data for a broader range of farms—facilitated by a collaborative multi-state data collection effort is therefore suggested to address these limitations.

Stakeholder Comments and Comparative Organizational Support for the Pennsylvania Dairy Industry

- Stakeholders have diverse views regarding the drivers of dairy industry growth in Pennsylvania, among them market access, regulation, farm structure, access to production resources, and professional development;
- The key data requirements include a set of broadly accessible information about farm financial performance and processing capacity, although future market opportunities and the benefits of existing programs were also mentioned;
- Pennsylvania has a diversity of organizations that provide support for dairy farms and dairy processors. However, our overview suggests that there are organizations and state-level programs in New York and Wisconsin that do not exist in Pennsylvania, and that might usefully be considered in greater detail to assess their effectiveness and appropriateness.

Economic Impacts of the Pennsylvania Dairy Industry

- The state's dairy industry is a major contributor to overall economic activity, generating an estimated 52,000 jobs and $14.7 billion in economic activity in 2015;
- Both the farm and processing sectors are important contributors to employment and income. with farms contributing about 46% of dairy-industry employment and 36% of the total economic activity generated by the Pennsylvania dairy industry.
- Economic multiplier values for dairy farm activity range from near 2 to 3, which means that in addition to direct economic activity, dairy farms generate substantial additional jobs and income. Multiplier values are larger for dairy processing activity, ranging from near 2 to more than 5;

Export Potential Through the Port of Philadelphia

- *PhilaPort* appears to have the capabilities, capacity and relationships with relevant shippers (dairy product exporters) and service providers (such as steamship lines) to support substantial growth in dairy product exports. This capability will be enhanced further by expansions funded by state government and currently under implementation;
- Despite extensive capabilities and historical product and market diversity, the share of US dairy exports departing from the Philadelphia Port District has been small—less than 1% on a value basis during 2007 to 2016. They comprise only about 6% of exports from mid-Atlantic ports (New York, Norfolk, Baltimore and Washington, DC);
- Projections of Prices, Farm Profitability and US Dairy Product Exports for 2018 to 2025 Reallocation of 2016 dairy product exports to *PhilaPort* rather than other mid-Atlantic ports would increase farm-level milk values, reduce the costs of milk assembly to processing plants, and reduce product distribution costs. The total net benefit is estimated to be about $1.8 million per year, excluding economic multiplier impacts. This net benefit is about $0.02/cwt on all milk produced in Pennsylvania.

Projections of Prices, Farm Profitability and US Dairy Product Exports for 2018 to 2025

- Milk and dairy product prices are expected to have markedly higher average values during 2018 to 2025 than during 2015 to 2017;
- Higher average milk prices, combined with projected relatively stable feed costs and growth in average cows per farm will result in higher levels of average profitability as measured by Net Farm Operating Income (NFOI), and this is true for all four of the farm sizes analyzed;
- Despite overall growth in the value of US dairy product exports, products for which *PhilaPort* has larger export market shares among Northeast ports (for example, ice cream) are not indicated to provide major growth opportunities.

Impacts of the Pennsylvania Milk Marketing Board on Fluid Milk Retail Prices and Processing Volumes

- We find no definitive evidence that suggests that price regulation under the PMMB is a major cause of declining fluid milk sales or decisions about the location of fluid milk processing, and thus, no evidence that major modifications to the PMMB would result in substantive improvement in sales of fluid milk or differences in processing location for same;

- Price enhancement due to the PMMB does not appear to be a major factor in the observed reduction of fluid milk sales in recent years. Our estimates suggest that the impact of retail pricing regulation under the PMMB at most accounts for less than one-fifth of the decline in fluid milk sales observed in the past five years. Key Points and Recommendations
- The volume of Pennsylvania farm milk priced by the PMMB has declined from 2007 to 2016, but these declines are largely in line with declines in fluid milk sales reported by the Northeast and Mideast Federal Milk Marketing Orders and for the US as a whole, which suggests that factors other than price regulation under the PMMB are more important drivers of the observed reductions in fluid milk sales;

Key Recommendations

- Growth and competitiveness of Pennsylvania's dairy industry is likely not constrained by agronomic resources, access to markets, support organizations or (before the last couple of years) processing capacity. Rather, the key constraints appear to relate to farm structure (size and interest of farmers in growing and(or) improving productivity of their farms;
- Opportunities to support improved growth and competitiveness of the Pennsylvania industry arise through additional resources for farm management education, collection and dissemination of information relevant for decisionmakers, improving awareness of supporting resources and continuing to highlight the opportunities for profitable investment in additional dairy processing facilities;
- Organize a series of strategic planning sessions with key industry stakeholders to develop a set of joint goals and suggested actions. Although strategic planning does not obligate key actors, it can be useful as a means of envisioning the actions required for enhanced growth and competitiveness and provide a framework for interpretation of available data;
- We recommend evaluation of existing demand-related programs and the assessment of potential for value-added and branded dairy processing investments that may leverage existing farm structure.

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Chapter 1: Study to Support Growth and Competitiveness of the Pennsylvania Dairy Industry: Phase I Report

Chuck Nicholson, Mark Stephenson and Andrew Novakovic[2]

Executive Summary

This study was begun early in 2017 after discussions with leadership of the Pennsylvania Department of Agriculture and the Center for Dairy Excellence. The objectives for Phase I are primarily diagnostic, focusing on a review of aggregated secondary data regarding farm and processing sector performance. A key purpose of this document is to provide input for subsequent discussions by industry stakeholders.

- Milk production in Pennsylvania has grown little in the past decade, with slower growth in milk per cow than in comparison states with similar agronomic resources (NY, MI, WI). The southeastern and central regions of the state have seen growth in milk production since 2007. Larger milk per cow is associated with use of a nutritionist, systematic breeding and location in the southeastern part of the state. Farm size is not associated with milk per cow, and older milking facilities were associated with lower milk per cow;
- A survey of nearly 1000 dairy producers by the Center for Dairy Excellence indicated that 14% expect to exit the industry in the next five years, with a 18% overall reduction in cow numbers based on current intentions. Surveyed producers placed less emphasis on increasing herd size or milk per cow than on obtaining higher and more stable prices to improve future business performance;
- Available published data on dairy processing in Pennsylvania are limited and do not allow a comprehensive assessment of state-level processing performance. NDM and butter plants processed volumes above the overall US average in 2015, but volumes per plant are small compared to the overall US average for other products.
- Available NASS data suggest that total Pennsylvania cheese production has been roughly constant since 2000, whereas Wisconsin cheese production has grown by 50%. Ice cream production has decreased in Pennsylvania, and although sour cream and yogurt have increased in recent years, the volumes remain small.
- There has been a marked increase in recent years in Pennsylvania milk pooled in Class IV under the Northeast Federal Milk Marketing Order, whereas the amount of milk pooled in other classes has been roughly constant since 2006. Volumes of milk utilized in dry milk products are highly volatile and have increased notably since 2014.
- Despite a 15% decline in overall Class I sales in the Northeast Federal Milk Marketing Order since 2006, the amount of Pennsylvania farm milk in Class I uses has remained roughly constant during the past 11 years;

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[2] The authors are, respectively, former Clinical Associate Professor of Supply Chain Management, Penn State University (now Adjunct Associate Professor, Cornell University), Director of Dairy Policy Analysis, University of Wisconsin, Madison, and E. V. Baker Professor of Agricultural Economics and Director of Land Grant Programs, Charles H. Dyson School of Applied Economics and Management, Cornell University.

- Economic development entities in Pennsylvania have benefitted a relatively small number of dairy-related entities in the state (primarily in dairy processing), but likely could be used to a greater extent.
- A study[3] sponsored by the International Dairy Foods Association (IDFA) indicated large economic impacts of post-farm dairy processing in Pennsylvania during 2014, including nearly $9 billion in direct economic activity and 45,000 jobs.
- An initial review of the data on Pennsylvania farm milk used in fluid processing and economic logic[4] suggests that the regulated milk pricing structure under the Pennsylvania Milk Marketing Board is not a major causal factor in the decline of fluid milk sales in the region more generally and the volume of fluid milk processed in the state. Moreover, the Pennsylvania Class I premium is considered a reference point for privately negotiated Class I premiums in other states. This probably means is that even if a Pennsylvania farm is selling to a NJ fluid plant, the farm is getting a premium that has benefited from the regulated pricing structure in Pennsylvania.

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[3] The IDFA study was released online in July 2017 and is separate from a similar assessment of economic impacts that will be undertaken as one component of the *Study to Support Growth and Competitiveness of the Pennsylvania Dairy Industry*. The findings of the IDFA-sponsored study are reported because they provide additional evidence of the economic importance of the Pennsylvania dairy industry.

[4] A subsequent component of study will examine the impacts of the PMMB in greater detail.

Background and Phase I Study Objectives

This study was begun early in 2017 after discussions with leadership of the Pennsylvania Department of Agriculture and the Center for Dairy Excellence. The objectives for Phase I are primarily diagnostic, and are designed to provide input for subsequent discussions by industry stakeholders. The Phase I objectives include:

1) Comparative performance of Pennsylvania dairy farm productivity and profitability;
2) Comparative performance of Pennsylvania dairy processing capacity, performance and future plans;
3) Availability assessment of data relevant to the analysis of current status of the dairy industry and development or modifications of programs or policies;
4) Comparative summary of organizations and institutions to support dairy sector development;
5) Summary of programs and policies in Pennsylvania that affect future growth and competitiveness;
6) What economic development efforts in Pennsylvania other states support growth of agribusiness and dairy?;
7) Initial discussion of issues related to the Pennsylvania Milk Marketing Board.

This interim report summarizes the findings to date for each of these project components.

Farm-level Performance

Sector-Level Performance Assessment

Although this component of the project seeks insights about how to enhance the productivity and profitability of Pennsylvania's dairy farms through comparisons of farm-level data, a review of more aggregated data provides relevant context. A key observation is that total milk production in Pennsylvania as reported by the National Agricultural Statistics Service (NASS) has grown little in the past 16 years (Figure 1), which contrasts with the much more rapid rates of growth in production in comparison states (WI, NY and MI). Michigan's milk production has nearly doubled during 2000 to 2016, and although Wisconsin lost production during the first few years of the 2000s, it has grown considerably since its low point in 2004. Growth in New York has increased since the low-margin year of 2009. One factor affecting state-level milk production is productivity. Milk per cow in Pennsylvania (also reported by NASS) has increased at less than 1% per year, a rate much slower than those of comparison states (Figure 2). These comparisons suggest that growth in milk production and productivity per cow are occurring in other states with similar agronomic resources, which underscores the need to understand why the pattern of growth is markedly different in Pennsylvania. These are key questions to be addressed by this study: what underlies the pattern of growth in Pennsylvania and what might be done to accelerate profitable growth at the farm level?

Although overall growth in milk production has been slow in Pennsylvania, production has increased in some counties and decreased in others (Figures 3 and 4). This analysis compares data from the 2007 Census of Agriculture and our estimates of county-level milk production in 2016[5] to assess changes in a volume and as a percentage. In general, counties with larger milk production in 2007 showed more growth—that is, there has been a further geographic concentration of milk production. The largest production increases occurred in Lancaster, Berks, Franklin and Blair counties (Figure 3). Milk production declines were concentrated in the northeast and southwest corners of the state, with the exception of York county. The percentage growth was larger for some counties with lower production levels, including Potter, Clinton, Jefferson and Columbia. As for state-level milk production, these patterns provide a basis for further analysis about why production is growing in some counties and declining in others.

[5] County-level milk production was estimated from county-level milk receipts, where reported, from various statistical bulletins from federal milk marketing orders receiving milk from Pennsylvania (Federal Orders 1, 33, 5, 7 and 6). Milk production estimates are also made from county-level Agricultural Census reports of dairy cow numbers conducted by the National Agricultural Statics Service for 2012. The sum of the county estimates of milk volume and components exactly sum to the state totals for the months used in the USDSS spatial model and the years reported.

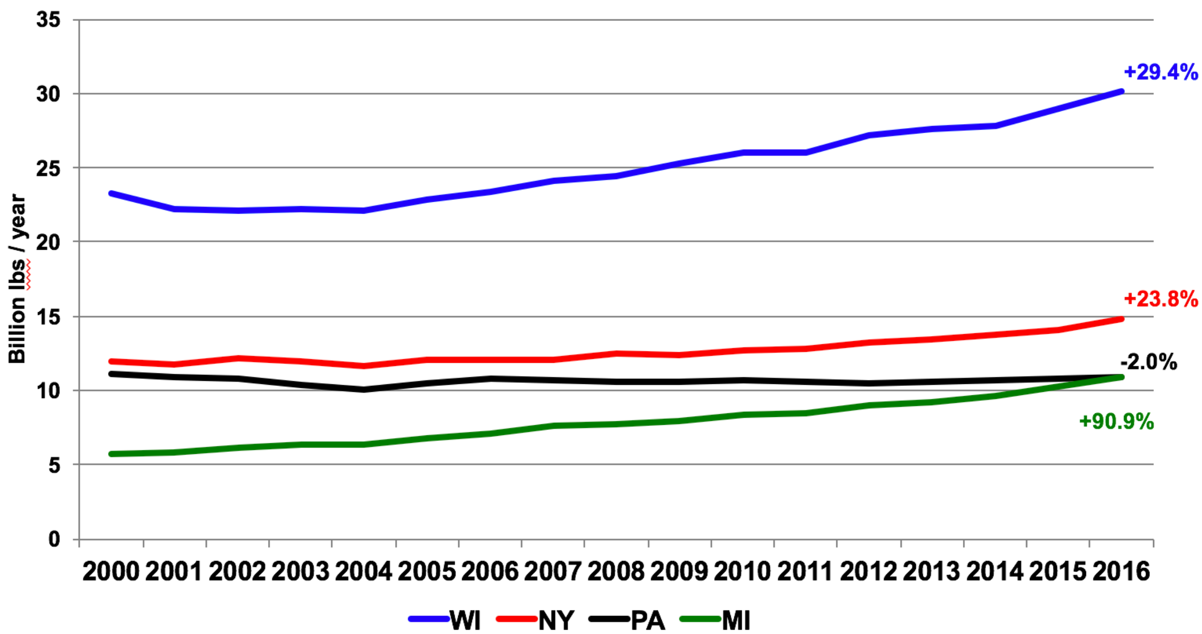


Figure 1.1. Total Annual Milk Production for Selected States, 2000 to 2016

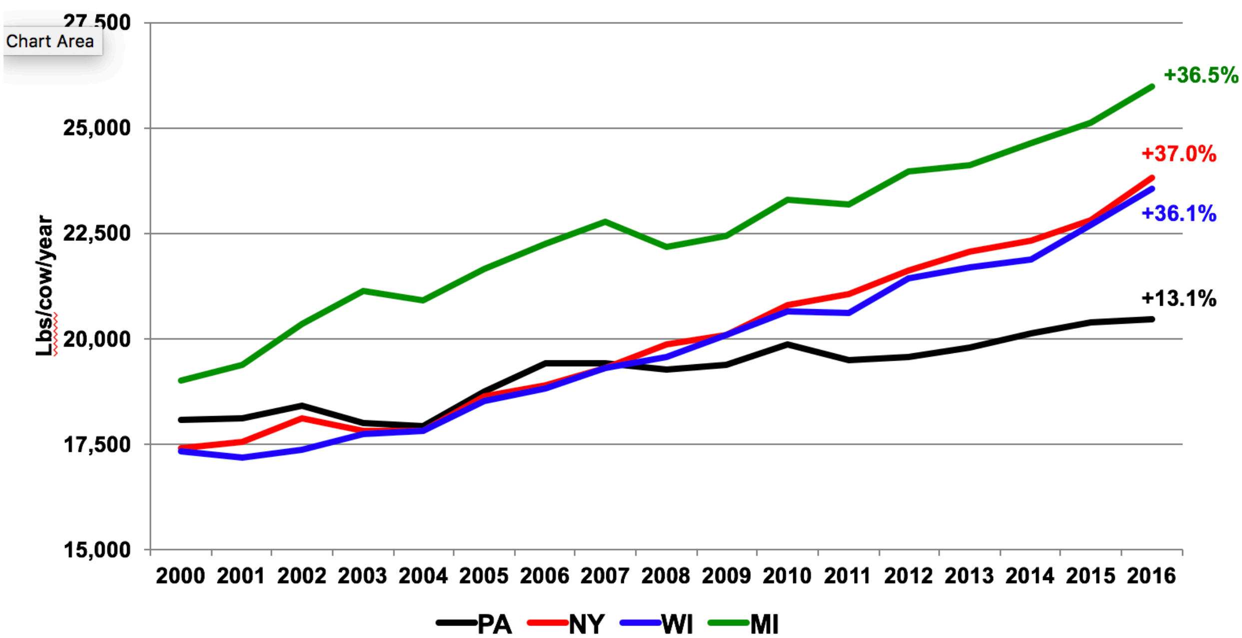


Figure 1.2. Total Annual Average Milk Per Cow for Selected States, 2000 to 2016

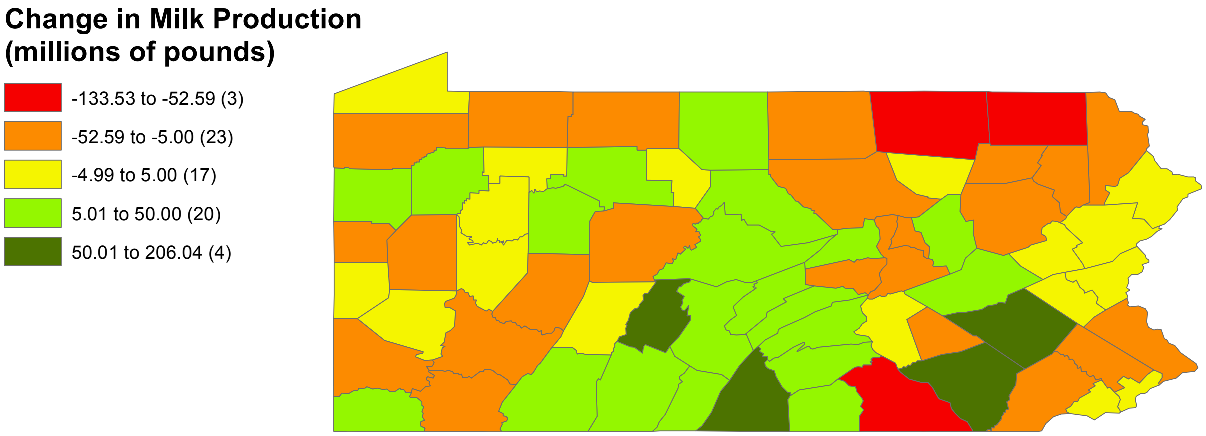
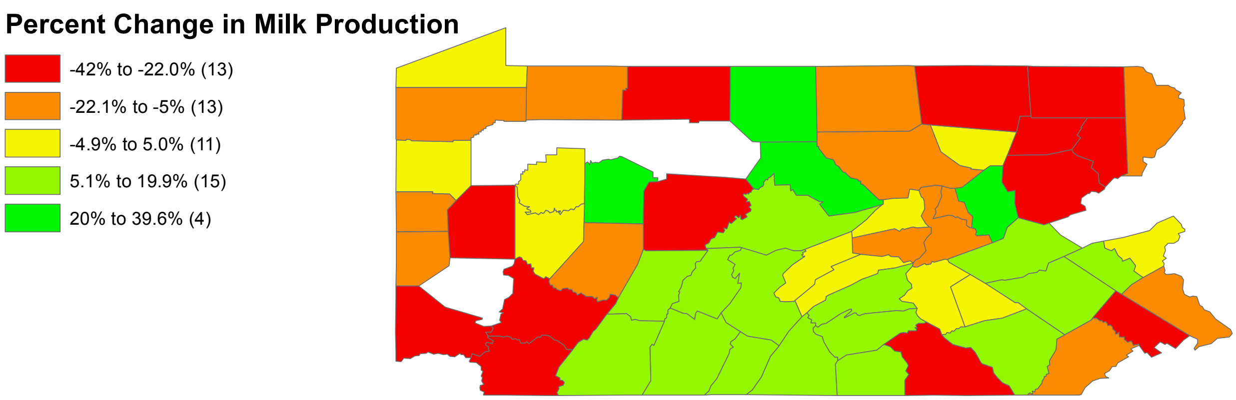


Figure 1.3. Estimated Change in Milk Production, Pennsylvania Counties, 2007 to 2016



Note: Counties not shown had milk production values that were not reported in the 2007 Census of Agriculture.

Figure 1.4. Estimated Percentage Change in Milk Production, Pennsylvania Counties, 2007 to 2016

Center for Dairy Excellence 2017 Producer Survey Analysis

Data from farm-level surveys can also provide some insights about the state- and county-level patterns described above. The Center for Dairy Excellence has undertaken statewide producer surveys in 2008, 2012 and 2017. We analyzed data from the 2017 survey to provide additional perspective on milk production and productivity patterns. In 2017, 992 dairy farms (roughly 14% of Pennsylvania's approximately 7,000 dairy farms) responded to the survey[6]. Responses were received from most counties in the state, and response rates were roughly proportional to the number of dairy farms and(or) milk production by county (Figure 5). About 11% of the farms surveyed indicated that they were no longer milking cows, which is suggestive of a rate of exit of farms during the five years between surveys. Of the survey respondents who are still milking cows (N=879), the average farm size was 102 cows, with a range from 6 to 1900. Seventy-five percent of respondents had fewer the 100 cows, and 50% of respondents had < 70 cows.

Although the CDE survey provides information on a broader set of characteristics and expectations for the state's dairy producers, we focused on a few key outcomes that relate to the potential for future growth and competitiveness. One such factor is whether farms expect to be in business five years from the time of the survey (that is, in 2022). Overall, about 14% of the surveyed farms expect to exit during the next five years (a rate roughly comparable to the exit rate suggested by the 11% of farms who exited between 2012 and 2017). However, the expected rates of exit vary by farm size, with higher rates expected for smaller farm sizes (Figure 6). About 20% of farms with 50 cows or less expect to exit by 2022, but none of the farms with more than 250 cows plan to exit. These expectations can also be examined based on expected reductions in cow numbers by 2022. On average, the survey farms expect to reduce cow numbers by 18%, which includes a number of "100% reduction" responses by farms that expect to exit. As for farm exits, smaller farms expect larger reductions in cow numbers, and the largest farms expect to grow (Figure 7). Together, these results do not suggest strong growth in milk production during the next five years, although it is important to note that these are <u>expectations</u>, not yet <u>realities</u>. The overall effect of future exits on milk production and appropriate processing capacity in the state depends on the decisions of producers who do not exit and the broader market context. The components of the current study do not include a projection of the numbers, or sizes of Pennsylvania farms and milk production under alternative market conditions or proposed changes, although perhaps a future study of this nature would be useful.

[6] A response rate of 14% to a broad-based survey of this nature would be considered fairly good from the perspective of most social science research. This survey appears to reflect somewhat smaller farms and less productive farms on average, but does not appear to have a degree of bias that renders the results either suspect or unhelpful.

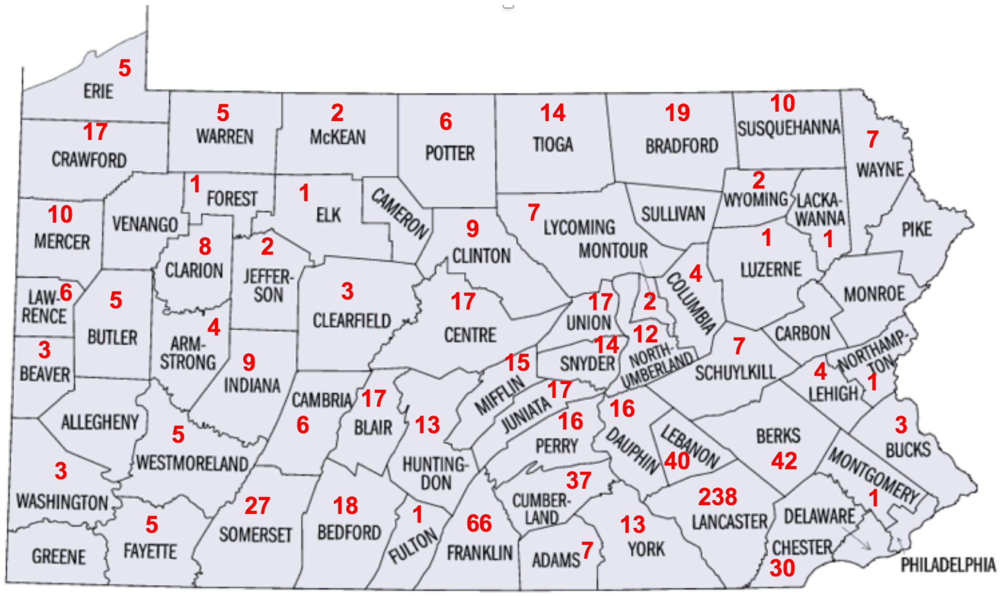


Figure 1.5. Number of Respondents by County to Center for Dairy Excellence 2017 Producer Survey

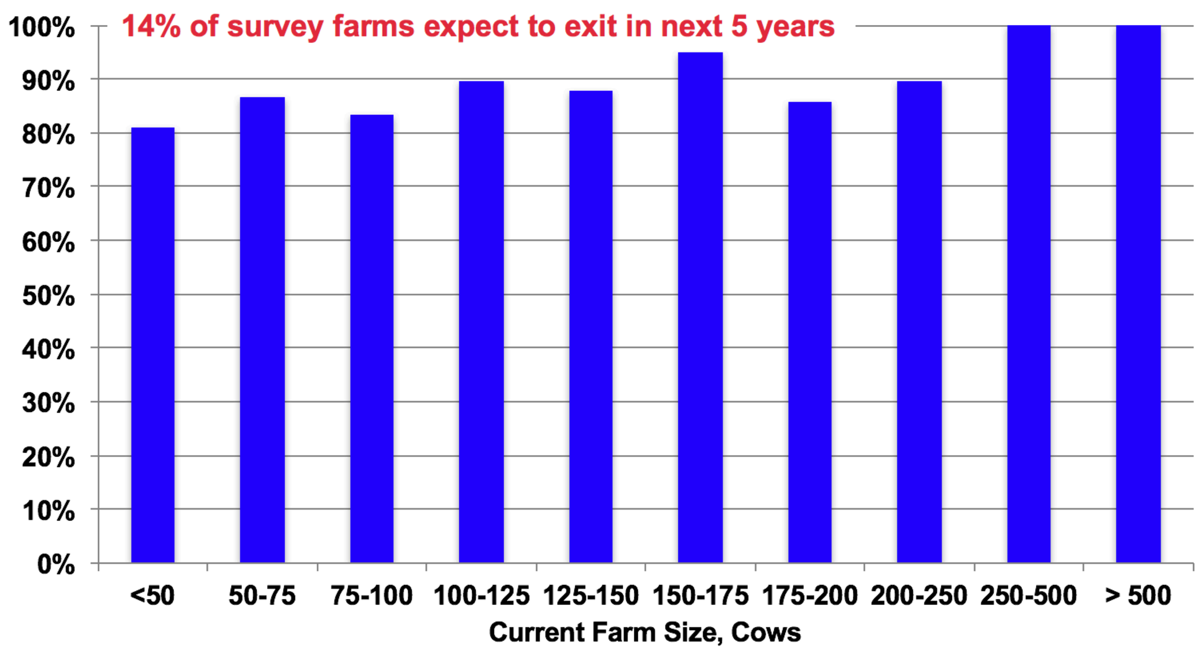


Figure 1.6. Proportion of Surveyed Farms Expecting to be in Dairying Five Years from Now, by Farm Size Category

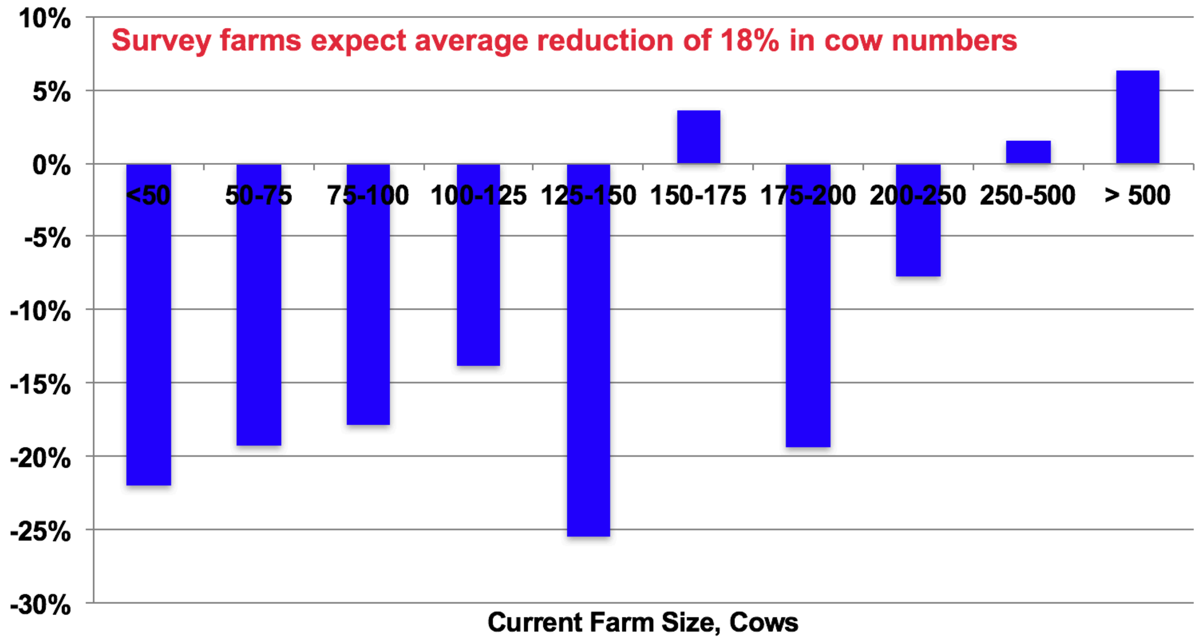


Figure 1.7. Expected Percentage Reduction in Cow Numbers Five Years from Now on Surveyed Farms, by Farm Size Category

The expected change in cow numbers by survey respondents can also be examined by county (Figure 8), although caution should be exercised based on the small number of respondents in some counties. Respondents from counties with larger milk production in 2016 generally indicated neutral to positive expected percentage changes in cow numbers, and counties with less milk production negative expected changes[7].

The factors reported by survey respondents as important to the improvement of farm business performance during the next three to five years also provide insights about the potential for growth and improvement competitiveness. The survey asked respondents to rank as “Not Important”, “Somewhat Important” or “Very Important” eight factors relating to milk prices, cost structures, productivity and farm size. To summarize these results, we assigned values of 0, 1 and 2 to these categories, respectively, and took the average of the responses. Maximizing the price received for milk and stabilizing milk prices were the highest ranked factors (Figure 9), followed by decreasing costs of production overall and specifically those for feed. Improvements in milk components and udder health were ranked next most important. As highlighted in the figure, survey respondents ranked increasing milk per cow and farm size as the lowest priority (particularly the latter), which suggests that surveyed farms do not view productivity gains or farm size as critical for future business performance.

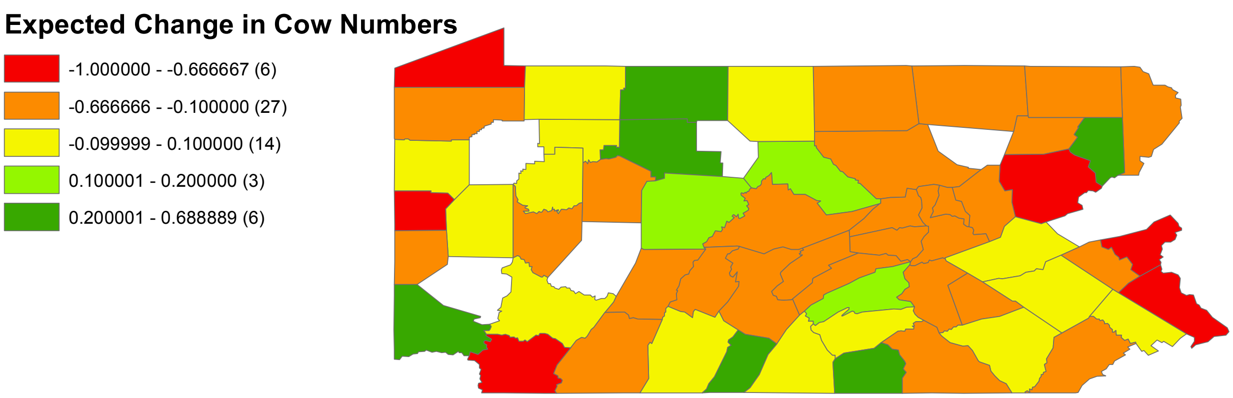
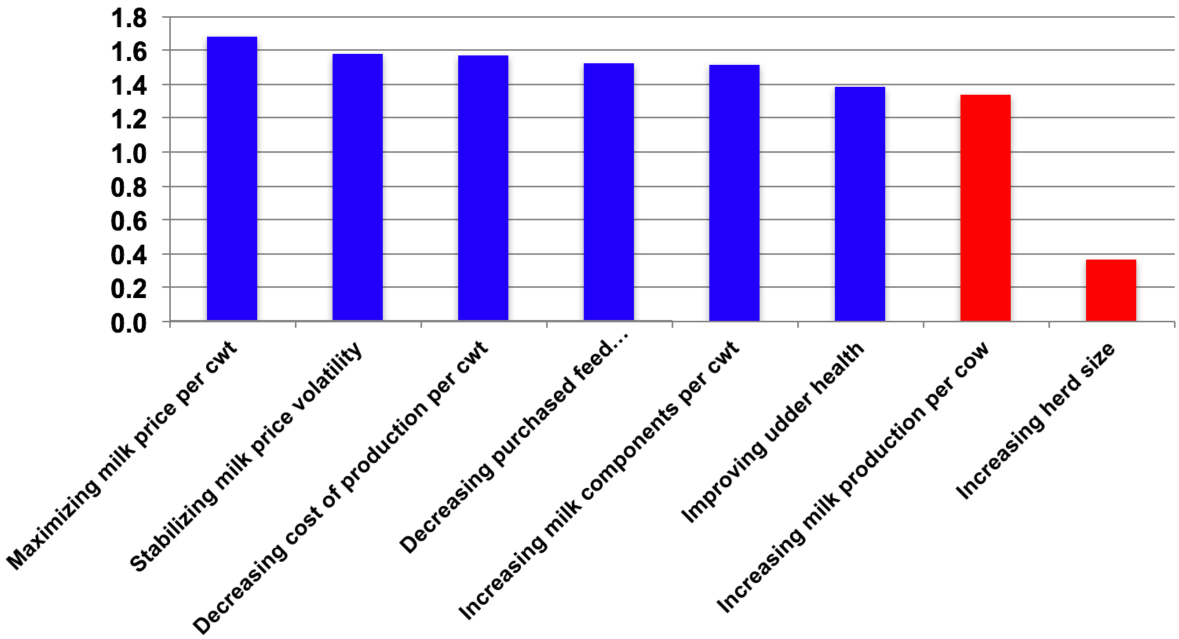


Figure 1.8. Expected Proportional Change in Cow Numbers Five Years from Now, Pennsylvania Counties

[7] The counties of McKean, Elk, Lackawanna, and Washington indicate growth but all have very small numbers of survey responses (3 or less).



Note: Values are the average of 0 = Not Important, 1 = Somewhat important and 2 = Very important.

Figure 1.9. Reported Importance of Factors to Improving the Business Performance During the Next Three to Five Years

Given that growth in milk per cow has been slower in Pennsylvania than in other states with similar agronomic resources, an analysis of factors associated with milk per cow reported by survey respondents is relevant. Respondents reported 2016 milk production, and we eliminated 74 farms for which either daily or annual milk production values appeared to be inaccurate. There is a great deal of variation in annual milk per cow reported by survey respondents, particularly for the smaller farm sizes (Figure 10). We then used regression analysis to determine statistical associations[8] between selected factors from the survey and reported daily or annual milk per cow. The CDE survey reports on the use of number of management practices, and when facilities for housing or milking were last upgraded on the farm. We used these variables, along farm size and whether the farm was located in a county in southeastern Pennsylvania to assess their impacts on daily or annual reported milk per cow. Farm size (based on cow numbers), use of a nutritionist, use of a systematic breeding program and use of AI for 75% of all breedings were all associated with an increase in both daily and annual milk per cow (Tables 1 and 2). The strongest of these effects was for management practices, particularly the use of a nutritionist. Farms located in southeastern Pennsylvania had higher milk per cow, despite a climate that is probably somewhat less conducive to productivity. The impact of farm size, although statistically significant, was small—for each 100 cows a farm owned, daily milk production was higher by only 2 pounds, and each cow owned was associated with an increase in annual milk production of 6 pounds. The number of years elapsed since a farm upgraded milking facilities was associated with a negative impact on milk per cow, but was not statistically significant for annual milk per cow.

[8] A statistical association indicates that there is a statistical relationship between the variables, but it is important to note that this is not the same as causality. That is, it does not suggest that changing a variable like the use of a nutritionist will automatically result in an effect on milk per cow.

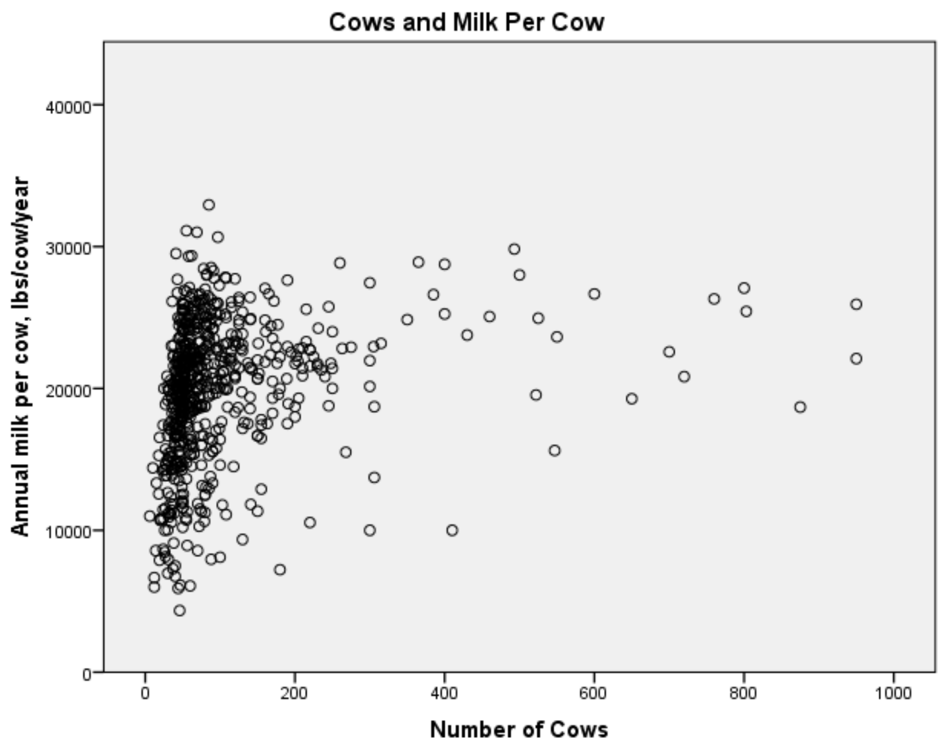


Figure 1.10. Scatter Plot of Reported Annual Milk Per Cow by Number of Cows on Surveyed Farms

Table 1.1. Regression Analysis of Factors Associated with Reported Daily Milk Per Cow

Variable	Coefficient	Std. Error	t-Statistic	P value
(Constant)	42.94	1.85	23.24	0.00
Number of Cows	0.02	0.00	5.35	0.00
Used Nutritionist?	14.70	1.68	8.77	0.00
Years since upgraded milking facilities	-0.11	0.04	-2.91	0.00
Used Systematic Breeding Plan?	4.26	1.07	3.98	0.00
Used AI for 75% of Breedings?	7.81	1.50	5.21	0.00
Farm in Southeastern PA Region?	3.42	0.96	3.56	0.00

N=692 CDE survey respondents, R^2 = 0.33, regression F-value = 56.3, regression p<0.000

Table 1.2. Regression Analysis of Factors Associated with Reported Annual Milk Per Cow

Variable	Coefficient	Std. Error	t-Statistic	P value
(Constant)	11,383	653	17.42	0.00
Number of Cows	6	1	4.00	0.00
Used Nutritionist?	4,419	587	7.53	0.00
Years since upgraded milking facilities	-21	14	-1.53	0.13
Used Systematic Breeding Plan?	1,383	375	3.69	0.00
Used AI for 75% of Breedings?	3,063	542	5.65	0.00
Farm in Southeastern PA Region?	1,483	340	4.36	0.00

N=598 survey respondents, $R^2 = 0.31$, regression F-value = 46.2, regression $p<0.000$

Although this analysis omits many other factors that might reasonably be associated with milk per cow, together, the basic pattern of a high degree of farm-level variation in the data and the statistical associations suggest that improvements are technically possible—but would require additional assessment for individual farm settings.

Processing Sector Performance

For growth and competitiveness of Pennsylvania's dairy farms to be enhanced, the processing sector must provide transformation and marketing of farm milk at a reasonable cost. Particularly in light of the discussions in recent years about the (in)adequacy of processing capacity in the state, we examined available data to assess trends in Pennsylvania's dairy processing sector. Our original intent was to rely heavily on NASS data on dairy production, but we quickly realized that these data were sufficiently incomplete to make a broad range of comparisons difficult. As an example, consider the available data for NDM production (Figure 11). National-level data are available continuously under NASS data-reporting guidelines, which specify that NASS must receive "at least (1) 3 good responses to our survey and (2) no producer controls 60% of more of the total production within the state" (personal communication from Adam Pike, Agricultural Statistician at the Northeastern Regional Field Office of NASS). Data on NDM production in Pennsylvania are available only for selected years, with a gap from January 2006 to December 2013. Similarly, data on cheese production are available only for selected states and time periods (Table 3, rendering comparisons to other states difficult.

However, we can assess selected trends with NASS data, and have complemented this with data from the Northeast Federal Milk Marketing Order on reported volumes processed in Pennsylvania dairy processing plants. Based on NASS data, production of butter and all cheese varieties in Pennsylvania has not increased to any great extent since 2000 (Figure 12), and the average value of production is essential constant during the past five years (albeit with sometimes significant seasonal variation). The limited growth of cheese production in Pennsylvania contrasts with the very rapid growth of cheese production in Wisconsin during this same time period (Figure 13). Total cheese production increased about 50% in Wisconsin during the 16 years beginning in 2000, and growth in production is more rapid in recent years.

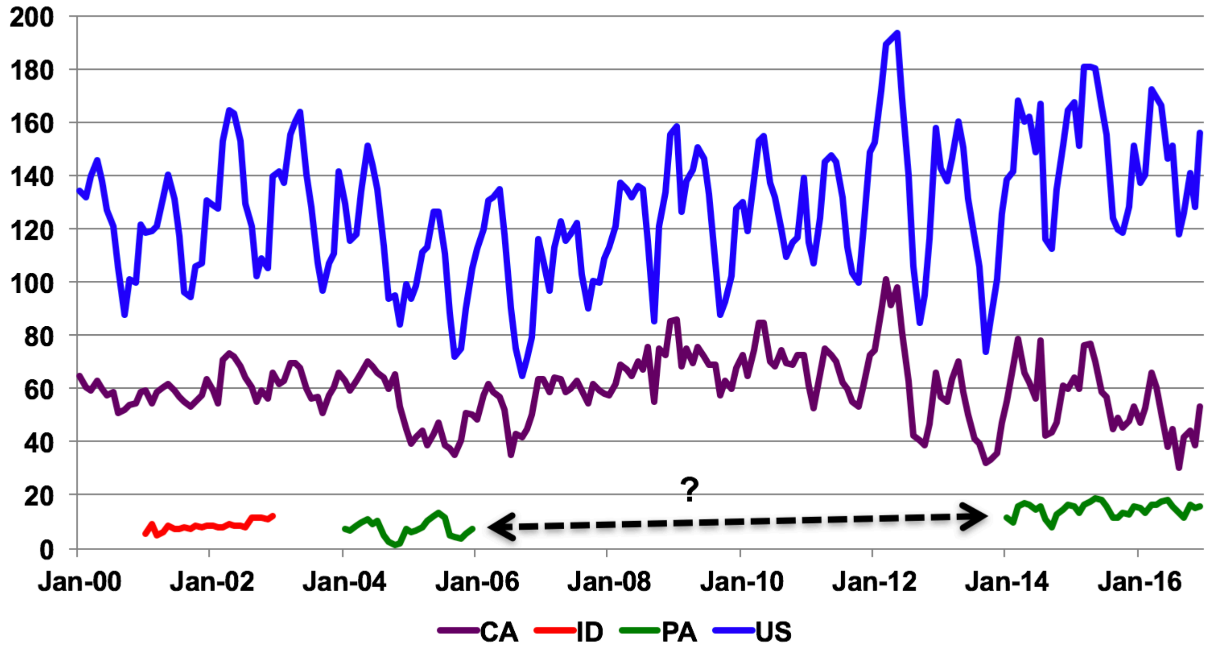


Figure 1.11. NDM Production Data Reported by National Agricultural Statistics Service, Selected States, 2000-2016

Table 1.3. Summary of NASS Data Availability for Selected Cheese Products for Pennsylvania and Comparison States

	US	PA	NY	WI
Cheese, All Other Types, Production	2000-date	1993-1994	2000-2008	2000-2001, 2004-2008
Cheese, American Types, Cheddar - Production	2000-date	1992	2000-2004	2000-date
Cheese, American Types, Production	2000-date	2014-2016	2000-2004, 2014-2016	2000-date
Cheese, American Types, Other (Colby, Monterey and Jack) - Production	2000-date	Not listed	2000-2009	2000-2015
Cheese, Blue and Gorgonzola, Production	2010-date	Not listed	Not listed	1990-1995
Cheese, Brick and Muenster, Production	2000-date	Not listed	Not listed	2000-2004
Cheese, Cream and Neufchatel, Production	2000-date	1996-1997	1994-1997	Not listed
Cheese, Feta, Production	2010-date	Not listed	Not listed	Not listed
Cheese, Gouda, Production	2010-date	Not listed	Not listed	Not listed
Cheese, Hispanic, Production	2000-date	Not listed	Not listed	2000-2015

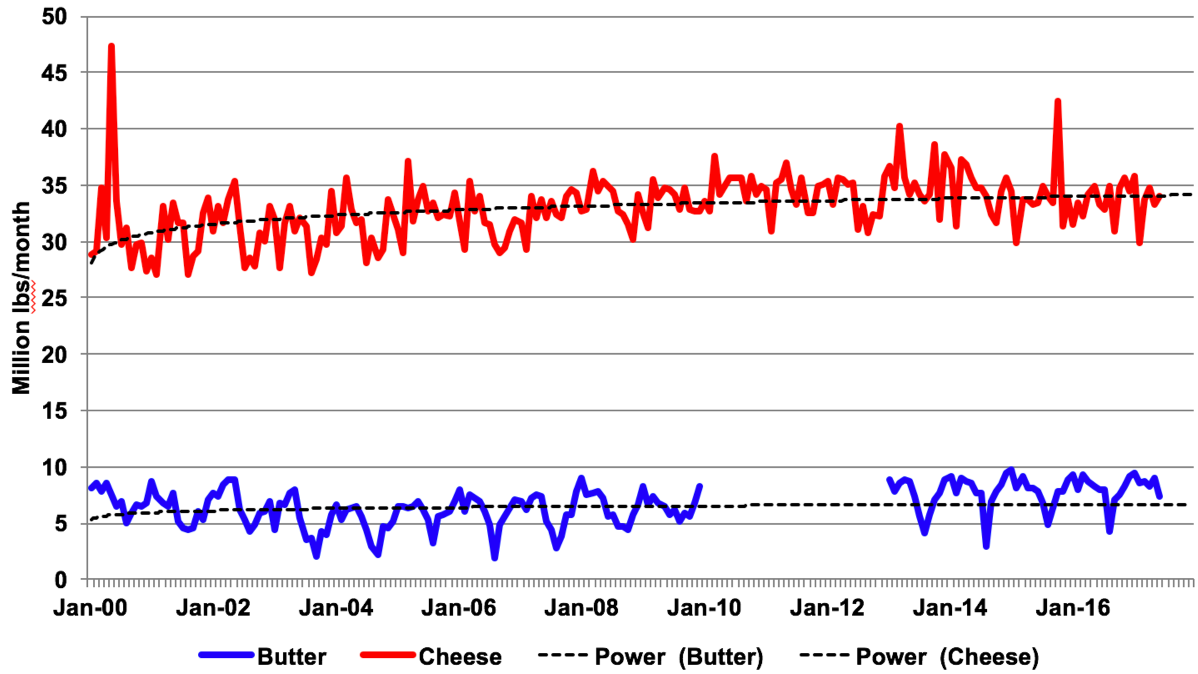


Figure 1.12. Pennsylvania Butter and Total Cheese Production Reported by NASS, 2000-2016

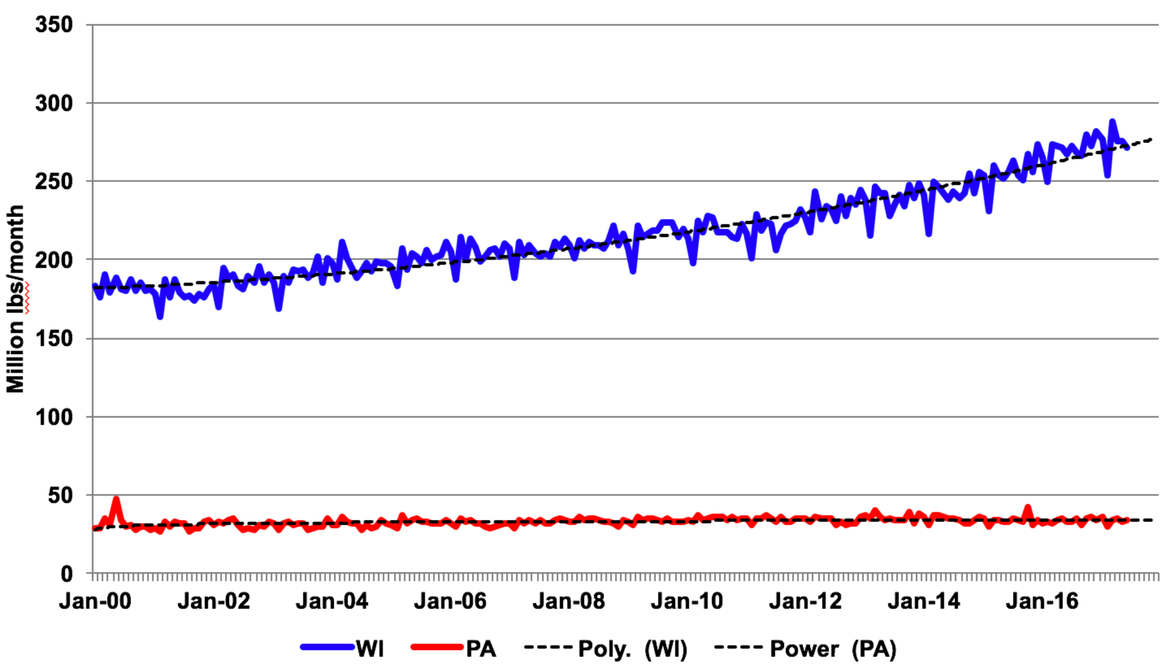


Figure 1.13. Total Cheese Production Reported by NASS, Pennsylvania and Wisconsin, 2000-2016

NASS data are also available of limited time periods to assess production of American Cheese, Sour cream and yogurt, although the American cheese data are now quite dated (more than 10 years old). Both sour cream and yogurt production have grown since 2014 (Figure 14), but the amounts of product are relatively small compared to other uses. Ice cream production in Pennsylvania has shown a declining trend since 2000, although is relatively stable since 2013 for regular hard ice cream (Figure 15).

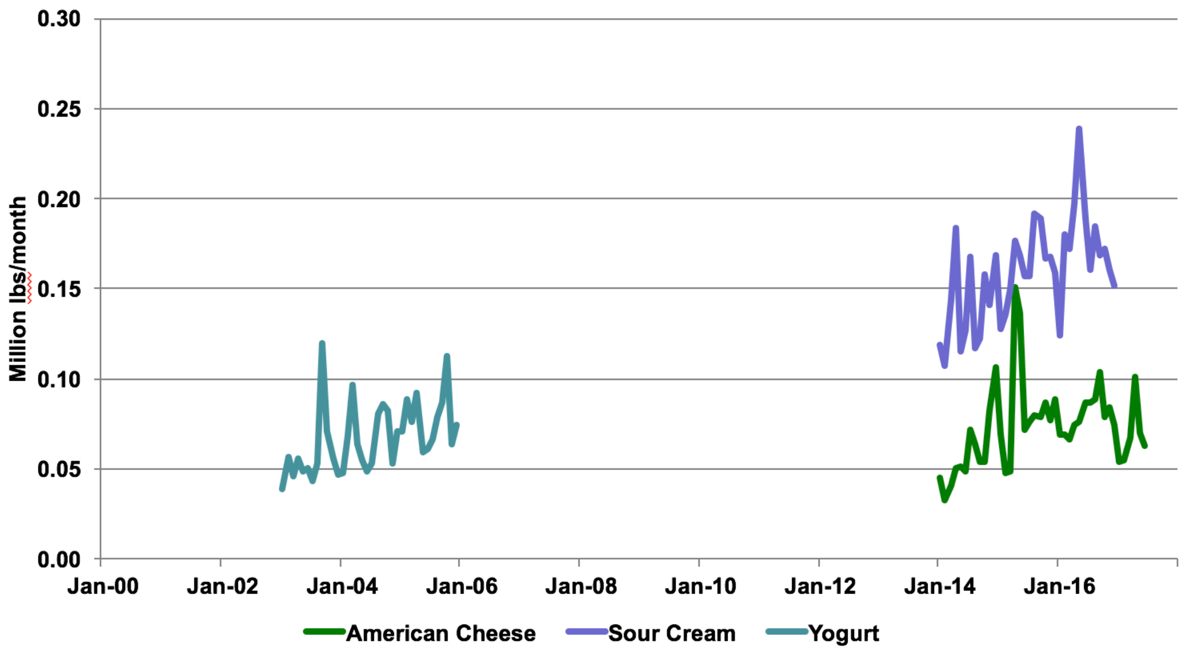


Figure 1.14. Pennsylvania American Cheese, Sour Cream and Yogurt Production Reported by NASS, 2000-2016

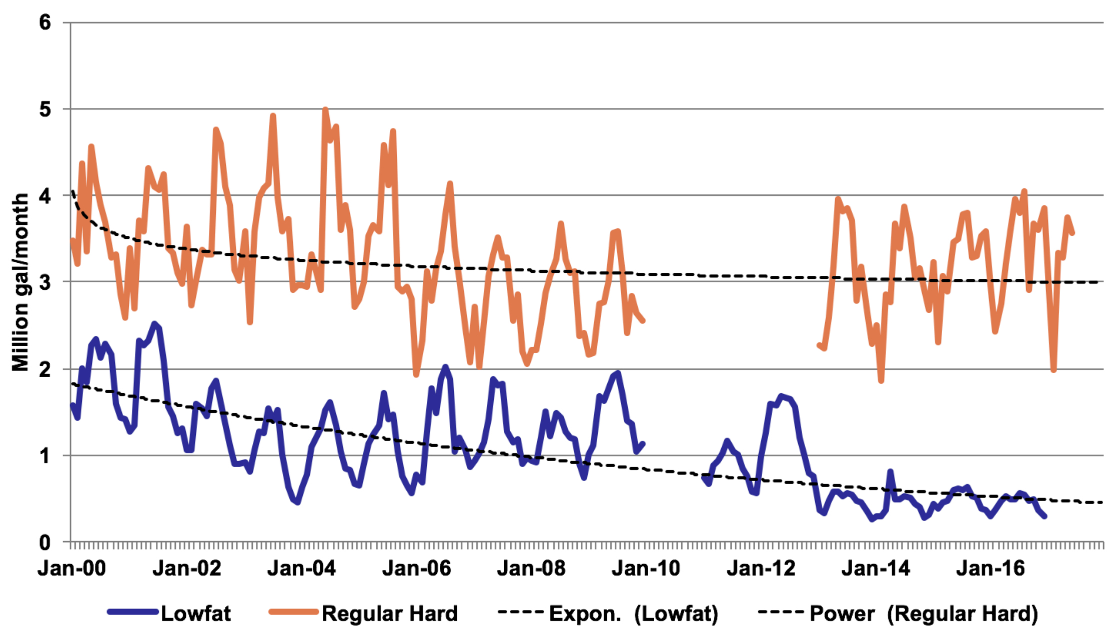


Figure 1.15. Pennsylvania Lowfat and Regular Hard Ice Cream Production Reported by NASS, 2000-2016

NASS data can also be used to provide a rough assessment of plant processing volumes by product compared to national average processing volumes. Average processing volumes often are related to unit processing costs, due to significant economies of scale in most dairy processing facilities. Based on 2015 data, Pennsylvania plants processed larger-than-average volumes of NDM (perhaps reflecting the balancing issues in the state in recent years), and about-average per plant volumes of butter and ice cream mix. Most other products for which data are available had much-smaller-than-average processing volumes per plant, which may be suggestive of higher per-unit processing costs[9].

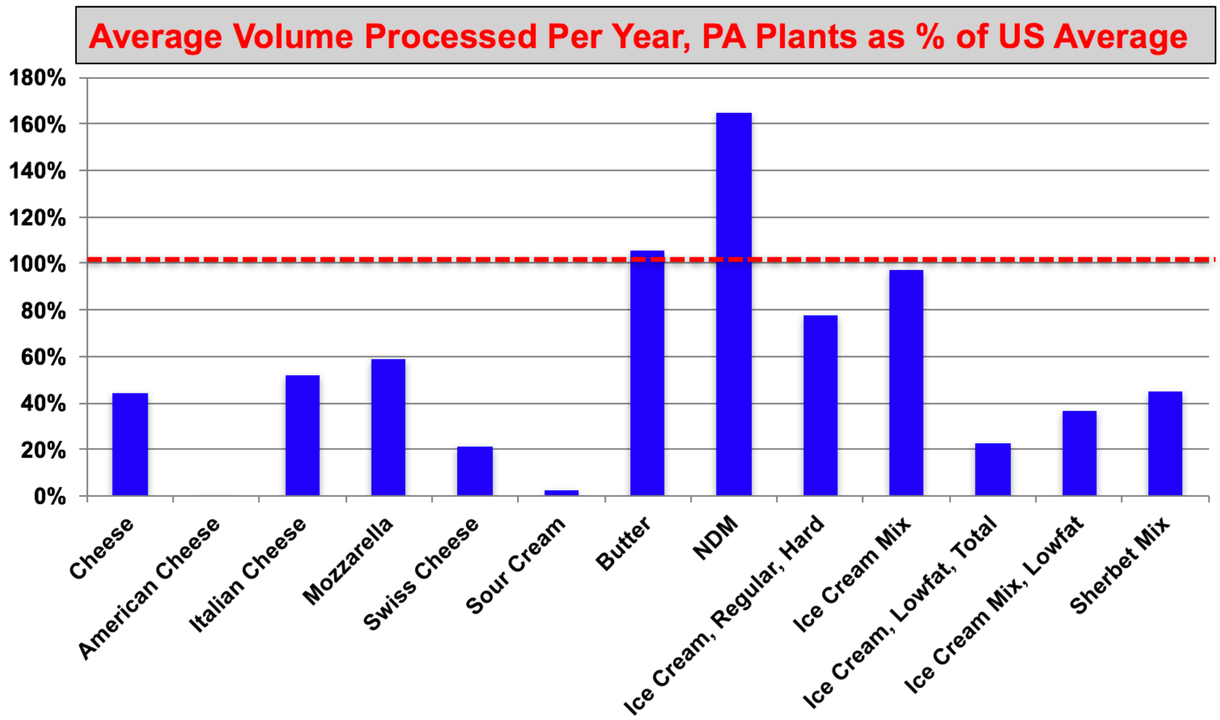


Figure 1.16. Volumes Processed Per Plant Per Year in Pennsylvania as a Percentage of Average US Plant Volumes, Selected Products, Based on 2015 NASS Data

NASS data can be useful—and would be more so if more years were available—but they do not report milk used for all product categories. In particular, processing volumes for fluid milk are not available, so we cannot assess the per-plant volumes for that product category in Pennsylvania relative to other states or the national average. As a complement to NASS data,

[9] There is insufficient information available to determine causal factors about why average processing volumes are lower. As noted in our discussion of the location of fluid milk processing in the PMMB study component, many factors affect the evolution of the dairy supply chain over time and we do not have sufficient data to assess them all. It is important to note that we are not implying that there is something somehow incorrect about decisions made in the Pennsylvania processing sector because there were smaller than average processing volumes for some products in 2015. We are only pointing out that relative to national averages, those volumes are smaller, and note that these tend to be associated with higher per-unit processing costs. We view this as a useful starting point for discussions about the extent to which this is an issue and what (if anything) could or should be done to address it.

we obtained information from the Northeast Federal Milk Marketing Order[10] about milk used in Pennsylvania processing facilities pooled under the order from 2006 to 2017. These data can be assessed by individual product uses of milk, but the reporting of milk by pricing class provides relevant insights. The average amount of milk pooled per month on the Northeast Order has remained roughly constant since 2006 for fluid milk products (Class I[11]) and cheese (Class III). The data suggest modest increases in Class II volumes pooled. Of particular note, though, is the great deal of seasonal fluctuation in Class IV use and the higher volumes processed since 2014.

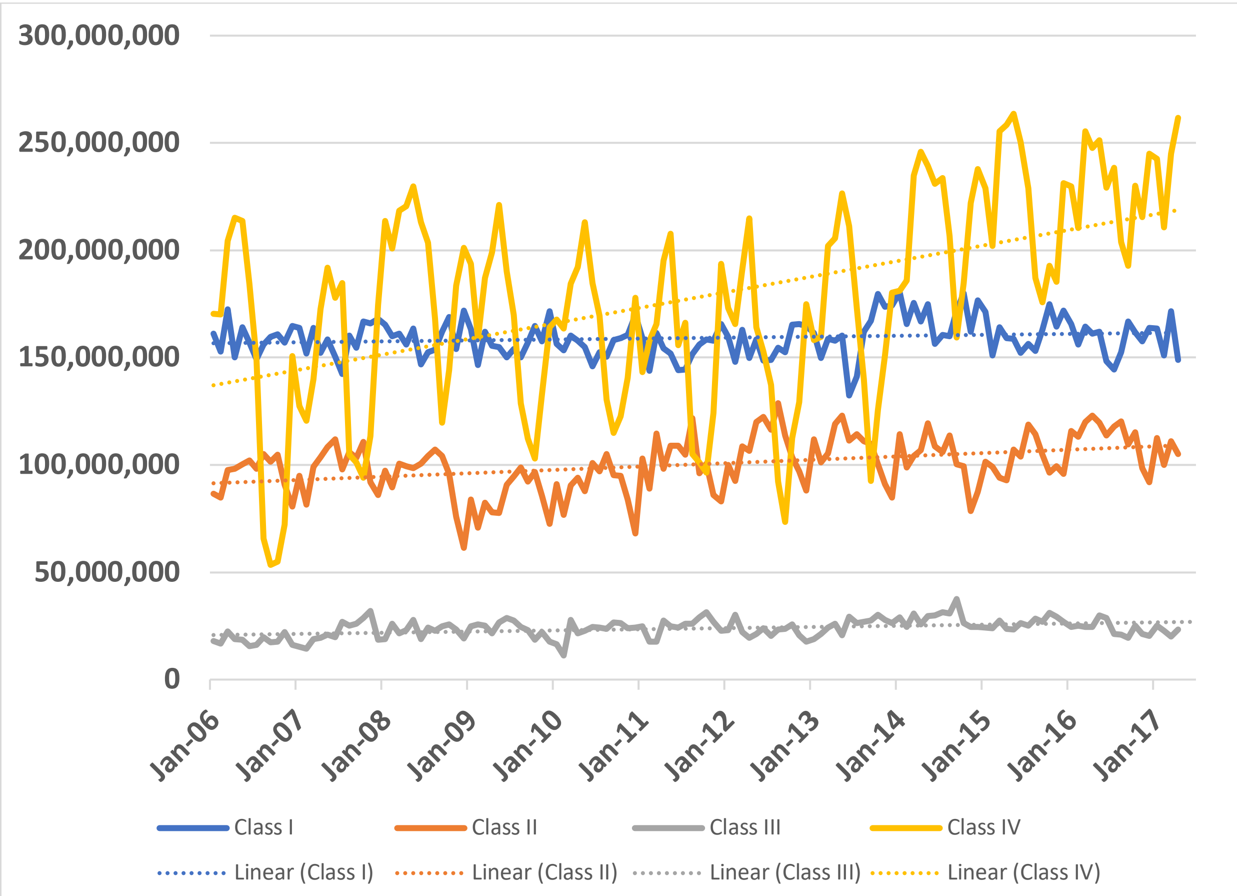


Figure 1.17. Utilization of Farm Milk at Processing Facilities in Pennsylvania Reported by the Northeast Federal Milk Marketing Order, by Class, 2006-2017 (lbs/month)

The pattern of fluctuations in Class IV utilization—especially the high and less variable levels since mid-2015—suggests the degree of stress on the state's butter/powder processing facilities in recent years. Further disaggregation of the data suggests that most of the issue arises with "dry milk products" (Figure 18).

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[10] We greatly appreciate the cooperation of Erik Rasmussen, Market Administrator of the Northeast Order, as well as Peter Fredericks and Brian Riordan to facilitate our access to these data.

[11] Roughly constant average amounts of Class I milk may suggest that minimum pricing regulation under the PMMB is not having a substantive detrimental effect on Class I processing in the state, and notably contrasts with the general decline in class I milk pooled in the Northeast order overall.

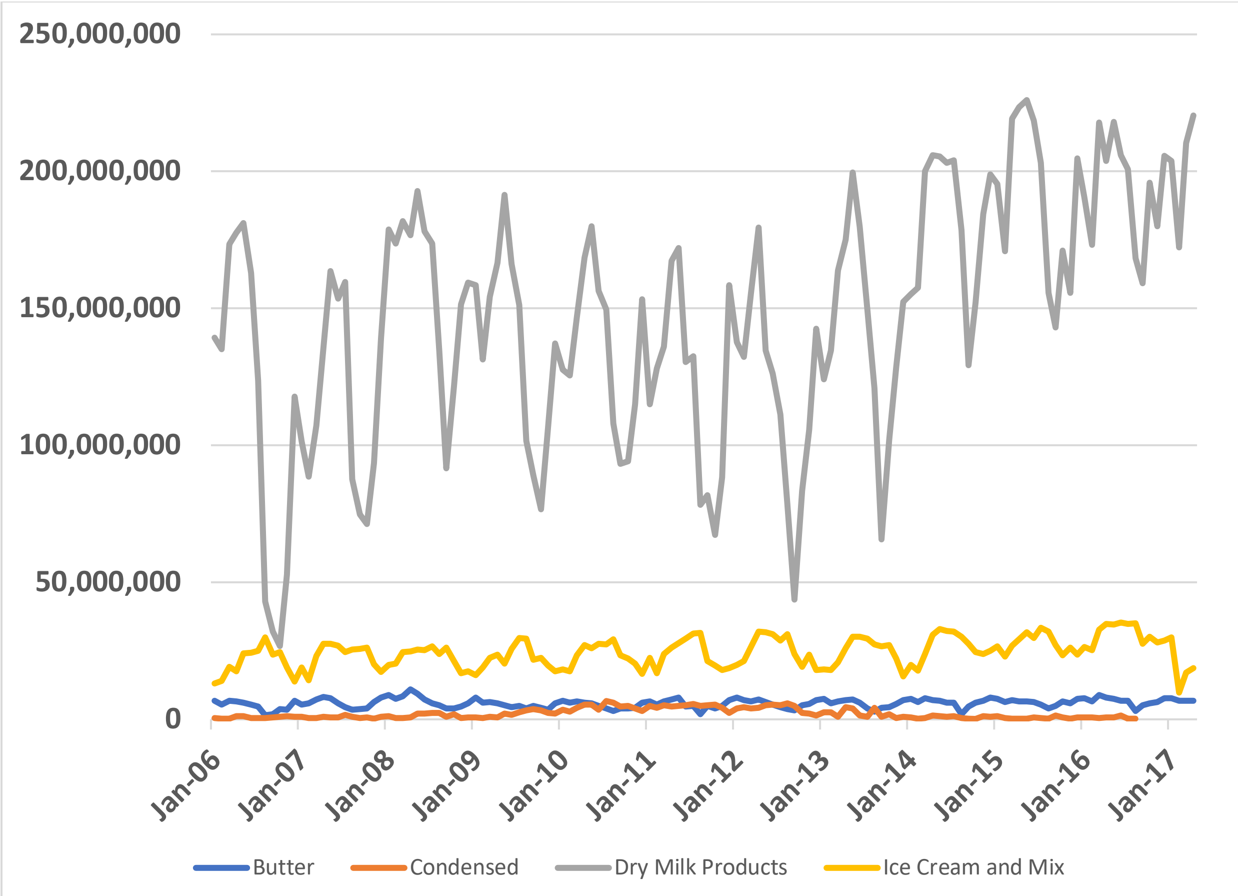


Figure 1.18. Utilization of Pennsylvania Farm Milk in the Northeast Federal Milk Marketing Order, Selected Products, 2006-2017 (lbs/month)

Data Assessment

Although our assessment of data needs perceived by industry stakeholders in the state is not yet completed, it is clear that additional data on farm-level performance and processing volumes and capacity would be of considerable use in assessing the current status of the industry and proposed programs or policies to support growth and competitiveness. The utility of obtaining a wider range of farm-level performance data was specifically discussed by stakeholders at the informational meeting at Ag Progress Days on 8/16/17, and will be facilitated by the further development of the FarmBench data collaboration effort that is ongoing. Pennsylvania entities will be extended an invitation to participate in the FarmBench project in the near future. It is our hope that the processor survey will provide relevant insights about current capacity issues and future plans, and may serve as a basis for its repetition at appropriate time intervals in the future.

Institutional Assessment

Our assessment of institutional arrangements perceived by industry stakeholders in the state is not yet completed, pending input from industry stakeholders at upcoming listening sessions. However, it has been noted in previous discussions that in other states (notably, Wisconsin), there is greater financial support and a closer working integration between state entities that support farm-level performance (e.g., the Center for Dairy Profitability), processing innovation (the Center for Dairy Research) and state-level policy development.

Current Programs and Policies

Our assessment of the perceptions of current programs and policies by industry stakeholders in the state is not yet completed, pending input from industry stakeholders at upcoming listening sessions.

Economic Development Assessment

Although our analysis of the role of economic development organizations in the state—and comparisons to other states—is not yet completed, initial discussions have been undertaken with relevant economic development entities. More specifically, we interviewed key stakeholders involved in dairy-related economic development, including Jodi Gauker, Agriculture Program Consultant, Chester County Economic Development Council (CCEDC) and Suzanne Milshaw International Marketing Program Manager, Food Export—Northeast. These interviews suggest that economic development assistance has benefitted a relatively small number of dairy related entities in the state (primarily in smaller-scale dairy processing), but likely could be used to a greater extent. It is important to note that this resource has also been available to support farm-level projects, and we received a comment on an earlier draft version of this document indicating that "Lancaster and Berks County have done substantial development assistance for dairy farmers and other farmers."

Economic Contribution of the Dairy Industry

Although our study of the economic impacts of the dairy industry in the state is ongoing, a complementary study of impacts by state in 2014 was released by the International Dairy Foods Association and is available at http://idfa.guerrillaeconomics.net.

This study uses a similar analytical approach (input-output modeling, implemented through IMPLAN) to that our study and that of the Temple University researchers will use. The 2014 is based on a year with record-high milk prices, and thus it likely to indicate larger impacts than would be observed in an average price year. The reported impacts include:

- $8.9 billion in direct post-farm economic activity;
- $4.0 billion in direct activity on farms ("agriculture" in the "supplier impacts" category)
- $1.75 billion in wages in directly related post-farm industries;
- More than 45,000 jobs in directly related post-farm industries;
- Total economic activity in the state of $28.3 billion, or 1.2% of state GDP;
- An additional 92,600 jobs indirectly supported by the dairy industry.

Of the direct impacts estimated, the largest post-farm component is for milk and yogurt processing, which accounts for more than half of the total value (Table 4).

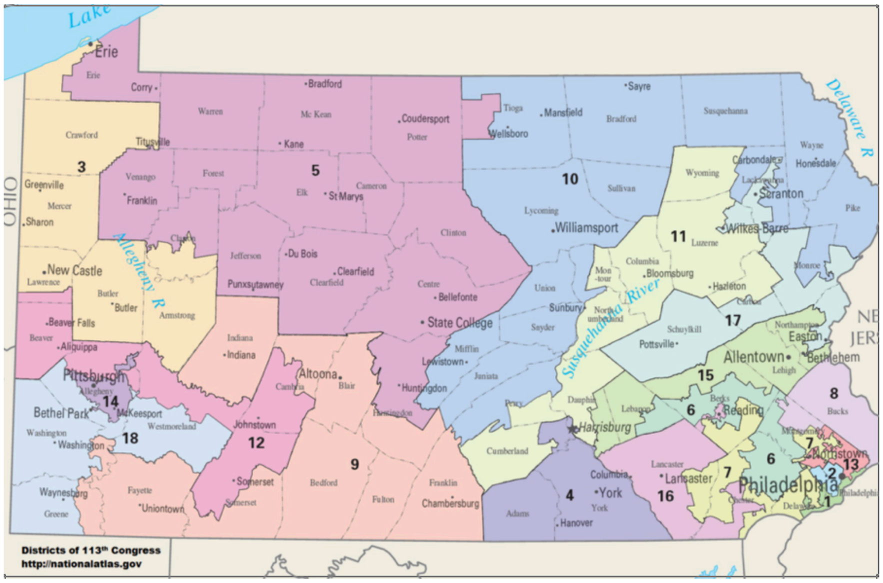
Table 1.4. Estimated Post-Farm Economic Impacts of the Dairy Industry in Pennsylvania, by Product or Marketing Activity, 2014

	Jobs	Wages	Economic Impact
Direct Impacts			
Dairy Products	7,477	$507,553,900	$6,177,967,500
Cheese	505	$39,477,300	$514,802,300
Ice Cream	526	$39,683,400	$215,597,000
Milk & Yogurt	6,026	$401,083,600	$4,754,496,500
Other Products	420	$27,309,600	$693,071,700
Wholesaling	3,237	$307,901,000	$828,025,900
Retailing	34,315	$935,834,500	$1,891,975,000
Total Direct Impacts	**45,029**	**$1,751,289,400**	**$8,897,968,400**

Source: Table generate for Pennsylvania at http://idfa.guerrillaeconomics.net. Note that “Milk” in the “Milk & Yogurt” category refers to “*Fluid* milk” processing.

The estimated effects differ by region of the state, as delineated below by Congressional District (Figure 19)[12]. These estimates reflect to some extent that only economic impacts within the state are accounted for, and do not include farm-related activity. This may explain why Congressional District 3 has the largest impact, despite much larger milk production in the southeastern part of the state.

[12] It is not entirely clear from the information provided by the previous study why results for some Districts were omitted, but it is likely because their impacts were smaller. Other analysts have noted that the district-level disaggregations tend not to be that accurate, and we reported them here with some reluctance. The multiplier analysis we developed for one component of the current study will seek to avoid this issue by using a different set of regional areas within the state as the basis for analysis. Note that although there is a conceptual link with the analysis of economic incentives for additional processing capacity in Pennsylvania, there is no direct quantitative link to multiplier impacts between the estimates here and those reported in our other study components.



District	Jobs	Wages	Economic Impact
PA Total	45,029	$1,751,289,400	$8,897,968,400
3	2,987	$136,024,100	$1,084,785,500
4	2,703	$111,641,000	$524,175,500
5	2,199	$72,026,000	$285,253,900
9	2,079	$72,137,600	$31,438,800
10	2,279	$90,030,600	$345,327,000
11	2,906	$121,675,300	$780,216,700
12	2,879	$116,571,400	$488,761,200
15	2,738	$114,201,000	$617,944,400
16	3,188	$145,054,500	$945,939,400
17	2,128	$82,370,600	$340,445,500
18	2,305	$77,287,500	$262,894,100

Source: Table generated by http://idfa.guerrillaeconomics.net

Figure 1.19. Summary of Estimated Direct (Post-Farm) Impacts of the Dairy Industry in Pennsylvania, by Congressional District, 2014

Initial Discussion of the Impacts of the Pennsylvania Milk Marketing Board

Although a more formal and quantitative analysis of PMMB impacts is forthcoming, it is possible to undertake a more conceptual analysis of certain issues discussed with regard to the PMMB. One set of questions descriptive, such as where does PA milk go, where does milk and dairy products sold in PA stores come from, etc. Another set of questions relates to the PMMB pricing system and how it traces through the supply chain. This gets into the issue of “stranded premiums” that are mentioned as an issue.

First, as noted above, the available evidence suggests that over the period 2006 to 2017, the average amount of fluid milk processed in Pennsylvania and pooled on the Northeast order) has remained roughly constant (Figure 17). This is the case despite marked declines in overall Class I sales and percentage utilization in the order. This suggests that the regulated milk pricing structure in Pennsylvania is not a major causal factor in the decline of fluid milk sales in the region more generally and or that processing volumes have been markedly affected (at least during the time period for which data are available).

The spatial economic model that is being used for analysis of the potential impacts of additional processing capacity in Pennsylvania is driven by the goal of minimizing costs along the entire supply chain, given milk produced here and dairy products consumer there. That is a bit of oversimplification, but the fact is that the industry pays attention to transportation and marketing costs. The reason why there are so many bottling plants around major cities is because supply chain costs favor processing liquid milk is small packages close to where people buy it. Manufactured products, in particular cheese, have a supply chain economics that favors putting plants closer to where the farm milk comes from. This economic logic is not much affected by our current pricing schemes, either federal or state. Butter/powder plants are more like cheese plants than fluid plants but with one important caveat. A lot of the cream that goes into a Class IV plant comes from the overflow from Class I plants. Because of this, we often see butter/powder plants in the Northeast being located closer to fluid plants than is true in the West or Central states.

Discussions of the PMMB sometimes refer to “stranded premiums” as an issue. It is not entirely clear what is meant by “stranded premium” but our current interpretation is as follows. It is widely understood that PMMB (or any state entity) can only regulate economic activity within the state. Thus, only milk that is produced on a PA farm, processed in a PA plant, and sold in a PA store can be regulated. Pennsylvania can regulate prices in a PA grocery store no matter where the milk comes from, either in terms of the processing plant or the farm. Thus, the minimum retail price applies to all milk sold in that store but only the PA bottler is obliged to pay the PA premium that undergirds that PA retail minimum. Then, that PA bottler is only obliged to pay the state premium to PA farmers. Hence the difference between the gross value of the premium at the retail level and the gross value of the premium paid out to PA farmers is identified as “stranded”: retailers collected the money in the form of the minimum price but not all of that up charge finds its way back to PA farms. This certainly can be perceived as a lost opportunity for PA dairy farmers, but is difficult to avoid given the constitutional limitations on state’s authority to regulate economic activity.

However, this probably is not quite as bad as it sounds to a lot of PA farmers. It is also fairly widely understood that the PA Class I premium is a reference point for privately negotiated Class I premiums in other states. Cooperatives, including the GNEMMA group, have said that having the PA premium makes it easier for them to establish price points in neighboring states. This likely has diminished with the current glut but nevertheless this probably means is that even if a PA farmer is selling to a NJ fluid plant, he is getting a premium that has benefited from the regulated pricing structure in PA.

It is also true that the PA retailer is obliged to pay the PA bottler the minimum wholesale price so that minimum retail price doesn’t provide any extra profits for the retailer. By the same token, if the delivered price from NJ plant is paying more or less the same premium as a competitive (instead of regulated) price, then there isn’t any extra money left in the retailers’ pockets. It is our conjecture that whether the NJ plant pays out premiums to its suppliers or not, they are clever enough to realize that the PA regulated wholesale price is their competitor. These plants likely sell for something that is close to that price and no lower than necessary to ensure the sale. Again, this would imply that there isn't a large sum of money left at the PA retailer.

Lastly, one of the considerations is that Class I premiums get paid by bottlers on Class I milk but farmers get this blended out across all milk (including II, III and IV sales). If a bottling plant has an independent supply, its Class I premium will go to all the milk it buys from that direct ship milk. Chances are that plant is a very high percentage Class I (maybe a little Class II); so that independent suppliers will see a high percentage of the Class I premium per cwt on their blend. On the other hand, a coop, say LOL or DFA, that gets all the PA premium and some competitive Class I premiums on non-PA milk will pool that premium across all their milk production. Chances are their coop Class I sales are more like 20 or 30 percent of total member milk; hence that Class I premium per cwt gets seriously diluted. This has nothing to do with being "stranded". This is about pooling and how big the pool is. BTW, if PA had market-wide pooling instead of handler pools, the per cwt payment could be distributed more equally to all PA producers. It wouldn't change the total amount of money paid out but it would change how it is distributed. Needless to say, that would be delightful for some PA farmers and a disaster for those independent shippers. It would also be a situation where all the PA premium was pooled across the state but competitive premiums were not. In effect, coop members would essentially be double dipping on Class I premiums.

Appendix 1.1: Response to Initial Questions

Participants at industry meetings early in 2017 were asked to provide questions for consideration by the study. A summary of these questions and the initial responses is provided below.

1) **What is the trend on packaged fluid milk coming into Pennsylvania from outside its borders?**

   We may be able to address this if data from PMMB are available under Task 2.7. We can consider what our national spatial economic model (the USDSS) would say is "optimal" to be sourced-processed-and distributed in PA for comparison with actual.

2) **How much does the price of milk affect purchasing decisions of consumers in the median to low income brackets?**

3) **Is the over-order premium helping or hurting growth of milk sales in Pennsylvania?**

   We should be able to address Questions 2 and 3 at least in part if data from PMMB are available and can be combined with estimates from previous studies on the price responsiveness of fluid milk sales, and also conceptually as a part of the review of the impacts of PMMB (Task 2.7). We believe that Jug Capps et al. at Texas A&M have done some fairly recent studies of income and own price elasticities relevant for this. We can look at demographic population profiles across PA including metropolitan areas to make some assessments. Questions 2 and 3 require data from PMMB on the magnitude of the premiums AND PA milk sales and processing. Of course, USDA provides data on PA milk production but we assume that "milk sales" here refers to Class I sales.

4) **Is the over-order premium helping or hurting new processing development in Pennsylvania?**

   We should be able to address this at least in part if data from PMMB are available and are combined with assessment of the profitability of processing within and outside of PMMB regulation, and also conceptually as a part of the review of the impacts of PMMB (Tasks 1.3, 2.4 and 2.7).

5) **Where does the money from the over-order premium go and who spends it? How is it distributed?**

   We believe that this question is best answered by the PMMB and dairy cooperatives, as it is largely procedural and descriptive, not analytical. As a result, we have no particular comparative advantage in addressing it.

6) **What are consumer habits in Pennsylvania compared to the purchasing habits of consumers in other states? What controls their purchasing habits?**

   To some extent, the implied question here may be addressed in our assessment of questions 2 and 3 above. We consider a broader assessment of dairy consumer *behavior to be outside the scope of our study, and note that CDE and others have funded previous work in this area (such as studies conducted by Dr. Stanton of St. Joseph's University).*

7) What is the value of the over-order premium to producers? To cooperatives? To processors?

We interpret this 'value' to be a cash value (i.e., how much $) not a broader value judgment question. We can provide at least an indirect answer to this question through Task 2.7. The counterfactual is really important here. The premium be in the absence of the PMMB would almost certainly not be 0. We will also assess in Task 2.7 the broader implications of PMMB regulation.

8) What is the value of the balancing of the marketplace provided by cooperatives in Pennsylvania?

This question is not included in the current scope of the study and to us does not seem to directly address the objective of strategic vision development for PA. We may be able to provide at least a partial assessment of the overall balancing issue given that PA is supplying milk and product to NYC and the Southeast, they are certainly forced into a balancing role. By our calculations, they are the largest net surplus milk state in the northeast and middle Atlantic region, so balancing is a given. As a component of Tasks 1.3 and 2.4 we may be able to analyze with the USDSS whether NDM and butter comprise the best product mix for balancing. Directly addressing this question in detail would require a modification of the current project scope.

9) What is the effect of the state pricing regulations on purchasing habits? Funding habits of processing infrastructure?

This is similar to questions 2, 3 and 4 above.

10) Are there other states where the dairy industry is regulated, and how do they compare?

11) Are there other states where the dairy industry went from a regulated environment to an unregulated environment? What happened?

For questions 10 and 11, our assessment is that although other states have milk price regulation, there is nothing similar enough to what is done by the PMMB that we should study them to assess the effects of PMMB. Comparisons to regulation under other geographic areas will always suffer from the differences in specifics of the regulation and the market context (time frame). We propose an alternative approach under Task 2.7 to develop an analysis for PA that provides a quantitative counterfactual (that is, what would happen in PA in the absence of PMMB regulation?).

12) Is there a guarantee on the share of the premium that cooperatives get?

We believe that this question is best answered by the PMMB and dairy cooperatives, as it is largely procedural and descriptive, not analytical. As a result, we have no particular comparative advantage in addressing it.

13) Why is Pennsylvania's cost of production higher than in other parts of the country? What can be done at the producer level and at the industry level to lower cost of production?

We propose to examine costs of production and other farm-level performance indicators under Task 1.2, and compare the PA indicators to other states. We have made a request to the Pennsylvania Farm Bureau to collaborate with them in the analysis of these issues using their farm-level data. The PFB data would allow us to look at farm costs compared to similar farm business models in three other states and we have some data about the proportion of farms in various size categories from 2012 and previous years. Task 2.4 will provides recommended actions to address farm-level productivity and profitability.

14) What are the dairy processing needs in the state? What is here and what is needed? What is the product mix that's needed?

This will be addressed to some extent with Tasks 1.3 and 2.4, including a survey of the state's processors.

15) What do exports look like coming out of the state? Are there opportunities in exports for Pennsylvania?
16) How can the Port of Philadelphia be used as an asset for dairy?

We will examine components of questions 15 and 16, specifically, the potential for "exports" from PA as a part of our analyses (Tasks 2.2, 2.3, 2.4 and 2.5), and can use the USDSS to assess both the potential for increased exports and the milk price impacts of increased exports through the port of Philadelphia.

17) What impact is the PMMB minimum pricing having on producer receipts and the competitiveness of Pennsylvania's milk sales?

This is a variant of previous questions related to the impacts of the PMMB, and would be addressed at least in part by Task 2.7.

18) What are the trends in the volume of packaged milk coming from out of state into the state of Pennsylvania for sale? (BACKGROUND: We do know that the PMMB has approved a growing number of out-of-state milk dealer licenses. This is relevant in showing impact of current PMMB minimum retail milk price (magnet) and the fate of the over-order premium which is a portion of that minimum price.)

Also a variant of previous questions, addressed at least in part by Task 2.7.

19) What impact is the PMMB minimum pricing and over-order premium having on sales of milk to consumers? The PA retail milk price exceeds national average by $1/gallon and there are no studies to quantify price impact on sales among middle

and lower income families. Anecdotal evidence indicates that mothers and families make choices based on 25 cent per gallon differences in price (example, choosing 2% instead of whole based on small differences in price)

As noted in previous responses, this can be part of Task 2.7 assuming data can be available. We believe, however, that comparisons to the national average probably are not the most appropriate here—the spatial value of farm milk used in fluid varies throughout the US, with the highest values in the southeast and northeast.

20) **What are the trends in the volume of milk coming into Pennsylvania from out of state by tankerload? As in question 1, it is important to know what impact our state pricing system is having on the profile of milk origin it attracts into our state even as we are looking for markets outside of our state in this modern day of milk movement and as the cooperatives and processors and USDA increasingly move toward nationalizing the price paid to farmers. Dairy market experts Calvin Covington and Mary Ledman have both confirmed that milk used to move north to south and it is now moving south to north and considerable east-west / west-east load transfers. How does PMMB fit with today's growing centralized control of milk marketing and movement?**

    This can be part of Task 2.7 assuming data can be made available. We also will be exploring the impact of processing capacity in the state on these milk movements, which seem driven more by lack of processing capacity in certain southeast regions at certain times of year. We can make a comparison of what USDSS believes is possible to produce, process and distribute within the state in an optimal solution and compare it to volumes that PMMB actually regulates. We could also look at forcing PMMB to make all fluid milk PMMB regulated product and see how the optimal solution compare to the cost of the constrained one.

21) **What specific benefit does the PMMB minimum pricing and over-order premium bring considering that Pennsylvania is losing ground while other states without such a program are growing, and in light of the fact that our 287 independent Pennsylvania dairy farms -- supplying Class I fluid bottlers that have either gone out of business or been purchased by DFA or contracted by DMS -- will be kicked to the curb by DFA on April 1. Meanwhile, we have milk entering Pennsylvania from Michigan and New York via the major national cooperatives. Pennsylvania has remained flat in its production, while Michigan and New York continue to show 4 to 8% year over year growth in production.**

    This is generally part of assessment of PMMB for Task 2.7.

22) **Can we examine the flow of the $30 million paid by consumers annually in over-order premiums that are built into PA's minimum retail and wholesale milk prices to evaluate its overall margin benefits to PA dairy farms and the competitiveness of PA's dairy industry?**

    We can examine the general impacts of PMMB on farm milk and fluid milk prices under Task 2.7, but the distributional impacts may be difficult to assess given a lack of data on which producers actually receive payment.

23) Where does the half-cent per hundredweight go that milk haulers pay on all milk transported in the state of Pennsylvania? (estimated to total $550,000 annually and ultimately paid by dairy farmers since dairy farmers pay for milk transportation.

This is not part of current study. If it appears to be a major component necessary to address other study objectives, we will consider it.

24) Why is a royalty paid by Dean Foods (ostensibly for a name) get built into the processing cost recovery for all bottlers within the state's minimum retail and wholesale price dating back to at least 2007 and perhaps as far back as 2002? This amounts to nearly 6 cents per gallon in the retail price and the board will vote in April whether to keep this in the processor cost recovery portion of the PMMB minimum retail/wholesale price but it is not a cost of bottling. Meanwhile dairy farmers are selling milk below their actual costs of production.

We consider this outside of the scope of the current study.

25) In the words of a dairy farmer: "As farmers, we want to understand where the value is added under the state's milk marketing law, what is gained by the law at the farm level, at the margin level, which is what we live and operate. Why -- with this state premium and minimum pricing -- have our margins dropped relative to national margins?"

This is generally part of assessment of PMMB for Task 2.7. We can consider the impacts of PMMB on margins, although a direct comparison to other states may not be the most appropriate (for reasons mentioned in response to questions 10 and 11 above).

26) An attorney for the milk processors at a recent meeting cited 2006 figures showing that PMMB had a stabilizing effect on Class I utilization and sales and resulted in PA having the tightest spread between the farm price and the retail price of milk. HOWEVER, That was more than a decade ago and much has changed. What is the spread IN CURRENT YEARS between the realized MAILBOX milk price received by PA farmers and the retail minimum price PA consumers are forced to pay?

If our initial assessment under Tasks 1.1 and 2.7 suggest that the stability of margins is an important potential impact of regulation under the PMMB, we will attempt to further assess this, assuming sufficient data are available.

Appendix 1.2: Processing Survey Questionnaire

The nationwide survey of processors was implemented beginning early in September 2017, and we expect that it will take some weeks to complete and begin analysis. The questions asked processors included the following:

Zip Code in which plant is located:

Management role of person completing survey:

Plant manager
Plant administrative staff (accountant?)
Other, specify

Contact Information:

Phone
Email

Products produced in this plant in the last 12 months (*select all that apply*)

Fluid milk products
Yogurt products
Ice cream products
Cottage cheese
Cream cheese
Cheddar/American Cheese
Mozzarella Cheese
Other Cheese
Dry whey
Lactose
Whey protein concentrate and/or isolate
Nonfat dry milk and/or skim milk powder
Whole milk powder
Milk protein concentrate
Casein or caseinates
Evaporated or condensed milk products (canned or bulk)

What is the typical volume of milk processed on an average processing day at your plant?

Less than 500,000 lbs
500,000-2,000,000 lbs
2,000,000-5,000,000 lbs
More than 5,000,000 lbs

What is the maximum volume of milk your plant could process, relative to the average daily volume?

0-10% more than average daily volume
10-25% more than average daily volume
25-50% more than average daily volume
50-75% more than average daily volume
75-100% more than average daily volume
>100% more than average daily volume

Which statement best describes how frequently your plant operated at close to this maximum capacity during the last 12 months?

Less than 5 processing days during the last 12 months
5 – 10 processing days during the last 12 months
10 - 30 processing days during the last 12 months
More than 30 processing days during the last 12 months

What statement best describes changes in your *maximum* plant capacity during the past 3 years?

Capacity has increased by more than 25%
Capacity has increased by less than 25%
Capacity has not really changed
Capacity has decreased by less than 25%
Capacity has decreased by more than 25%
Don't know

What statement best describes planned changes in your maximum plant capacity during the next 3 years?

Capacity will be increased by more than 25%
Capacity will be increased by less than 25%
Capacity will not really change
Capacity will be decreased by less than 25%
Capacity will be decreased by more than 25%
Don't know

Which of the following statements about the potential to expand capacity describe the situation at your plant (*select all that apply*)

Milk receiving facilities would be a major constraint to expanding plant capacity
Milk storage facilities would be a major constraint to expanding plant capacity
Milk pasteurization equipment would be a major constraint to expanding plant capacity
Processing equipment would be a major constraint to expanding plant capacity
Finished product storage facilities would be a major constraint to expanding plant capacity
Labor availability would be a major constraint to expanding plant capacity
Marketing products produced in the plant would be a major constraint to expanding plant capacity
It would be relatively easy to add additional shifts with current plant facilities and equipment
Milk supply in region would be a major constraint to expanding plant capacity
Other: *please explain*

Which of the following statements describes the current status of products produced in this plant with regard to exports to countries outside the US?

Products are not currently exported and no plans to export
Products are not currently exported but exports are planned in the next 12 months
Products are not currently exported and are not currently planned, but could be of interest
Products are currently exported and we may expand the volume
Products are currently exported and we will probably remain at this volume
Products are currently exported but we will probably reduce volume or discontinue altogether

Chapter 2: Analysis of Economic Incentives for Additional Dairy Processing Capacity in Pennsylvania

Chuck Nicholson, Mark Stephenson and Andrew Novakovic[13]

Executive Summary

Motivated by concerns about the adequacy of dairy processing capacity in Pennsylvania (and the Northeast more generally), we evaluated the benefits and costs of investments in additional processing capacity in Pennsylvania based on milk supplies and product demands for March and September 2016 using a detailed spatial economic model of the US dairy sector.

Our key findings are:

- Substantial incentives appear to exist for additional processing capacity in Pennsylvania –especially for other" cheese (non-American types, including Italian and specialty cheese) plants—based on their potential to reduce overall supply chain costs given 2016 milk production and dairy product demands;
- Significant economic benefits would accrue to the state because additional processing capacity would markedly increase processing of milk in Pennsylvania that is now shipped out-of-state;
- Investment in two "other" cheese (non-American types, including Italian and specialty cheese) plants processing volumes of 4 million lbs of milk per day in the State College and Reading locations would result in the largest reduction in supply chain costs, and thus indicate the strongest incentives for new processing capacity;
- Investment in these two plants could enhance the marginal value of milk for Pennsylvania dairy producers by about $28.8 million per year compared to *Baseline* scenario model outcomes, at least in the short-term. These plants would also reduce hauling costs for Pennsylvania dairy producers by an estimated $5.9 million per year compared to *Baseline* scenario outcomes;
- The combined estimated value of hauling cost savings and increased marginal milk values of $34.7 million per year compared to the *Baseline* scenario would support investment of about $433 million in new plant capacity, which is approximately equal to the amount required for construction of the two plants;
- Additional benefits in terms of enhanced milk values are estimated for dairy producers in Maryland and Virginia, which may provide an incentive for their involvement as investment partners;
- In addition to the potential direct benefits to Pennsylvania dairy producers, investment in the two plants would generate additional economic activity estimated at $1.5 billion and about 1,100 full-time jobs. These multiplier effects may provide a basis for discussion of

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concessions with local and state government that may lower the investment and operating costs.

Background and Study Objectives

The balance between milk production and dairy processing capacity and in the Northeast has long been a topic of discussion and analysis. Particularly with the events of the last few years, when a considerable amount of farm milk has been dumped and cooperatives have been much more restrained about supporting increases in milk production on member farms, the degree to which processing capacity is adequate for current milk supplies is a key question. Although other analyses will review the historical performance of dairy processing in Pennsylvania, it is also useful to assess the degree to which spatial economic considerations suggest the potential for (or need for) modifications to dairy processing capacity in the region. Thus, the overarching objective of this study is to assess the potential for new processing capacity in Pennsylvania to reduce dairy supply chain costs, enhance farm milk values and generate a broader range of economic activity. The specific objectives include:

- Assessment of the plant types and locations that would minimize overall dairy supply chain costs if additional processing capacity were possible in Pennsylvania, and a more specific analysis of a smaller number of plants;
- Assessment of the changes in farm milk values and milk assembly costs associated with least-cost dairy supply chain configurations;
- Assessment of dairy product manufacturing volumes, dairy product value and milk uses associated with least-cost dairy supply chain configurations;
- Estimation of the economic multiplier effects of increased dairy processing in the state in terms of economic activity and employment creation.

Overview of the Analysis

For supply chains more generally, decisions about the amounts and locations of capacity are part of what is termed "distribution network design" and often are made on the basis of whether overall costs can be lowered. We apply this basic approach to assess what types and locations of dairy processing facilities in Pennsylvania are consistent with the lowest supply chain costs. To implement this analysis, we use a large-scale spatial economic model of the US dairy supply chain (the United States Dairy Sector Simulator, USDSS) that has a long history of use to address spatial economics research questions[14]. A more detailed description of the USDSS is provided in the appendix, but the basic description is that the model begins with assumptions about the locations and amounts of farm milk supplies, locations of potential processing facilities and the locations and amounts of dairy product demand (including for exports) for a given month[15] for the entire US. The model also uses information on the transportation costs for milk assembly between all possible points of farm milk supplies and (potential) dairy processing locations, dairy product processing costs and distribution costs for all possible movements of

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[14] The USDSS has a twenty-year history of development, and has been used in the assessment of spatial pricing surfaces for Class I milk, impacts of dairy plant closures, assessment of the potential for and impacts of localization of dairy supply chains, and the optimal locations for new processing capacity.
[15] The model assumes fixed milk supplies (and components) and dairy product demands during the given month, which are reasonable assumptions for that time scale. The model does not include any dynamic response of production or dairy product demand over time, so it indicates incentives for supply chain re-configuration for a given point in time.

dairy products from all potential dairy processing facilities to demand locations. The USDSS uses an optimization approach to determine which supply chain configuration (milk assembly movements, processing locations and volumes, and distribution movements) minimizes the overall supply chain costs—milk assembly, product processing and product distribution from the large number of possible configurations. (This is consistent with the "Network Optimization" approach that is commonly used in supply-chain-related analyses of distribution networks.)

The USDSS can be used to assess the potential of additional plant capacity in Pennsylvania to reduce supply chain costs by comparing scenarios that limit processing to existing plant locations and capacity with the results from scenarios that allow additional plant locations. If the least-cost supply chain configuration when additional (potential) processing locations are possible includes many new plant locations processing increased volumes of farm milk, this suggests that the spatial economics supports investments in new plant capacity. That is, if new plant capacity has the potential to markedly reduce supply chain costs, this is an initial measure of whether investment in additional capacity would be financially feasible. The USDSS also indicates when reductions in the volume of production for dairy products might be appropriate based on supply chain costs.

The specific implementation of this analysis uses data for March and September 2016, for which nine milk supply points in Pennsylvania are defined (Table 1) and existing processing capacity is represented at 21 points for 13 different product types (Table 2). Demand for dairy products is specified at 13 locations in Pennsylvania, which, as for farm milk, represent the aggregation of quantities for multi-county areas. Note that although the focus in the tables and discussion is on Pennsylvania, the model includes similar data for all of the 48 continental US states, with a total of 240 farm milk supply locations, 628 potential processing locations and 334 demand locations.

Table 2.1. USDSS Milk Supply Locations[a] and Production Values for Pennsylvania, March and September 2016

Milk Supply Location	March (mil lbs/mo)	September (mil lbs/mo)
Chambersburg	155.4	169.0
Greenburg	71.3	77.5
Lancaster	242.9	264.1
Lewiston	157.5	171.3
Meadville	57.7	62.7
Reading	74.1	80.6
Towanda	46.6	50.6
Tunkhannock	17.9	19.4
Wellsboro	43.8	47.6
Total	867.0	943.0

[a] Supply locations are the city used to represent multi-county supply areas. See Appendix describing the US Dairy Sector Simulator (USDSS).

Table 2.2. USDSS Allowable Processing Locations in Pennsylvania, Baseline Scenario

Potential Plant Location	Fluid	Yog	GRK Yog S	Grk Yog T	NDM	ICM MIX	ICM	BUT	COT	CHE	OCH	Dry Whey	Other ECD
Allentown										X	X	X	
Altoona								X					
Carlisle		X		X	X	X	X	X	X				X
Chambersburg	X	X		X			X		X				
Erie	X												
Greenburg	X									X	X	X	
Harrisburg	X	X		X	X		X		X	X	X	X	
Johnstown	X				X	X		X		X	X	X	X
Lancaster	X	X		X	X	X	X	X	X	X	X	X	X
Lansdale	X	X		X			X		X	X	X	X	
Meadville													
New Wilmington	X	X		X			X		X	X	X	X	
Philadelphia	X	X		X			X		X	X	X	X	
Pittsburgh	X	X								X	X	X	
Reading	X	X		X	X	X	X	X	X				X
Scranton										X	X	X	
Sharon	X	X		X									
State College								X					
Towanda													
Wellsboro		X		X	X		X	X	X	X	X	X	
Williamsport	X									X	X	X	

NOTE: Products not shown because no processing is allowed in the baseline include WPC products, lactose, casein, caseinates, MPC products, ultra-filtered milk products.

We use the above information to determine the least-cost supply chain configuration for a *Baseline* scenario that uses information on existing plant locations, product types and capacities. We then examine the changes in key outcomes if any of 17 products[16] can be processed at any of the 21 possible plant locations in Pennsylvania, referred to as the *All Pennsylvania Locations* scenario. Under this scenario, any new capacity that lowers overall supply chain costs is assumed to be available without (investment) cost. The results of this analysis suggest the product types and locations that incur the largest changes in processing volumes, which were used to develop an additional scenario (*Two New Plants*) that limited additional capacity to two locations (State College and Reading) where “other” (non-American types) cheese and WPC products would be processed, assuming utilization of 4 million lbs of farm milk per day. This latter is more consistent with assessment of the potential for making actual investments in a limited number of new processing facilities in the state.

We examine the impact that additional processing capacity has on milk assembly costs, and regional milk location values (which can be thought of as location-related or market premiums), on total milk processed and product volumes in Pennsylvania, and on the value of dairy products based on prices in March and September 2016. The change in overall values is then used to estimate economic multiplier effects on overall economic activity and employment. The estimated benefits to dairy producers from reduced milk hauling costs and higher milk values can be calculated on an annualized basis and under the assumption that this value accrues to them in future years, can be used with an assumed discount rate to estimate the total value of investment in capacity that would be supported by this stream of future values—assuming that the actual processing operation breaks even (has no profits, a conservative assumption).

Results

The results of our analysis suggest that there are substantial spatial economic incentives for additional dairy processing capacity in Pennsylvania based on milk production values in 2016, and that additional processing capacity would generate significant benefits to dairy producers and the state economy.

Additional processing capacity would provide economic incentives for a substantive increase in milk processed within Pennsylvania rather than shipped to other states for processing (Table 3). On an annualized basis, the increases in milk processed in Pennsylvania amount to more than 20% of the state’s 2016 milk supply of 10.9 billion lbs. Milk shipped to neighboring states (especially New York and New Jersey) would be decreased in both months under both scenarios analyzed.

The additional milk processed in the state would be accompanied by changes in product volumes (Tables 4 and 5). The volume of “other” cheese (all non-American cheese types, including Italian and specialty cheeses) showed the largest increase and accounted for more than three-quarters of the overall increase of $921 million per year in value of dairy products processed in Pennsylvania for the *All Pennsylvania Locations* scenario. Other products for which additional processing capacity increased production included ice cream, whey protein

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[16] In addition to the products shown for the Baseline scenario in Table 2, this scenario allows the processing of WPC34, WPC80, lactose, and casein.

Table 2.3. Estimate of Change in Farm Milk Shipment Volumes from Pennsylvania Milk Supply Locations to Processing Location Destination States, March and September 2016

Scenario, Destination State for Farm Milk	March (mil lbs/mo)	September (mil lbs/mo)	Average (mil lbs/mo)	Annual (mil lbs/yr)[a]
All PA Locations				
Delaware	-8	-11	-9	-112
Florida	0	0	0	0
Maryland	-5	-7	-6	-72
New Jersey	-106	-41	-73	-882
New York	-102	-88	-95	-1,137
Pennsylvania	**242**	**169**	**205**	**2,465**
Virginia	-19	-20	-20	-238
West Virginia	-2	-2	-2	-25
Two New Plants				
Delaware	-8	-11	-9	-114
Florida	0	5	3	30
Maryland	-7	-18	-12	-145
New Jersey	-109	-51	-80	-960
New York	-74	-61	-67	-807
Pennsylvania	**218**	**161**	**190**	**2,274**
Virginia	-19	-25	-22	-266
West Virginia	-2	0	-1	-12

[a] Calculated as the average of March and September values times 12.

concentrates, lactose, and Greek yogurt. The analyses of both scenarios suggest that fluid milk processing in the state would be decreased under the optimal supply chain configuration if new processing capacity were available. Together, the results of the *All Pennsylvania Locations* scenario suggest that the incentives for increased processing capacity are strongest for "other" cheese types, perhaps in association with a facility processing whey into WPC products. The USDSS also indicates the specific plant locations that minimize supply chain costs, and the largest "other" cheese plants were indicated for the State College and Reading locations, respectively. These locations were chosen for the Two New Plants scenario with a total processing capacity equal to the overall increase in "other" cheese production indicated by the *All Pennsylvania Locations* scenario.

The overall utilization of farm milk produced in Pennsylvania would also be different under the scenarios with additional processing capacity (Table 6). Although the total farm milk used is the same by definition, there would be increases in milk used in cheese and yogurt, and reductions in milk used in fluid.

Table 2.4. Changes in Dairy Product Manufacturing Volumes and Values in Pennsylvania With *All PA Locations* Scenario, March and September 2016

Product	Change in Volume					Change in Value		
	March, mil lbs/mo	September, mil lbs/mo	Average, mil lbs/mo	Annual[a], mil lbs/yr		March $/mo	September, $/mo	Annual[a], $/yr
Butter	0.8	2.2	1.5	18.4		1,627,215	4,476,581	36,622,773
American cheese	0.0	0.0	0.0	0.0		0	0	0
Cottage cheese	-4.2	-4.0	-4.1	-49.7		[b]	[b]	[b]
Dried buttermilk	0.1	0.3	0.2	2.2		64,101	232,220	1,777,929
Dry whey	-4.6	-4.8	-4.7	-56.3		-1,166,054	-1,556,000	-16,332,324
Lactose	9.0	6.1	7.5	90.4		2,040,782	1,963,360	24,024,855
Other ECD	2.7	0.7	1.7	20.2		3,465,012	907,066	26,232,464
Fluid	-16.8	-13.3	-15.1	-180.6		-2,773,054	-2,650,011	-32,538,389
Greek yogurt, strained	3.1	4.4	3.7	44.5		3,924,434	6,652,260	63,460,169
Greek yogurt, thickened	0.3	0.3	0.3	3.6		33,879	59,522	560,404
Ice Cream	14.1	10.7	12.4	148.6		3,981,653	2,908,198	41,339,102
NDM	-2.8	-2.1	-2.5	-29.5		-2,185,151	-1,941,890	-24,762,246
Other Cheese	31.7	23.4	27.6	331.1		67,684,437	54,145,575	730,980,068
WPC34	0.7	2.9	1.8	21.3		381,433	2,120,934	15,014,202
WPC80	6.7	0.0	3.3	40.0		9,176,762	0	55,060,573
Yogurt (non-Greek)	0.0	0.0	0.0	0.0		0	0	0
Total						86,255,449	67,317,815	921,439,581

Note: Values based on product prices for March and September from various sources.

[a] Calculated as the average of March and September values times 12.

[b] Value for cottage cheese not calculated

Table 2.5. Changes in Dairy Product Manufacturing Volumes and Values in Pennsylvania With *Two New Plants* Scenario, March and September 2016

Product	Change in Volume					Change in Value		
	March, mil lbs/mo	September, mil lbs/mo	Average, mil lbs/mo	Annual[a], mil lbs/yr		March $/mo	September, $/mo	Annual[a], $/yr
Butter	-3.5	-2.4	-3.0	-35.7		-6,880,571	-4,853,835	-70,406,435
American cheese	0.6	0.0	0.3	3.6		865,116	0	5,190,697
Cottage cheese	-4.2	-3.4	-3.8	-45.8		[b]	[b]	[b]
Dried buttermilk	0.0	0.0	0.0	0.0		0	0	0
Dry whey	-1.4	-1.7	-1.5	-18.3		-352,461	-536,087	-5,331,285
Lactose	0.0	0.0	0.0	0.0		0	0	0
Other ECD	2.2	0.1	1.1	13.7		2,872,394	74,374	17,680,606
Fluid	-18.6	-12.6	-15.6	-187.7		-3,083,633	-2,511,264	-33,569,386
Greek yogurt, strained	0.0	0.0	0.0	0.0		0	0	0
Greek yogurt, thickened	-0.2	-0.1	-0.1	-1.4		11,496	2,547	84,263
Ice Cream	5.3	3.6	4.5	53.5		1,492,136	988,489	14,883,749
NDM	-0.6	-1.9	-1.3	-15.2		-488,536	-1,753,136	-13,450,031
Other Cheese	27.5	21.6	24.6	294.6		58,708,280	49,845,728	651,324,046
WPC34	0.1	1.3	0.7	8.3		57,057	937,962	5,970,114
WPC80	3.3	0.0	1.7	19.9		4,568,966	0	27,413,797
Yogurt (non-Greek)	0.0	0.0	0.0	0.0		0	0	0
Total						57,770,245	42,194,778	599,790,136

Note: Values based on product prices for March and September from various sources.

[a] Calculated as the average of March and September values times 12.

[b] Value for cottage cheese not calculated

Table 2.6. Estimated Change in Product Uses of Pennsylvania Milk for *All Pennsylvania Locations* and *Two New Plants Scenarios*, March and September 2016

Scenario, Product for Which Milk Used	March (mil lbs/mo)	September (mil lbs/mo)		March (% of Base)	September (% of Base)
All PA Locations					
American cheese	0.0	0.0		0.0%	0.0%
Cottage cheese	-26.7	-25.6		-100.0%	-100.0%
Fluid	-191.0	-130.0		-33.6%	-23.7%
Greek yogurt, strained	9.1	12.8		a	a
Greek yogurt, thickened	-0.4	0.3		-17.1%	9.8%
NDM	-6.8	0.0		-5.1%	0.0%
Other Cheese	200.9	142.6		130.6%	111.1%
Yogurt	15.0	0.0		91.6%	0.0%
Two New Plants					
American cheese	6.1	0.0		12.9%	0.0%
Cottage cheese	-26.7	-21.5		-100.0%	-83.9%
Fluid	-168.4	-120.4		-29.6%	-21.9%
Greek yogurt, strained	0.0	0.0		a	a
Greek yogurt, thickened	-0.7	-0.1		-32.0%	-2.6%
NDM	-6.8	-3.9		-5.1%	-2.9%
Other Cheese	180.9	141.6		117.6%	110.3%
Yogurt	15.7	4.2		95.6%	13.4%

[a] Percentage change from Baseline not calculated because use is 0 in that scenario.

Economic Benefits of Additional Processing Capacity

From the perspective of dairy producers in Pennsylvania, the benefits of additional processing capacity include reductions in hauling costs and increases in milk location values (market premiums). These benefits can be assessed by location (Table 7), but are positive for all Pennsylvania supply locations and total $35 million per year for the *Two New Plants* scenario and $48 million per year for the *All Pennsylvania Locations*. Hauling costs would be reduced by an average of $0.05/cwt for all Pennsylvania milk for the *Two New Plants* scenario and milk location values increased a statewide average of $0.26/cwt to $0.29/cwt—with some variation by location. As noted previously, the total benefits per year—if assumed to continue into the future—can be used to develop a rough estimate of the total investment that this stream of benefits would support, assuming an annual percentage return. Assuming an 8% rate of return and breakeven (no profits accruing from production and sale of products), annualized benefits of $35 million and $48 million would support investments of $433 million and $598 million, respectively, which compare favorably to plant construction costs under the *Two New Plants* scenario. This initial assessment of financial feasibility suggests that further consideration of specific investment scenarios is merited based on the benefits accruing to Pennsylvania dairy farms.

Table 2.7. Estimate of Net Benefits of Additional Processing Capacity, All Pennsylvania Locations and Two New Plant Scenarios, 2016

Scenario, Location	Change in Milk Value, $/cwt		Change in Milk Value, $/month		Change in Milk Value, $/year
	March	September	March	September	Annual[a]
All PA Locations					
Chambersburg	0.44	0.34	675,860	534,013	7,259,233
Greenburg	0.44	0.33	315,726	238,435	3,324,968
Lancaster	0.43	0.35	1,034,541	854,441	11,333,891
Lewiston	0.47	0.37	746,692	591,095	8,026,722
Meadville	0.36	0.26	209,306	150,687	2,159,956
Reading	0.37	0.29	273,540	218,605	2,952,868
Towanda	0.36	0.30	166,219	139,670	1,835,334
Tunkhannock	0.34	0.26	61,438	47,583	654,128
Wellsboro	0.30	0.25	130,902	110,406	1,447,851
Total			3,614,224	2,884,934	38,994,950
Assembly Cost Reduction			-791,488	-682,026	-8,841,088
Total Benefit			4,405,712	3,566,961	47,836,038
Two New Plants					
Chambersburg	0.37	0.34	570,208	538,752	6,653,762
Greenburg	0.17	0.05	117,596	34,062	909,946
Lancaster	0.36	0.34	883,974	849,502	10,400,855
Lewiston	0.41	0.38	637,997	602,308	7,441,827
Meadville	0.05	0.00	29,983	1,173	186,935
Reading	0.27	0.23	202,375	171,869	2,245,461
Towanda	0.07	0.07	30,730	33,615	386,070
Tunkhannock	0.12	0.10	21,789	17,435	235,345
Wellsboro	0.09	0.03	41,591	12,910	327,009
Total			2,536,242	2,261,627	28,787,210
Assembly Cost Reduction			-564,661	-413,129	-5,866,739
Total Benefit			3,100,903	2,674,755	34,653,949

[a] Calculated as the average of March and September values times 12.

However, farms in a broader area of the mid-Atlantic states (especially in Maryland and Virginia) would be predicted to experience substantive increases in milk premiums if additional processing capacity were available in Pennsylvania (Figures 1 and 2) under the *Two New Plants* scenario. Producers in these two states would also benefit from reductions in hauling costs (particularly producers in Virginia) although the overall savings are smaller than those in Pennsylvania. These results suggest that investments in additional processing capacity in Pennsylvania would provide benefits to producers outside that state that may provide an additional motivation for investment by entities whose operations encompass a wider geographical area.

In addition to the benefits accruing to dairy producers from additional processing capacity, it is possible to estimate the impacts on economic activity and employment from increases in dairy processing in Pennsylvania. The estimated change in the value of dairy products produced in the state with additional processing capacity was $599 million for the *Two New Plants* scenario ad $921 million for the *All Pennsylvania Locations* scenario. Using an approximate (but conservative) multiplier of 2.5 dollars of additional economic activity for each additional dollar generated by dairy processing[17], this suggests that overall economic activity generated by dairy processing would be $1.5 billion and $2.3 billion for the two scenarios, respectively. Previous studies have estimated that every additional $1 million in processing activity can generate 1.8 full-time equivalent positions (in dairy processing and other industries), which in this case suggests that between about 1,100 and 1,700 new jobs would be created under the increased processing volumes for the *Two New Plants* and *All Pennsylvania Locations* scenarios.

Implications and Limitations

Although the foregoing analyses suggest that substantive benefits can accrue to dairy farmers, the overall dairy supply chain and the state's economy if additional processing capacity were available in the state, there are a number of important considerations and limitations that merit mention.

First, of the two scenarios described, the *All Pennsylvania Locations* is probably overly optimistic in the sense of allowing a wide range of processing capacity investments to occur with no cost. It does, however, provide a useful indicator of what products and location would most reduce supply chain costs—thus providing the basis for the *Two New Plants* scenario—and suggests a benchmark for the largest possible benefits from supply chain reconfiguration. However, the results of the *Two New Plants* scenario should be considered suggestive, rather than definitive. The results of our analysis suggest sufficiently large benefits to merit further, more detailed evaluation the construction of new dairy plants in Pennsylvania. In addition to more specific detail based on the actual hauling costs for Pennsylvania dairy producers, next steps would include: 1) further assessment of the specific plant locations, 2) examination of the sales potential of the proposed products from "other" cheese and WPC plants, 3) greater refinement of the costs of constructing these plants, 4) exploration of potential investors in and concessions for building the plants, 5) ownership structure of the facilities and 6) plant management.

[17] A more specific analysis of the multipliers for dairy farming and dairy processing activity in Pennsylvania are currently in progress, and will provide more accurate assessments of the multiplier effects discussed here.

Second, our analyses report supply chain configurations that minimize relevant costs, which captures a large component of the incentives for location of dairy processing facilities relative to milk supplies and dairy product demands. However, other institutional factors, such as ongoing supply relationships between dairy cooperatives and milk buyers, incentives due to service charges to serve fluid markets and pooling under milk marketing orders, can have a notable influence on the incentives for milk movements and new processing capacity.

Third, our analyses suggest that additional processing capacity in Pennsylvania is most likely to reduce supply chain costs if it focuses on “other” cheese. This would imply that more milk would be used in Class III, but with much of that milk would have been used in fluid processing under the *Baseline* scenario. Although most Pennsylvania milk would continue to be pooled under the Northeast Federal Milk Marketing Order and the overall utilization in the Northeast similar under the different scenarios, our analyses to not include effects on service payments, other over-order premiums from fluid use, or potential effects on regional blend prices.

Fourth, our analyses focus on the effects of larger-scale dairy processing investments in commodity products with large economies of scale under the *Two New Plants* scenario, but the *All Pennsylvania Locations* analysis also suggests that there may be a role for smaller-scale investments in a broader range of products, especially “other” cheese (specialty cheese), ice cream and Greek yogurt, that might be branded products. (We also have omitted from this analysis any consideration of non-cow dairy products that might use similar agronomic and processing resources.)

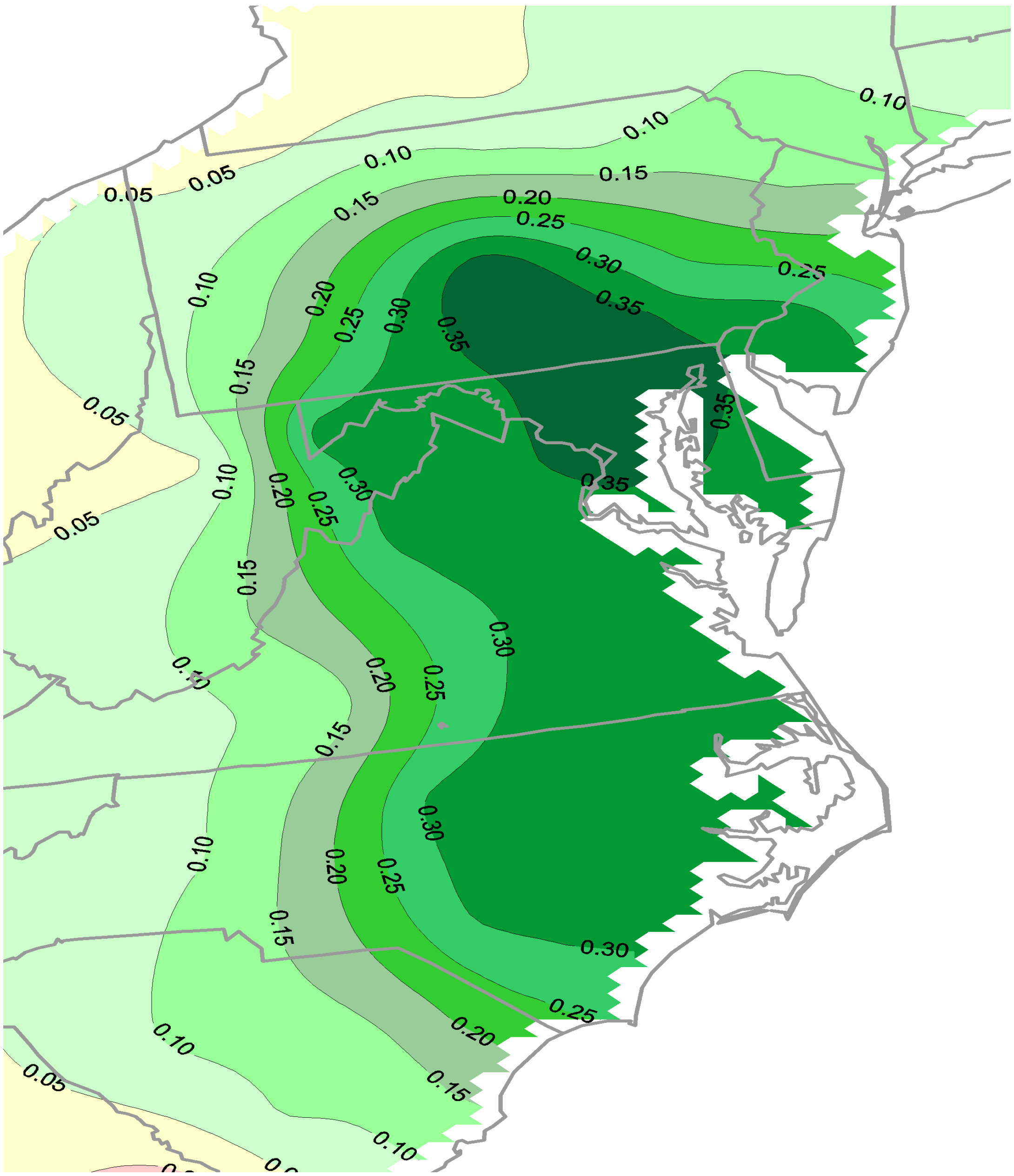

Figure 2.1. Impact of Two New Plants Scenario on Milk Values at Supply Locations in the Mid-Atlantic Region of *Two New Plants* Scenario, March 2016

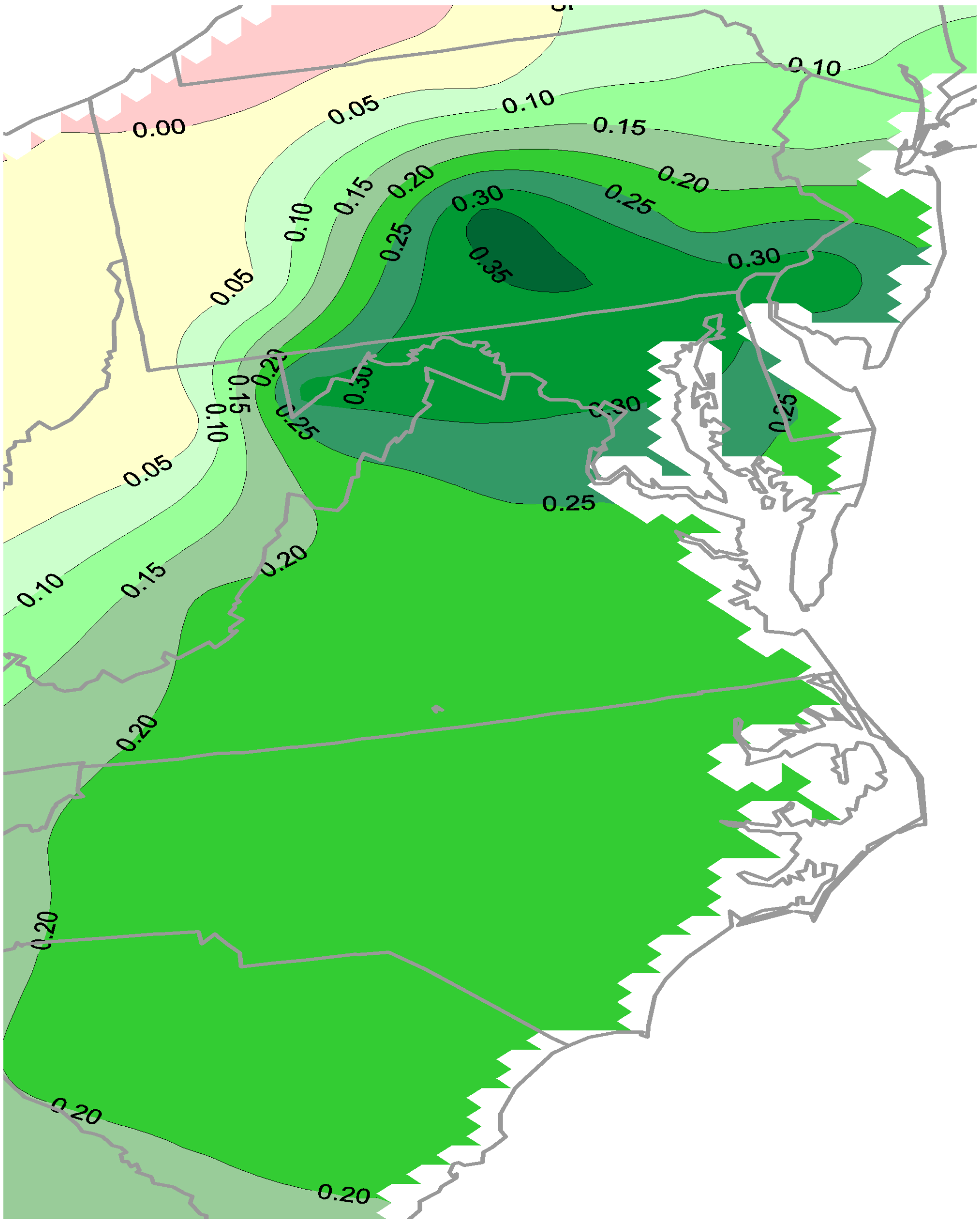

Figure 2.2. Impact of Two New Plants Scenario on Milk Values at Supply Locations in the Mid-Atlantic Region of *Two New Plants* Scenario, September 2016

Appendix 2: Description of the U.S. Dairy Sector Simulator (USDSS)

The USDSS is a highly detailed mathematical spatial optimization model[18], but at its core solves a fairly practical problem: how to get milk from dairy farms to plants to be processed into various dairy products and distribute those products to consumers in the most efficient way (lowest cost) possible. The model takes the total milk supply, plant locations and product mix, and product demand as it existed for an individual month. It indicates how to move that farm milk to plants via the existing road network, process milk into final and intermediate products and distribute the finished products to consumers also according to the road network.

The Milk Supply Data

Data needs for the USDSS are significant. These data include the amounts and composition of farm milk and dairy products consumed, disaggregated by regions in the U.S. and also accounting for imports and exports. To represent the U.S. milk supply, where possible we use county estimates of milk production and composition. California and Wisconsin are states where those values are available. Where those data are not available, we use state values and estimate county-level milk production from Agricultural Census and Federal Milk Marketing Order (FMMO) data. We aggregate the data from the 3108 counties in the contiguous 48 states into 231 milk supply regions (Figure A1) to reduce the computational intensity of solving such a spatially disaggregated model.

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[18] A more detailed and technical description of the USDSS is available in “Environmental and Economic Impacts of Localizing Food Systems: The Case of Dairy Supply Chains in the Northeastern United States” C. F. Nicholson et al. *Environmental Science and Technology*, 49 (20), pp 12005–12014, 2015.

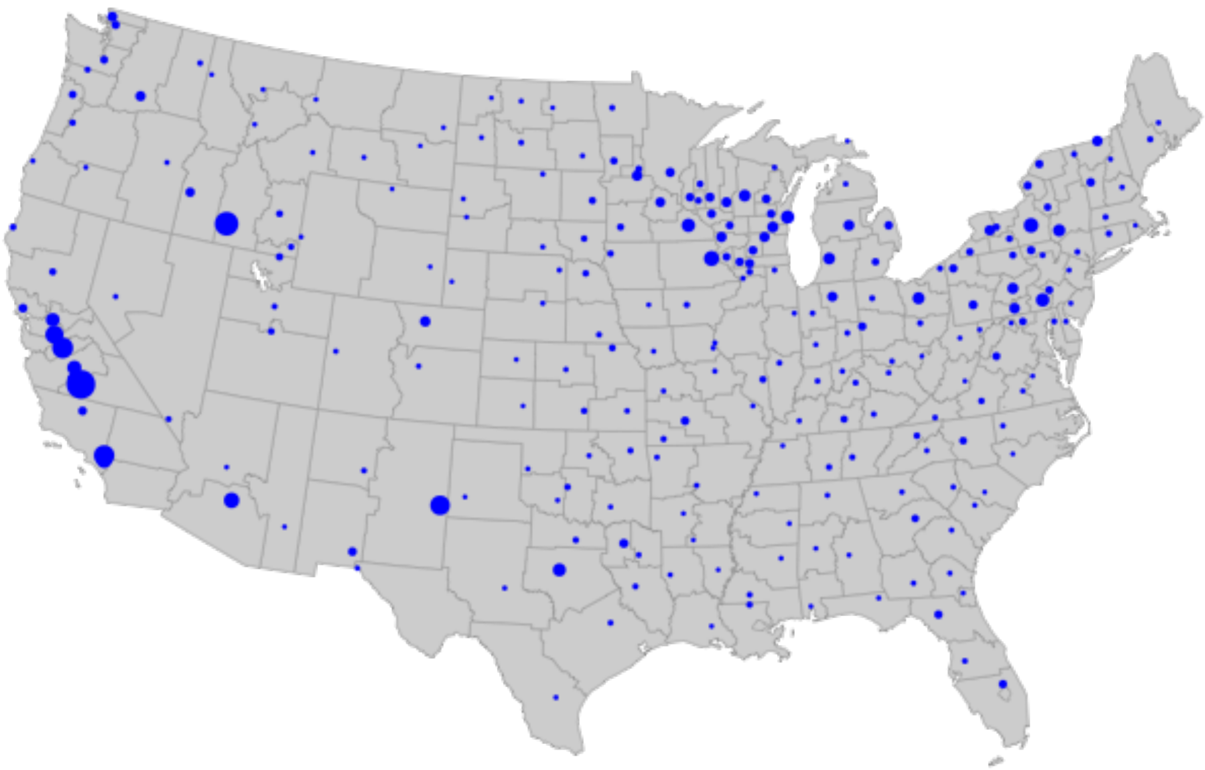

Figure A2.1. 240 U.S. Milk Supply Locations in the USDSS.

Dairy Product Demand Data

The USDSS model is comprehensive: it includes all sources and uses of milk and dairy components in the U.S. The current structure includes 19 final and 18 intermediate product categories. Intermediate products are those like cream, condensed skim milk, nonfat dry milk, etc., which can be used in the further manufacture of other dairy products such as cheese or ice cream. The final products are products such as fluid milk, yogurt, cheese, etc., which satisfy domestic consumption (by individuals, food service and other food manufacturers) or export sales. All dairy products have different component requirements and some product component values differ by region. For instance, California's lower fat fluid milk is fortified with skim milk solids as per the state regulation.

A variety of data sources are used to determine per capita demand for dairy products. For example, the Economic Research Service (ERS) reports calculations for some dairy product demands[19] and other values are determined from route dispositions of FMMOs. County-level demands are then calculated based on per capita demand and population and then aggregated to 424 demand locations (Figure A2).

[19] https://www.ers.usda.gov/webdocs/DataFiles/48685/CmDsProd.xlsx?v=42866

Figure A2.2. 424 U.S. Milk Demand Locations in the USDSS.

Dairy Plants Data

We maintain a fairly extensive database that includes 1167 dairy plant locations and products processed in the U.S. Of these plants, we have estimates of processing volume for more than 500 of the most significant plants, which account for more than 95% of the US milk supply. As with the aggregation of milk supply and demand locations, dairy plants could be represented at up to 628 possible locations (Figure A3) but actually are represented at 281 locations in the USDSS. Although there are more plants than this in the U.S., we use a single location to represent a multiple processing entities if they are not actually geographically distant from one another (most USDSS plant locations are within 30 miles of the actual plants). Plants are constrained to process only the products that are produced at any location (i.e., a fluid milk plant location cannot process cheese).

The USDSS tracks and accounts for multiple components in products. For example, a fluid milk plant that has excess butterfat can send cream to a churn, ice cream plant or other manufacturing facility with need of the cream. Of course, sending cream from a fluid plant also sends nonfat solids to the receiving plant requiring somewhat more raw milk than is necessary to meet only fluid needs.

Figure A2.3. 628 Possible U.S. Dairy Plant Locations in the USDSS.

Imports, Exports and Stocks

USDSS uses thirty-four locations to represent export demand, based on US port district designations. Imports and exported products exactly match those reported in the months modeled. Some dairy products are storable and accounted for in the model as stocks, which can be increased or drawn upon as observed in the months modeled.

Products

The model includes 19 final and 18 intermediate product categories (Table A1). Note that some products, such as NDM, are in both categories. In our terminology, “intermediate” products refer to those dairy products that are used in the manufacture of other dairy products, such as NDM in cheese making. “Final products” are those that are sold by the dairy manufacturers to uses other than further dairy processing, regardless of whether sales are directly to consumers or to other food manufacturers or wholesalers. This is different than the terminology more typically used by economists, but is useful as a means of tracking and modeling component sources and uses in the U.S. dairy industry. Although many products are allowed as intermediate products, some combinations have been excluded to limit model size and facilitate model solution in a reasonable time. We include unit costs of processing at average plant milk processing volume based on previous data collection efforts and other secondary sources.

Components

For most products, component composition can be adequately modeled using three components: fat, protein and other solids. For ultra-filtered products (whey protein concentrates, ultra-filtered milk, milk protein concentrates), this disaggregation is inadequate, because product yields and compositions depend on retention of components that differs for the other solids components. Thus, for these products, six components are specified: fat, casein, whey protein, non-protein nitrogen, lactose and ash. When needed for calculations and reporting purposes, these six components are aggregated back to the three components used for most of the products incorporated into the model. The composition of products are determined by the components supplied in raw milk or intermediate products received at a particular processing plant, based on iterative solutions of the model given exogenously-specified product compositions based on the product composition determined by the previous model solution.

Transportation Costs

A road network of actual road mileage connects all of the supply, demand, plant and trade locations in the model. There are about 200,000 possible road routes connecting the 628 locations in the USDSS. States also have differing Gross Vehicle Weight (GVW) limits, which restrict the size of loads shipping raw milk or finished products that can be transferred between some states. These limits are also represented within the model. Most states have an 80,000 GVW but some states have GVWs up to 164,000. The most limiting state along a route becomes the GVW restriction in the USDSS. Being able to haul greater GVWs does reduce the cost of transporting raw milk and products.

Table A2.1. Product Categories Included in the USDSS Model

Product	Description	Final Product	Inter-mediate Product	IP Allowed to Make This Product	This Product Allowed as IP in	Imports or Exports
Fluid milk	Fluid milk, cream	X		Cream, skim milk		
Yogurt		X		Cream, skim milk, dry whey, WPC34, WPC80		X
Ice cream				Mix		X
Nonfat dry milk		X	X	Skim milk	Fluid[a], yogurt, American cheese, other cheese, casein, ice cream mix	X
Butter		X		Cream, whey cream		X
Dried buttermilk		X		Cream, whey cream		
Cottage cheese		X		Cream, skim milk		
American cheese		X		NDM, cream, skim milk, condensed skim, UFS42, UF56, MPC42, MPC56, MPC70, MPC80		X
Other cheese		X		NDM, cream, condensed skim, UFS42, UF56, MPC42, MPC56, MPC70, MPC80		X
Dry whey		X	X	Separated whey	Yogurt, ice cream mix	X
WPC34		X	X	Separated whey	Yogurt, ice cream mix	X
Dried whey permeate (lactose)		X	X	Separated whey	Yogurt, ice cream mix	X
WPC80		X	X	Separated whey	Yogurt, ice cream mix	X

Table A2.1. Product Categories Included in the USDSS Model

Product	Description	Final Product	Inter-mediate Product	IP Allowed to Make This Product	This Product Allowed as IP in	Imports or Exports
Casein		X	X	NDM	Caseinates	X
Caseinates		X		Casein		X
MPC42		X	X	UF skim milk	American cheese, other cheese	X
MPC56		X	X	UF skim milk	American cheese, other cheese	X
MPC70		X	X	UF skim milk	American cheese, other cheese	X
MPC80		X	X	UF skim milk	American cheese, other cheese	X
Other evaporated condensed and dried		X		Cream, skim milk		X
Cream			X	Raw milk	Most products	
Skim milk			X	Raw milk	Most products	
Ice cream mix			X	Cream, NDM, WPC34, WPC80, dry whey	Ice cream	
Fluid whey			X		Separated whey, whey cream	
Separated whey			X	Fluid whey		
Whey cream			X	Fluid whey		
Condensed skim milk			X	Skim milk	Ice cream mix, American cheese, other cheese	
UF skim for MPC42			X	Skim milk	American cheese, other cheese, MPC42	

Table A2.1. Product Categories Included in the USDSS Model

Product	Description	Final Product	Inter-mediate Product	IP Allowed to Make This Product	This Product Allowed as IP in	Imports or Exports
UF skim for MPC56			X	Skim milk	American cheese, other cheese, MPC56	
UF skim for MPC70			X	Skim milk	MPC70	
UF skim for MPC80			X	Skim milk	MPC80	

All of the 200,000 possible road routes have transportation costs calculated for raw milk assembly, inter-plant movements of bulk products (cream, skim milk, condensed skim milk, etc.), and final products, both refrigerated and non-refrigerated distribution. These transportation costs are updated to reflect changes in equipment, fuel and labor costs for 2016. There are also regional variations in fuel and labor costs reflected in the USDSS depending on the point of origin for a transportation movement. Transportation costs are an important driver of model outcomes and as for other information, are calculated for each month for which the model is used.

The Primal Solution

The model's purpose is to find the least-cost combination of assembling milk from farms to plants, processing all different final and intermediate dairy products and distributing them to meet domestic and export demand while respecting a large number of constraints imposed (Figure A4). There are about 1.6 million possible activities (milk assembly routes, processing volumes, interplant movements, and final distribution routes) that the USDSS model must evaluate to determine the least-cost solution. Constraints include such things as cheese or any other dairy product can't be made without ingredients that ultimately come from milk supplied by the farms represented in the model. Another constraint is that finished dairy products must contain the milk components and be provided in the amounts that customers in the region demand. Finally, shipments can't exceed the road weight limits of any state. There are about a half million constraints in the USDSS model.

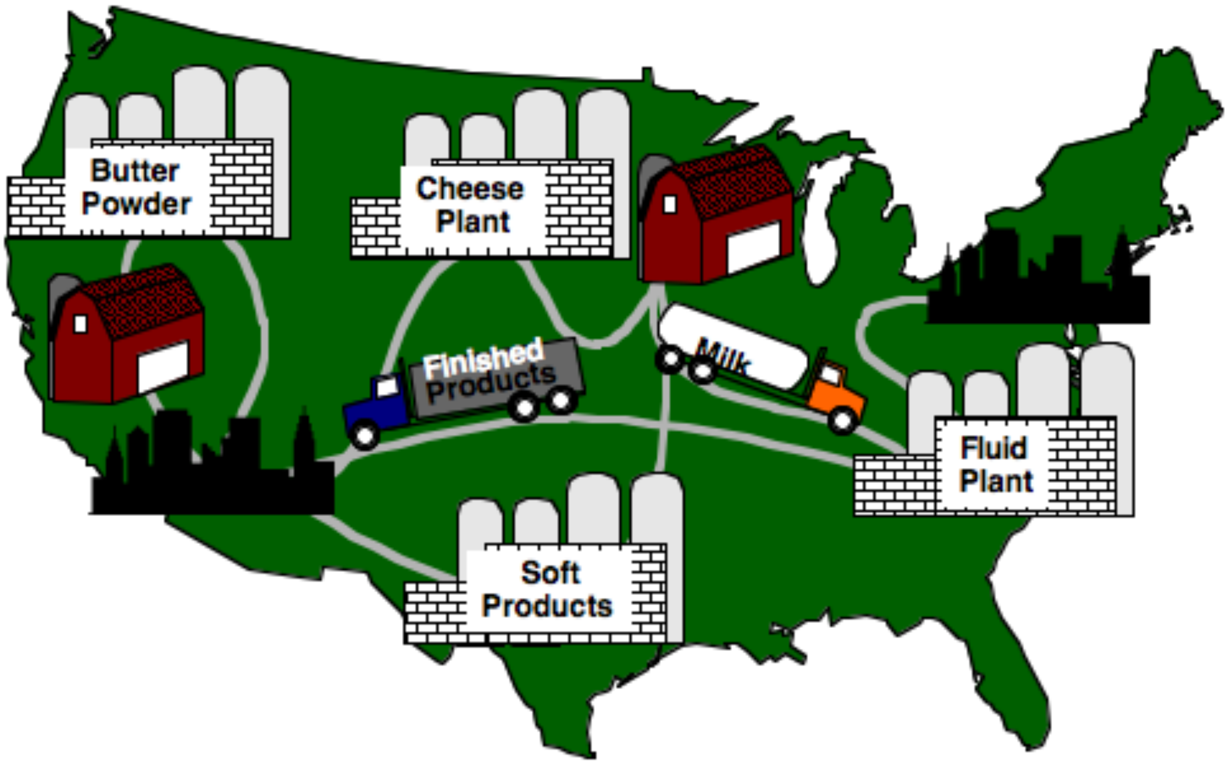

Figure A2.4. Conceptualized Primal Solution of the USDSS Model.

There are two types of output that come from such a model: a “primal solution” and a “dual solution”. The primal solution describes the physical flows of product through the dairy supply chain network. The dual solution represents the relative monetary values of milk and dairy products at each model location.

We have assembled data and determined solutions for the USDSS model for March and September 2016 (representative of flush and short months). An example of the primal output is shown in Figure A5. In this figure, the green lines represent milk assembly flows from farms to plants, which are represented by triangles. A triangle with no obvious green line simply represents a local milk supply. Orange squares represent demand locations and orange lines represent distribution of finished products from plants to demand locations. The yellow lines are cream shipments from fluid plants. The size of triangles, squares and the thickness of lines gives an indication of relative volume shipped or processed—larger triangles, squares and thicker lines indicate larger quantities transported or processed.

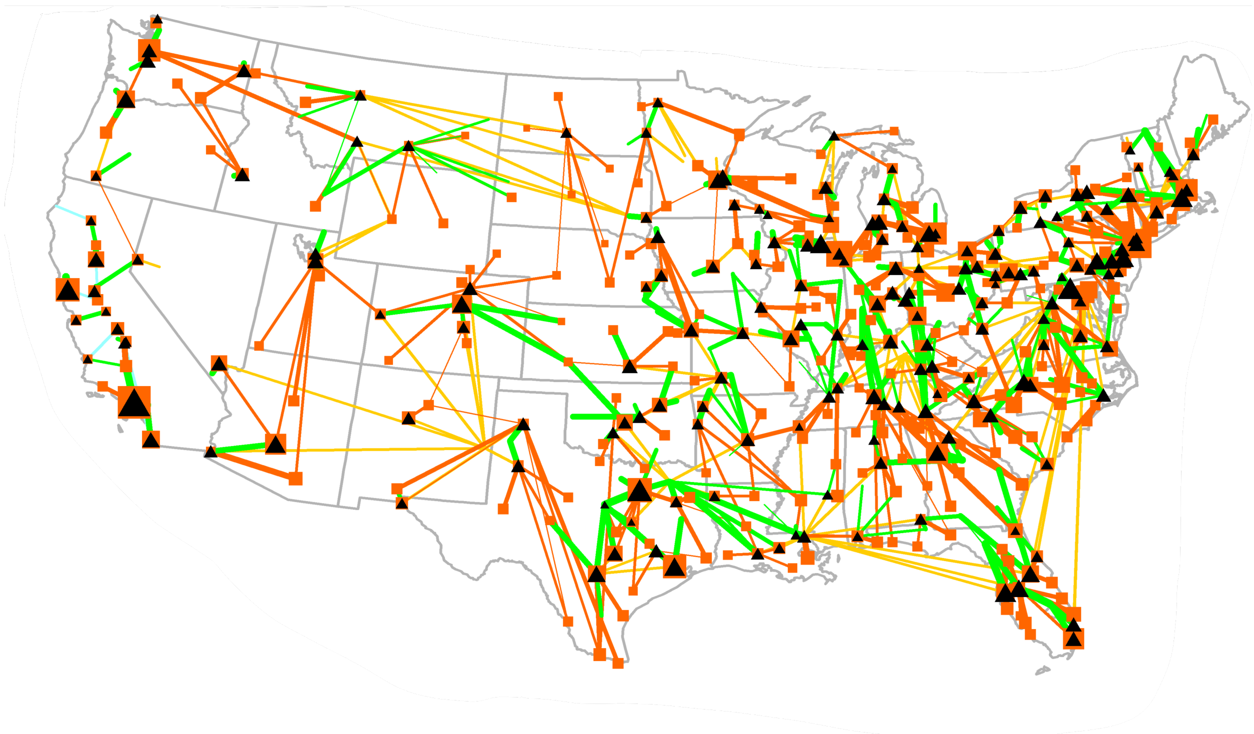

Figure A2.5. Milk Assembly and Packaged Milk Flows (USDSS Primal Solution), March 2016

Figure A6 shows the primal solution of cheese plants for March 2016. Cost-minimizing solutions favor a more local milk supply and more distant distribution of finished products than is the case for fluid milk plants (Figure A5). This is an outcome that was expected from a supply chain in this type of market characterized by surplus and deficit regions of the country.

Criticism of the optimization modeling approach is that it does not exactly replicate what is seen in reality. It should be noted that by definition, modeling is a simplification of reality but it can reveal underlying insights as to what "should" happen. There will always be some institutional rigidity in a supply chain that causes milk from one cooperative to be sent to a particular bottler that the model would say is not the most efficient movement. Some of these less-than-optimal arrangements can be made at the margin, but it is like swimming in an economic current—much easier to go with the flow than against it.

Although it is difficult to fully evaluate the degree to which the USDSS model matches actual outcomes with available data, we can compare the model-generated volume of five dairy products to those produced in regions of the US based on the monthly *Dairy Products* report from the National Agricultural Statistics Service. The correlation between the model-generated regional production quantities and observed values is greater than 0.88 for all products evaluated in both months and as high at 0.99 for many products such as cheese. Previous results have been assessed by analysts familiar with milk movements in various US regions, and they indicated that spatial milk values reasonably closely matched those generated by the model. Moreover, the model results are not sensitive to changes of plus or minus 5% in demand values or estimated transportation costs. All of these suggest a high degree of confidence in the basic sensibility of the model outcomes.

Figure A2.6. Milk Assembly and Cheese Flows (USDSS Primal Solution), September 2016

Primal solution information for other products during March and September 2016 is less directly relevant to understand how the USDSS model works, but they are provided in the Appendix for the interested reader.

The Dual Solution

The dual solution shows the marginal value of milk at a processing location—such as for fluid plants—or at a supply location as for raw milk. Conceptually, this can be thought of as follows. If you would ask fluid plant owners how much more they would be willing to pay for another hundredweight of milk, they would have to consider all of their options for other milk supplies and the cost of transporting that milk to their plant. And, they would have to consider the additional sales opportunities for the finished product and the cost of distribution to those locations. This value would never be more than the cost of transportation from the closest supply region and it will be minimal in some locations where there is plenty of milk or little nearby demand. These three factors: supply, demand and transportation costs become the important determinants for the relative spatial values of milk.

Dual values are calculated by the USDSS at all fluid milk plant locations across the country. A mapping software is then used to develop a continuous “price surface” by interpolating the values between the points.

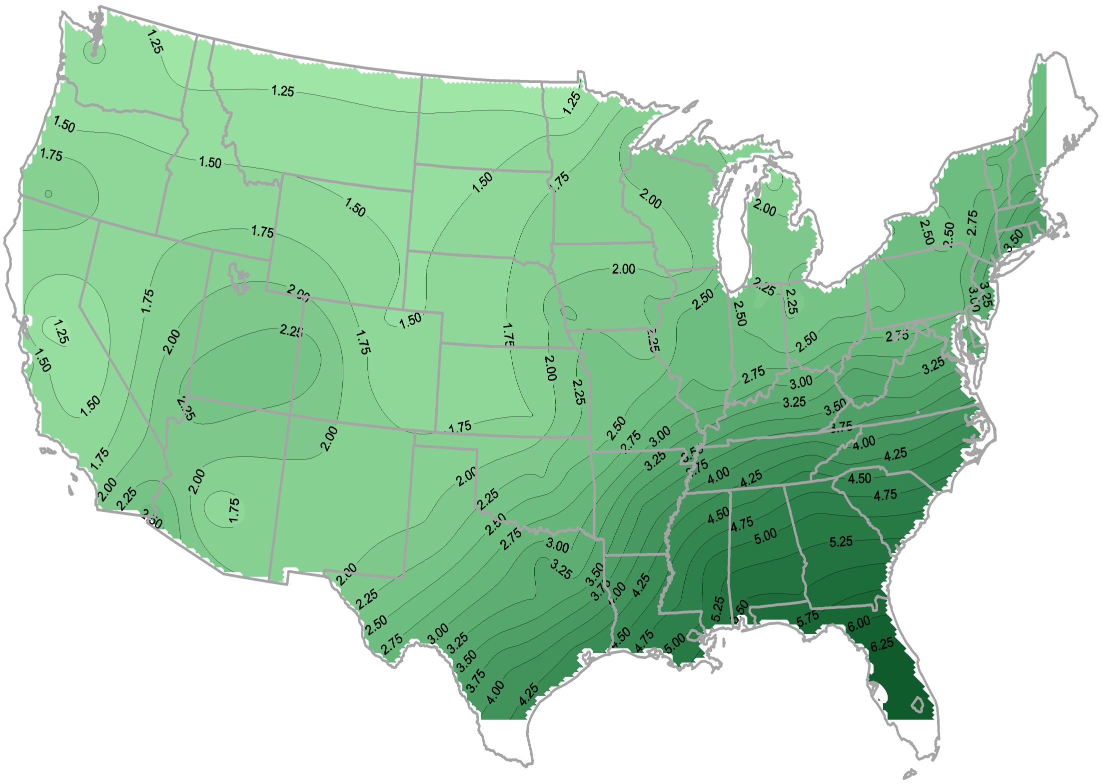

Figure A2.7. Marginal Value of Milk at Fluid Plants (USDSS Dual Solution), March 2011

The values indicated in Figures A7 should not be interpreted as class I differentials. Rather, they should be thought of as “price relatives”, the relative difference in values across space. For instance, the March value in most of Wisconsin is about $2.00 whereas in southern Florida the value is about $6.25, which would suggest a $4.25 price difference in class I values between these regions. In fact, a decision was made to increase the Southeast class I differentials in 2008 from a maximum of $4.30 to $6.00. The current class I differential in Wisconsin is about $1.75 which would make a $4.25 relative price difference. In this case, the model results are consistent with the federal order price difference between southern Florida and the Upper Midwest. The Agricultural Marketing Service (AMS) of the USDA has used this model in many Federal Order hearings as evidence of the need to change Class I differentials.

The dual solution for the value of raw milk is also important in our analyses. We will calculate this value to see what the impact marginal milk values of allowing an additional plant or plants in the Southeast would be.

<u>The Analytical Approach</u>

For the dairy industry as a whole, the USDSS calculates something called the “objective function”. Quite literally, this is the model’s estimate of the entire cost of the dairy industry as described by the model. Because we take milk supplies as a given, it does not include the cost of milk production. But, it does include the relevant costs between the farm gate and the retail store, food service buyer or food manufacturer. The model's job is to minimize this total cost without violating any of the physical constraints that we have imposed upon the system.

For dairy producers, there are two potentially important sources of benefit for the consideration of new plants in Pennsylvanai. One is the reduction of milk assembly costs (getting milk from farms to a plant) and the raw milk dual value (this can be thought of as a change in the premiums paid above the Federal Order minimum prices). The final analyses will consider both the cost savings and the revenue enhancement.

Chapter 3: Comparative Analysis of Profitability, Solvency and Liquidity of Dairy Farms in Pennsylvania, Michigan, New York and Wisconsin

Chris Wolf, Michigan State University[20]
Mark Stephenson, University of Wisconsin
Chuck Nicholson, Cornell University

Executive Summary

This component of the *Study to Support Dairy Growth and Competiveness* compares the financial performance of Pennsylvania farms to those in three other states with similar agronomic resources (Michigan, New York and Wisconsin) and across farm size categories regardless of the state. Data for these comparisons are from voluntary farm-financial records programs in each of the states, and thus do not represent the average farm characteristics or performance for any of the states. In particular, farms analyzed tend to own a larger number of cows with higher productivity than average. However, this is true for each of the states. We compare three measures of farm financial performance—profitability, solvency and liquidity—during the period 2011 to 2016, using Return on Assets (ROA), Debt-to-Asset Ratio (D/A) and Current Ratio, respectively.

Our key findings are:

- Pennsylvania farms tended to have lower Return on Assets, higher Debt-to-Asset Ratios and lower Current Ratios than analyzed farms in other states, although in some cases the differences are relatively small. These differences exist both for overall average values during 2011 to 2016 and many of the individual years, and when considering farm size and milk per cow;
- Overall, these measures suggest that larger and more productive Pennsylvania farms may be less resilient in the face of economic stress than similar types of farms in other states;
- However, our analysis does not directly indicate the underlying causes of these differences and their practical management or programmatic implications. Additional analyses of data for a broader range of farms—facilitated by a collaborative multi-state data collection effort is therefore suggested to address these limitations.

Overview and Study Objectives

The overall purpose of this document is to provide a comparative assessment of selected farm financial performance indicators in Pennsylvania and other nearby states with similar agronomic resources. Farm business analysis records were used to compare farm-level performance and trends among the states to glean insights about what underlies performance and what support might be provided to improve it. It is important to note that the farms included in this analysis

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were not randomly selected and the number of farms per state is small as a proportion of the total farms. For Pennsylvania, data were provided anonymously for 168 farms by AgChoice Farm Credit[21]. For New York, Wisconsin and Michigan, farm data were obtained from farm business analysis summary programs that are participating in the development of a multi-state comparison project that will shortly make them available through the online tool "FarmBench"[22] . The farms included in the analysis tend to be larger and more productive than the average farm in each of the state, but comparison of the financial information from these operations, however, is useful in understanding the performance trends and current levels of financial stress that dairy farms in these states are experiencing.

We assess farm financial performance based on information from balance sheets and accrual adjusted income statements. Three measures of provide an overall assessment of farm financial performance: *profitability* (measured by Return on Assets), *solvency* (measured by the Debt-to-Asset Ratio) and *liquidity* (measured by the Current Ratio). Overall, farm financial feasibility requires all three of these indicators to be within workable ranges. Although we assess only overall averages by state or farm size in this document, there is a good deal of variation among farms that would be relevant to the assessment of state-level performance.

Farm Descriptive Characteristics

The average size and milk production by state during the five-year period from 2011 through 2016 indicate that the participating New York farms had the highest average cow numbers (Table 1), and that the average Pennsylvania farm had about double the state's overall average farm size. Milk per cow for the participating Pennsylvania farms is substantially larger than the average for all Pennsylvania farms (which was about 20,000 per cow during 2011 to 2016) and is roughly comparable to milk per cow in the other participating states. The participating farms in Wisconsin had the smallest average milk sold per cow. Milk per cow tends to be positively correlated with herd size, so it is not surprising that the largest herds had the highest average productivity. It is also important to note that the reporting of average values masks a great deal of underlying variation among farms.

Comparative Farm Profitability Assessment

A profitable farm can be thought of as one that is generating a sufficient return to the unpaid labor, management and capital for the dairy operation. Profitability here is measured using Rate of Return on Farm Assets (ROA) which is the ratio of operating profit to total farm asset value. Using a ratio allows us to compare across farms and over time as it adjusts for farm size. As a benchmark, the long-run average ROA value on dairy farms generally is between 6 and 7 percent.

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[21] The authors extend their appreciation to Mike Hosterman of AgChoice Farm Credit for his efforts to make these data available for the purposes of the project.

[22] The FarmBench project initially seeks to streamline the collection and summary of farm financial data from the Center for Dairy Profitability at the University of Wisconsin, Cornell's Dairy Farm Business Program and Michigan State's Telefarm data. This expanded effort will also look to partner with additional Land Grant universities as well as commercial interests who want to access broader financial benchmarks for the farm data they can supply. The FarmBench project will be operational in late 2018.

Table 3.1. Summary Averages During 2011-2016 for Farms Analyzed, by State and Herd Size for Pennsylvania

State and Farm Size Category	Number of Farms Analyzed	Herd Size (cows/farm)	Milk per cow (lbs/cow/yr)	Return on Assets (ROA, %)	Debt to Asset Ratio	Current Ratio[a]
Michigan	120	315	23,486	6.3	0.276	3.1
New York	244	662	23,524	6.5	0.306	2.5
Wisconsin	582	205	21,906	4.2	0.285	4.9
Pennsylvania	168					
All herds	1,114	222	22,450	4.8	0.301	2.2
<200 cows		113	21,592	4.4	0.304	2.2
200-499 cows		271	22,316	5.2	0.288	2.1
500+ cows[b]		673	24,297	5.0	0.317	2.6

[a] The current ratio is defined as the current total assets of a farm (both liquid and illiquid) relative to that farm's current total liabilities. It is therefore a liquidity ratio that measures a farm's ability to pay short-term liabilities.

[b] For Pennsylvania herds with 500+ cows, the averages are for only the years 2013 to 2016.

The average ROA values for Pennsylvania during the five years studied are lower than those for New York and Michigan farms (Table 1). Even for farms of comparable size measured by cow numbers, profitability is lower for Pennsylvania farms. For example, the ROA for NY farms (with an average of 662 cows) is 1.5% higher than for the largest Pennsylvania farms (with an average of 673 cows). Michigan farms (average 315 cows) have an ROA 1.1% higher than Pennsylvania farms with 200 to 499 cows (average of 271 cows). However, the average ROA during these years for the smallest PA farm size (less than 200 cows, average 113 cows) was slightly higher than for average for Wisconsin farms with an average of 205 cows.
Although the numbers of farm observations is relatively small, it is instructive to consider the relationship between ROA and two associated variables, herd size and milk per cow. There is a positive association[23] between farm size measured by cow numbers and ROA (Figure 1), and this relationship appears to be nonlinear. This figure illustrates that Pennsylvania farms have profitability lower than NY and MI farms of similar sizes. The ROA also does not increase for Pennsylvania farms as farm size increases—the average ROA for the largest Pennsylvania farms is less than that for a farm with 200-499 cows. There is also a positive association between milk per cow and ROA (Figure 2). For this relationship also, Pennsylvania farms have lower ROA for a given farm size, and the ROA does not increase with higher milk per cow in the same manner as it does for the overall relationship. Further analysis of the reasons for these differences (for example, cost structures and milk prices) would be appropriate.

It is also helpful to consider profitability measures over time, which we do for the four respective states during 2011 to 2016—a period that included both record high prices (2014) and the troughs of two price cycles (2012 and 2016). The pattern was quite similar in all four states with

[23] A "positive association" means that the variables have a positive correlation. That is, as one variable increases, the other also increases. This does not imply that one variable CAUSES another (i.e., that larger farm size causes higher ROA) because other factors that affect ROA are not controlled for. It would not be the case that just increasing cow numbers would improve ROA without appropriate modifications to farm management that underlie farm profitability. Still, it is useful to consider the associations.

2011 and 2014 being higher return years and 2015 and 2016 exhibiting very low returns (Figure 3). Although overall Pennsylvania farms had better ROA over time than WI, their ROA was lower than that observed on NY and MI farms for five of six years (except 2012 for NY and 2016 for MI). Pennsylvania farms also realized the lowest average returns in 2015 and second lowest (after MI, which has a negative ROA value) in 2016.

Farms in all states exceeded the benchmark of 6% ROA in 2014, a year with record high prices, but the average ROA for all states during 2015 and 2016 was below this level. Given the comparative patterns over time, Pennsylvania farms appear to be about as resilient in terms of profitability as farms in other states, with higher ROA in high price years and low ROA in low-price years.

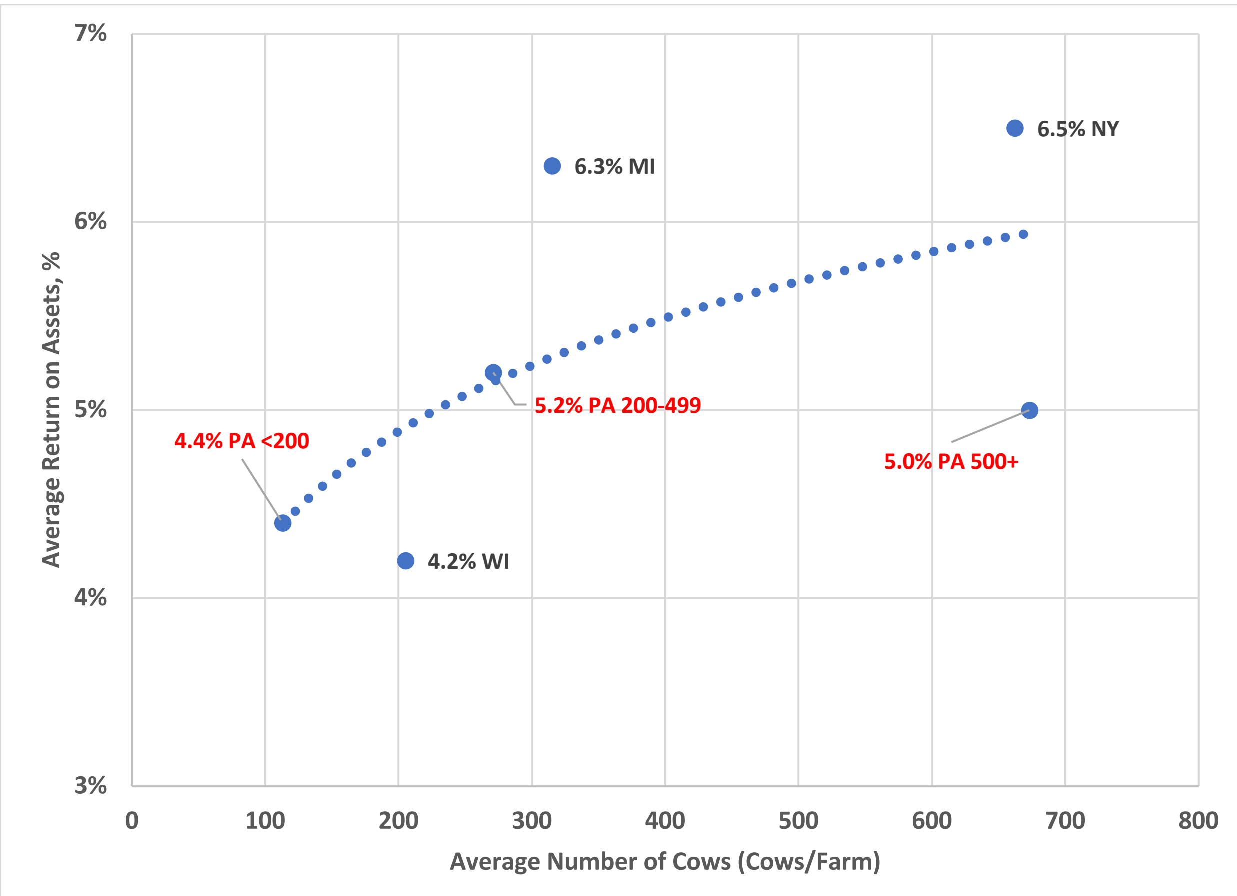

Figure 3.1. Observed Relationship Between Average Cows Per Farm and Average Return on Assets for Participating Farms, 2011 to 2016

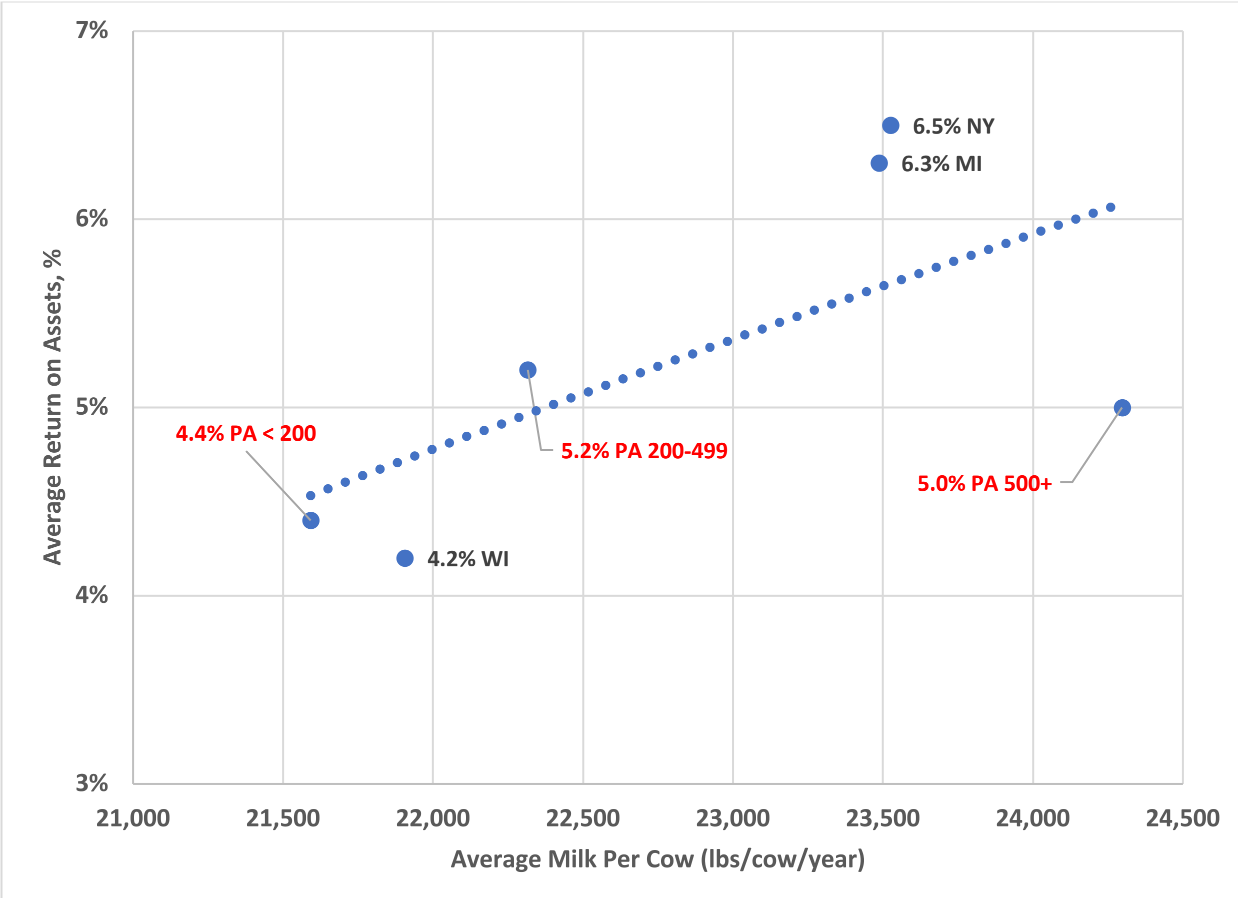

Figure 3.2. Observed Relationship Between Average Milk Per Cow and Average Return on Assets for Participating Farms, 2011 to 2016

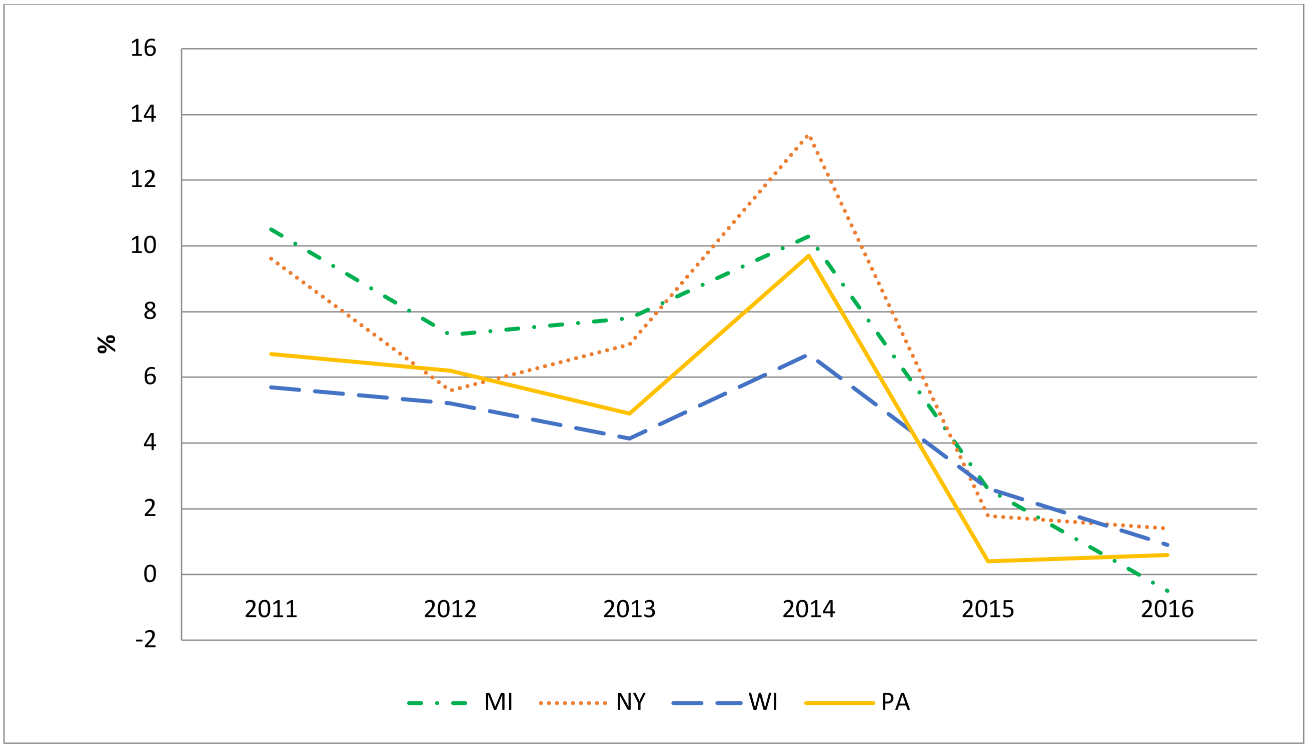

Figure 3.3. Average Annual Rate of Return on Assets, By State, 2011 to 2016

Combining the data for other three states and dividing the farms by herd size helps facilitate a further understanding of the differences in profitability over time between those states and Pennsylvania dairy farms. For each state, we define the herd size categories are <200 cows ("Small"), 200-499 cows ("Medium", and 500+ cows ("Large"). Michigan, New York, and Wisconsin herds were combined and averaged for comparison to Pennsylvania herds. Note that because of small number of observations, the values for 500+ cow herds from Pennsylvania were not available for 2011 and 2012.

During the five-year period analyzed, larger herds were more profitable based on ROA (thus, even when controlling for the value of business assets). In general, the large herds tend to be more profitable in good years (2011 and 2014) and converge towards the same level as smaller herds in poor years (2016). With the exception of 2014 for medium farms), the average ROA for medium and large Pennsylvania farms was below that of the average of the other three states. The smaller Pennsylvania herds were more profitable than small herds in the other three states for years other than 2015. Perhaps surprisingly, the ROA for small Pennsylvania farms was higher than that for the medium and large farms in 2016 (when the ROA was negative for the two larger Pennsylvania farm size categories).

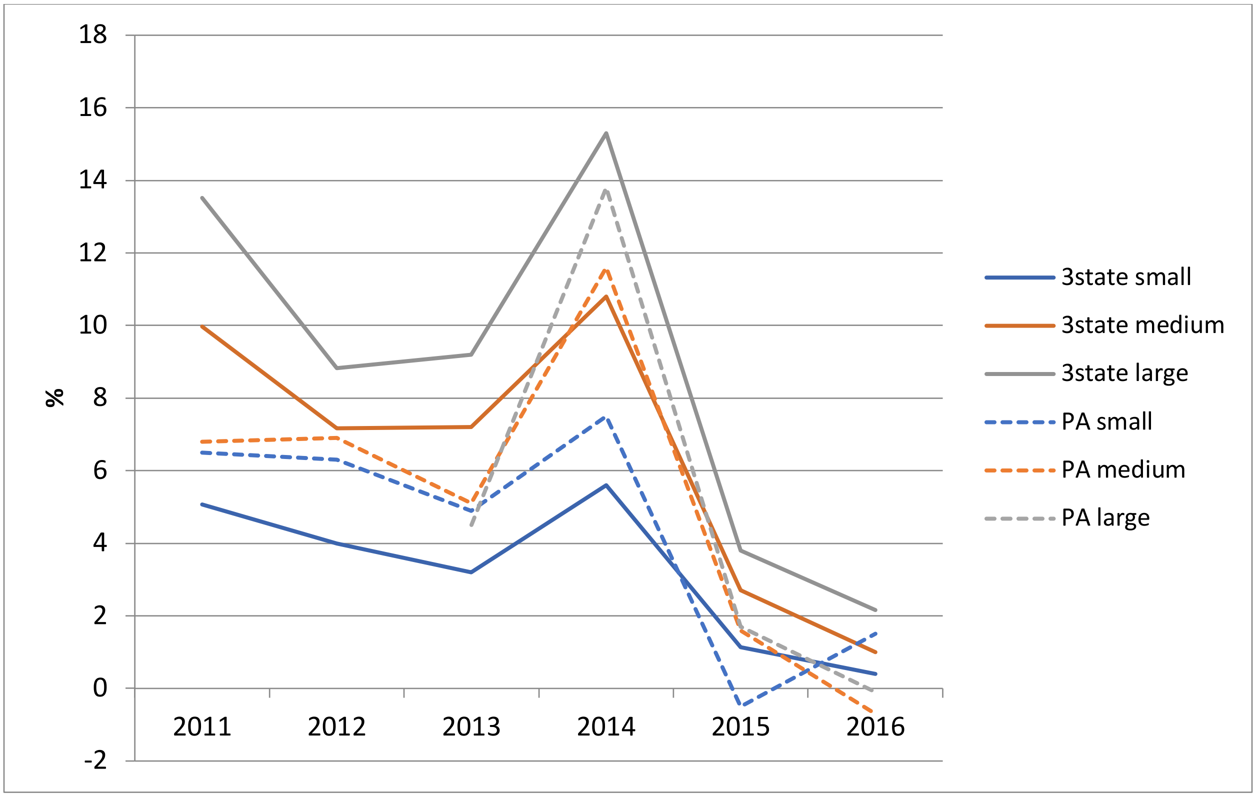

Figure 3.4. Average Annual Rate of Return on Assets, Pennsylvania Compared to Average of Three Other States, by Herd Size Category, 2011 to 2016

Comparative Farm Solvency Assessment

Solvency means that the farm business possesses positive equity with total farm asset value exceeding total farm liabilities. Solvency can be measured using the Debt-to-Asset (D/A) ratio defined as farm asset value divided by farm liabilities. Higher D/A indicates more risk of insolvency and has financial consequences for farm operations. For example, for farms above 60 or 70 percent D/A, borrowed capital becomes substantially more expensive. The long-run average D/A is about 30 percent for all US farms and for these dairy farms as well. There are significant life-cycle effects of D/A as it tends to rise when major expansions are undertaken and fall near retirement as operators are hesitant to take on new debt obligations.

The average value of the Debt-to-Asset ratio for Pennsylvania farms is generally higher than those for other states, except for category with 200-499 cows (Table 1). For farms of similar sizes and milk per cow, average Debt-to-Asset ratio values are larger for Pennsylvania than for other states, although the differences are relatively small (Figures 5 and 6). For example, the medium size Pennsylvania farm with an average or 271 cows has a D/A ratio of 0.288, whereas the value for all farms in WI with an average of 205 cows, is not substantively different at 0.285. Although the relationship is not a particularly close one, the D/A ratio tends to increase with farm size (Figure 5) and with milk per cow (Figure 6). As for the analysis of profitability, additional insights could be gained through examination of the variation in D/A ratios and an assessment of underlying factors.

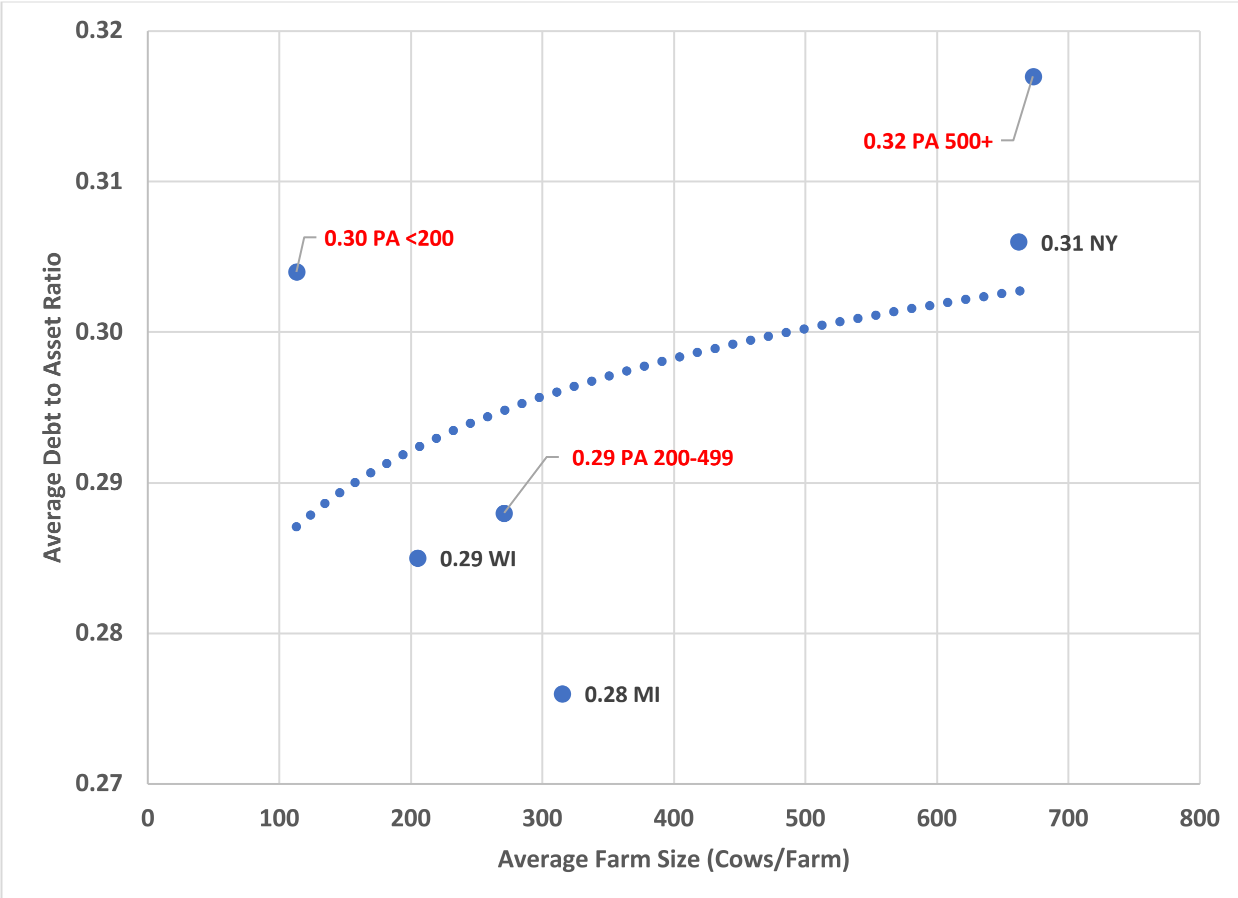

Figure 3.5. Observed Relationship Between Average Cows Per Farm and Average Debt-to-Asset Ratio for Participating Farms, 2011 to 2016

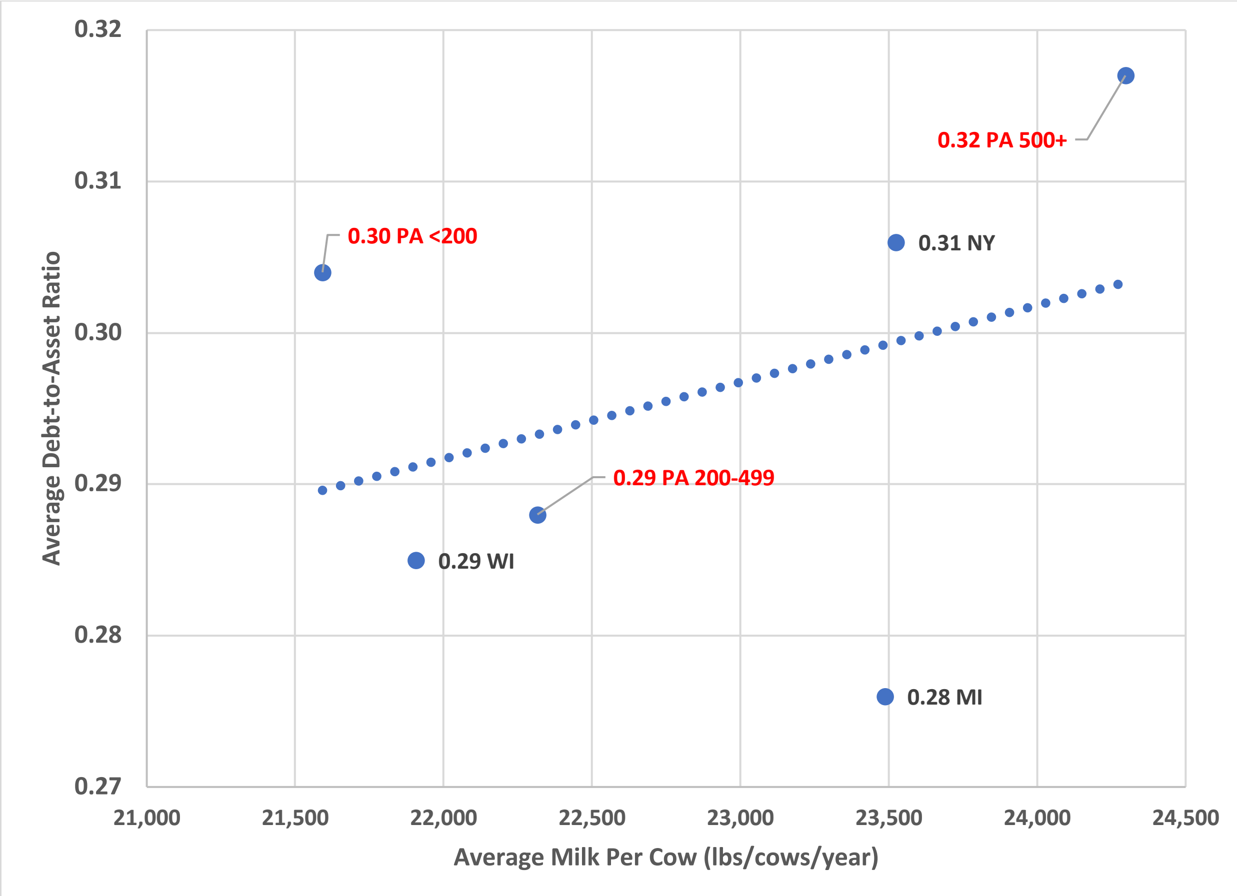

Figure 3.6. Observed Relationship Between Average Milk Per Cow and Average Debt-to-Asset Ratio for Participating Farms, 2011 to 2016

As for farm profitability, it is also helpful to consider solvency measures over time, which we do for the four respective states during 2011 to 2016. Although the pattern of D/A ratio over time was roughly similar in the four states, this measure tended to be somewhat more variable over time for Pennsylvania farms (Figure 2). The average value for all states decreased in 2014, a high profit year that allowed operations to pay down debt and lower the D/A ratio. The D/A ratio increased in all states as profitability decreased in 2015 and 2016. Pennsylvania farms exhibited rapidly increasing average D/A in 2015 and 2016, reflecting the financial stress of those years. The increase in average D/A ratio was somewhat more than other states. This value increased from under 0.28 in 2014 to more than 0.33 in 2016 for Pennsylvania, but only from 0.24 to 0.275 in Wisconsin. However, D/A value for Pennsylvania farms showed a pattern quite similar that for New York farms during 2014 to 2016 (although reporting New York farms are considerably larger on average).

Large- and medium-sized herds had the most debt relative to assets, likely reflecting debt undertaken for farm expansion (Figure 7). The small herds for the three states had a very low level of relative debt. Small herds in Pennsylvania had more debt and thus less solvency. However, none of these averages would tend to indicate a concerning level of debt. It is worth noting that the high levels of profitability in 2014 led to a more solvency (i.e., less debt) and that solvency has been eroding quite quickly for all sizes of dairy farms in 2015 and 2016.

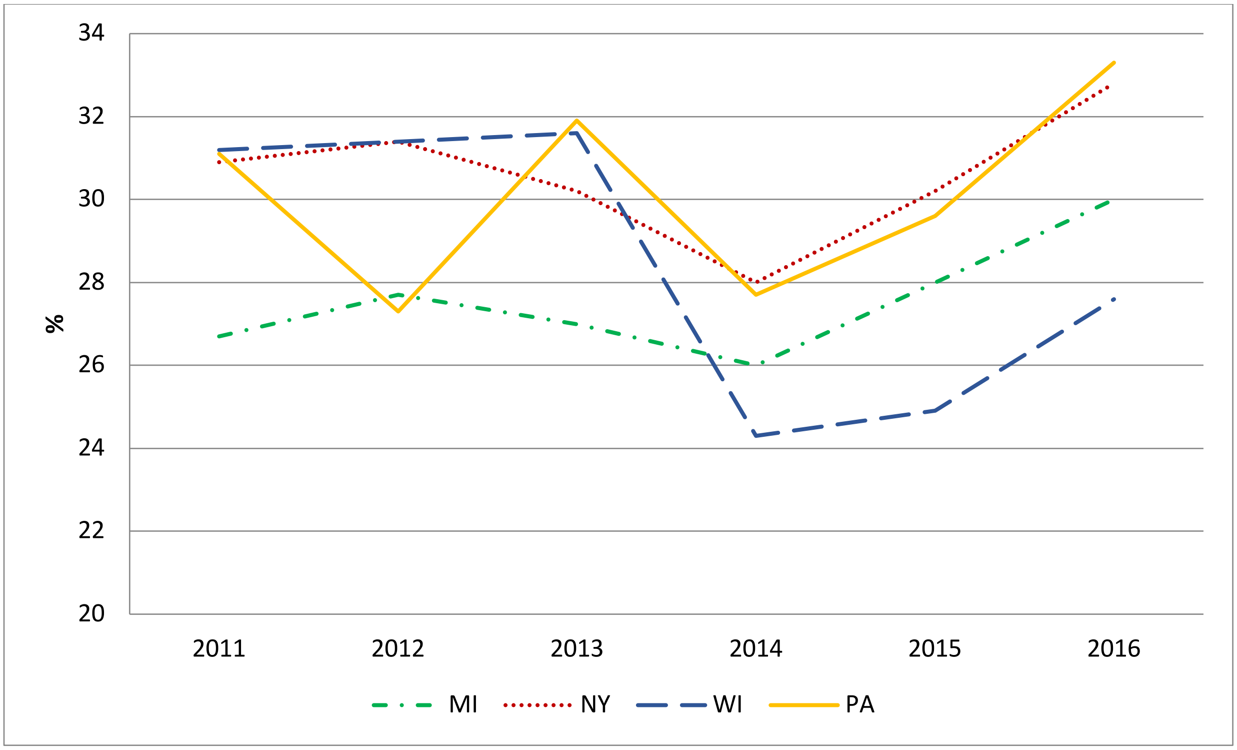

Figure 3.7. Average Debt-to Asset Ratio, By State, 2011 to 2016

As for the analysis of profitability, combining the data for other three states and dividing the farms by herd size helps facilitate a further understanding of the differences in solvency over time between those states and Pennsylvania dairy farms. The average D/A ratio for the small farm size category in Pennsylvania was considerably higher than the that for the average small farm value in the three other states (Figure 8). In contrast, for medium and large size farms, Pennsylvania average values were lower than those in other states in each of the five years (or three years, for the large farm category). The average D/A ratio increased for all farm categories during the lower-profitability years 2015 and 2016, but the size of the impact differed among categories. In particular, the average D/A ratio rose rapidly for the small farm category in Pennsylvania during 2015 and 2016, whereas the (lower) value for small farms in other states increased much. Overall, these results suggest that Pennsylvania farms are probably about as resilient in the face of adverse economic conditions as farms in other states.

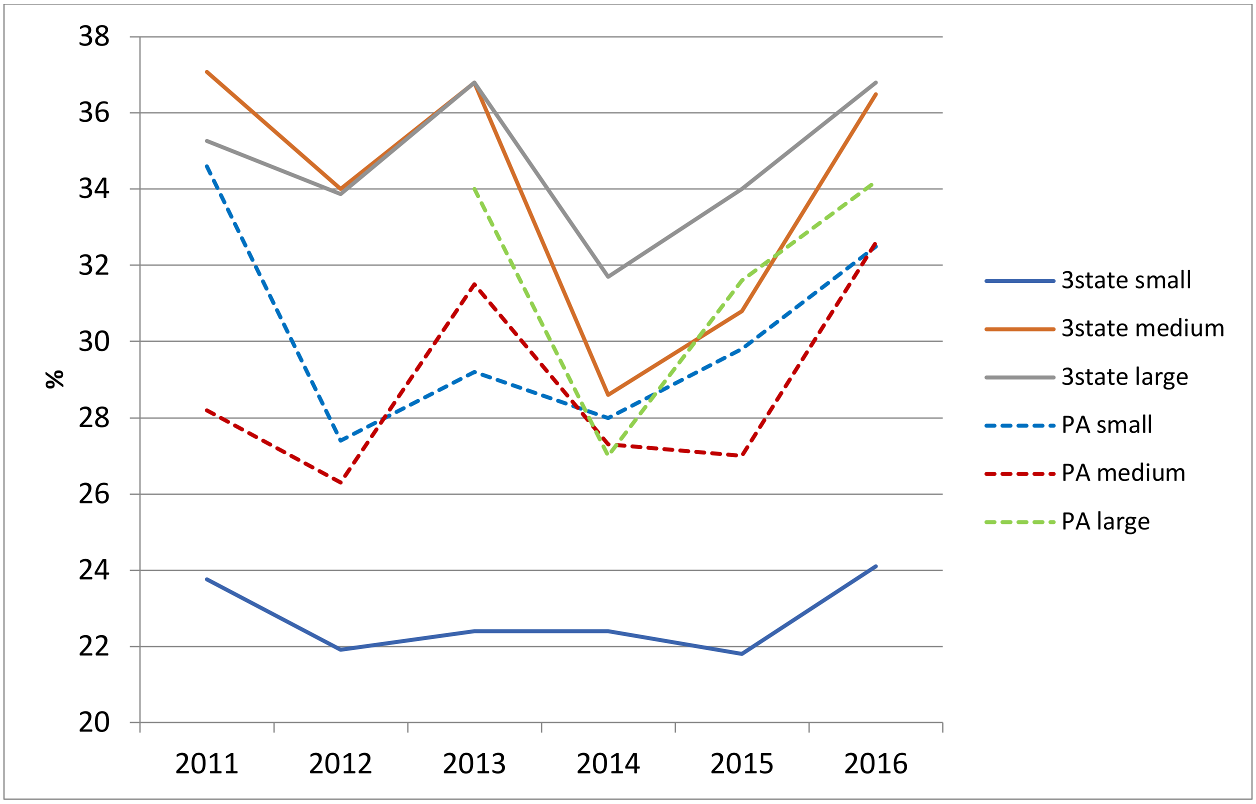

Figure 3.8. Average Debt-to-Asset Ratio, Pennsylvania Compared to Average of Three Other States, by Herd Size Category, 2011 to 2016

Comparative Farm Liquidity Assessment

Liquidity measures the ability to pay bills. The Current Ratio (CR) is the ratio of current farm assets (cash and assets expected to be converted to cash in the next year) to current farm liabilities (bills and debt due in the next year including the current portion of term debt). A higher ratio indicates more liquidity. If the value were one, for example, current farm assets and liabilities are equal and there is no margin of error to pay bills due in the next year. Lenders have been encouraging higher amounts of liquidity and often use a CR value of 2.0 as the minimum desired level. Excessive liquidity may not be desirable, however, as there is an opportunity cost to holding too many liquid assets, which could be invested in more productive assets.

The average value of the current ratio exceeded the often-recommended guideline of 2.0 for all states (and farm sizes for Pennsylvania), but differences existed between states. The average value of the Current Ratio for Pennsylvania farms is generally lower than those for other states, except for category with more than 500 cows, which was similar to that for New York (Table 1). For farms of similar sizes and milk per cow, average Current Ratio values are smaller for Pennsylvania than for other states, except for the largest Pennsylvania farms. Although the relationship is not a particularly close one, the Current Ratio tends to decrease with farm size (Figure 5) and with milk per cow (Figure 6). As for the analysis of profitability, additional insights could be gained through examination of the variation in Current ratio values and an assessment of underlying factors.

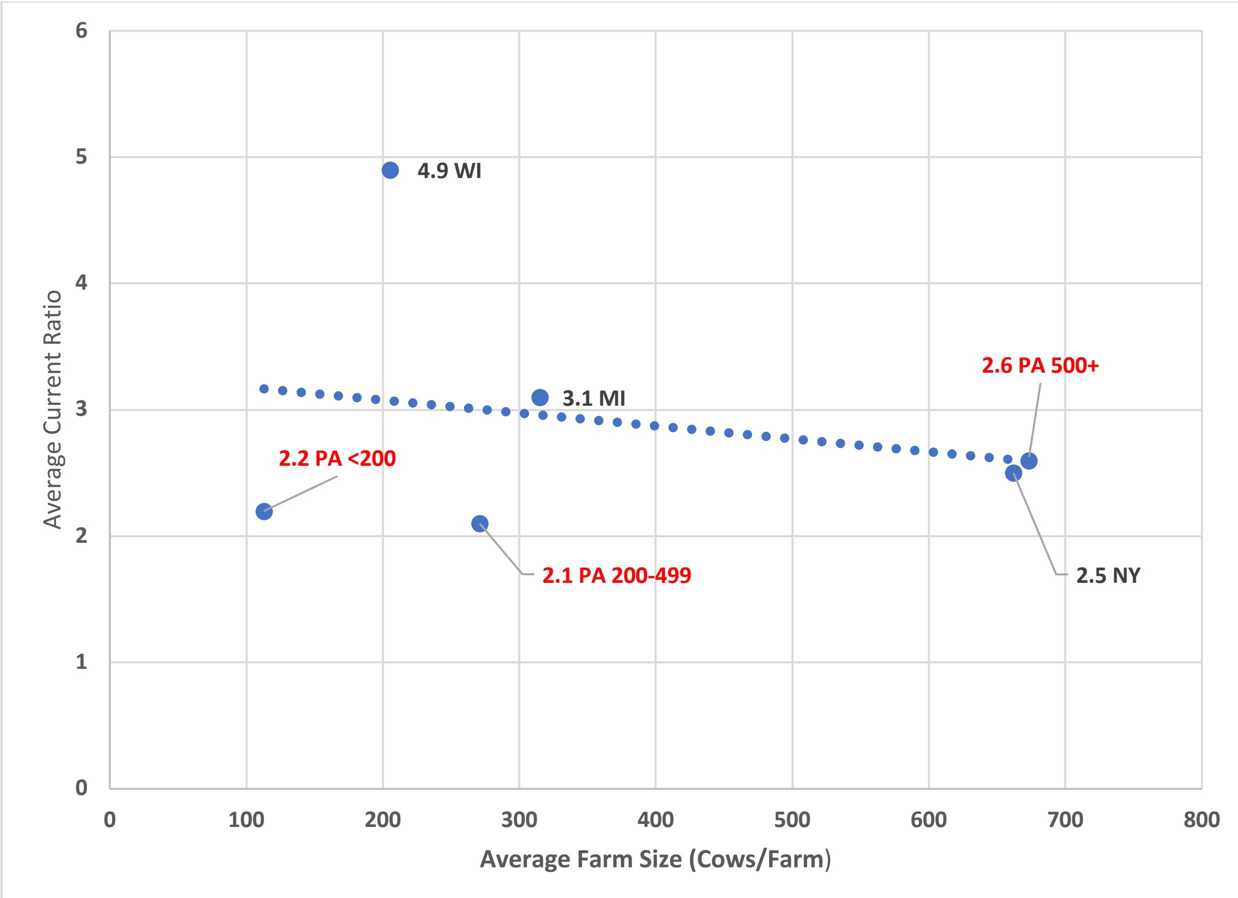

Figure 3.9. Observed Relationship Between Average Cows Per Farm and Average Current Ratio for Participating Farms, 2011 to 2016

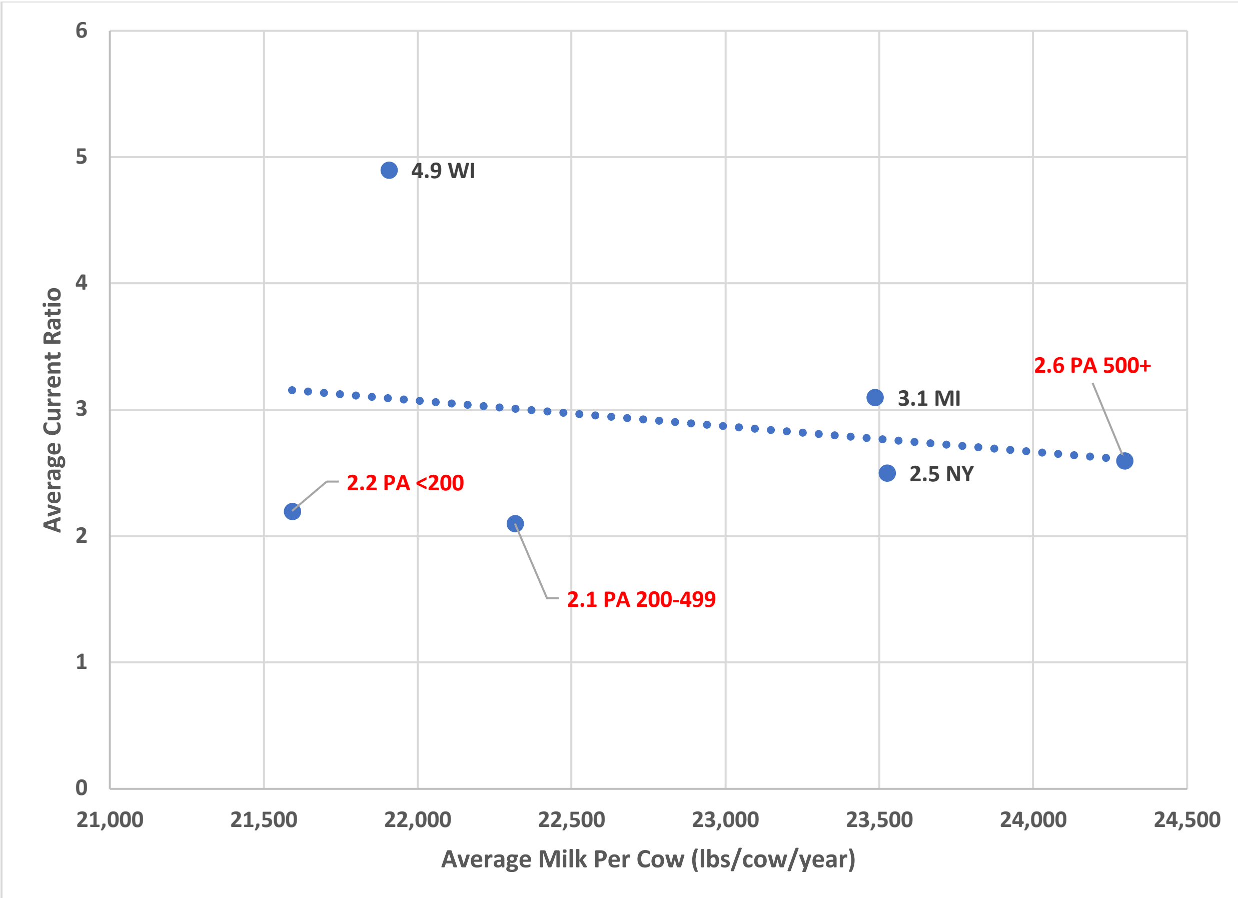

Figure 3.10. Observed Relationship Between Average Milk Per Cow and Average Current Ratio for Participating Farms, 2011 to 2016

As for the previous two measures of farm financial performance, it is also helpful to consider liquidity measures over time. The average values for all states were generally above 2.0 in all years (Figure 11)—although the average for Pennsylvania farms fell below this benchmark value in 2011 and again in 2016. It is again important to note that these averages mask significant variation among farms. The average value for Pennsylvania farms was always below the average value in other states. That is, Pennsylvania herds had relatively less liquidity than those in New York, Michigan and Wisconsin. The average values also reflect the stress of the past couple of years in all states, as they have trended downward indicating an increasing amount of financial risk. In particular, the average current ratio for small and medium sized herds was quite low to finish 2016. Financial stress tends to manifest initially as low liquidity. However, although the starting points and patterns differ, the decrease in Current Ratio for Pennsylvania farms is similar to that in other states from 2014 to 2016.

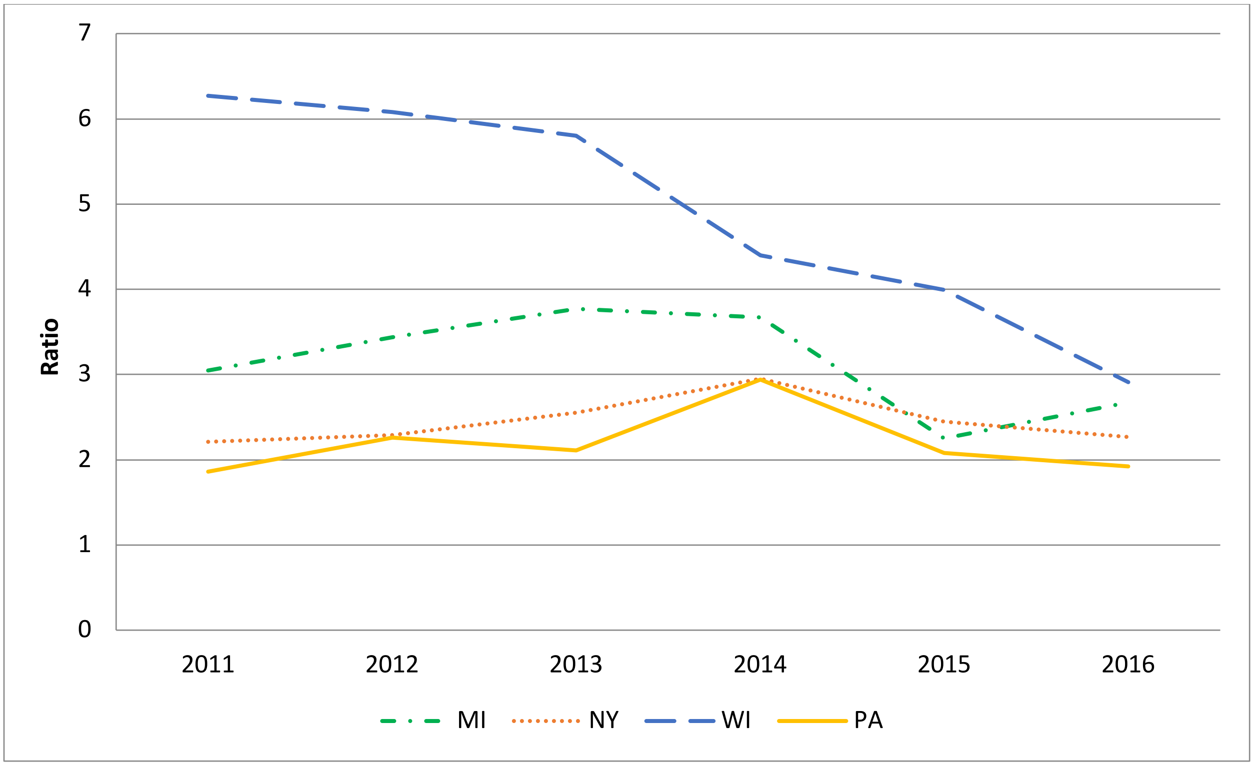

Figure 3.11. Average Current Ratio, By State, 2011 to 2016

As for the analysis of the other farm financial performance measures, combining the data for other three states and dividing the farms by herd size helps facilitate a further understanding of the differences in liquidity over time between those states and Pennsylvania dairy farms. The average value of the Current Ratio tends to be lower for Pennsylvania farms in a given size category than the average of farms in the three other states for most years. For the smallest farm size category in Pennsylvania, the Current Ratio dropped below 2.0 during both 2015 and 2016, whereas the value for the small farms in other states did not. The average value of the Current Ratio for medium-sized Pennsylvania farms never rose above 2.8 during this five year period and was well below 1.5 during both 2011 and 2016. The largest Pennsylvania farm size category also experience a value below 2.0, in 2013. Overall, these results suggest that Pennsylvania farms are somewhat less resilient than those in other states—as measured by liquidity—when under financial greater degrees of financial stress.

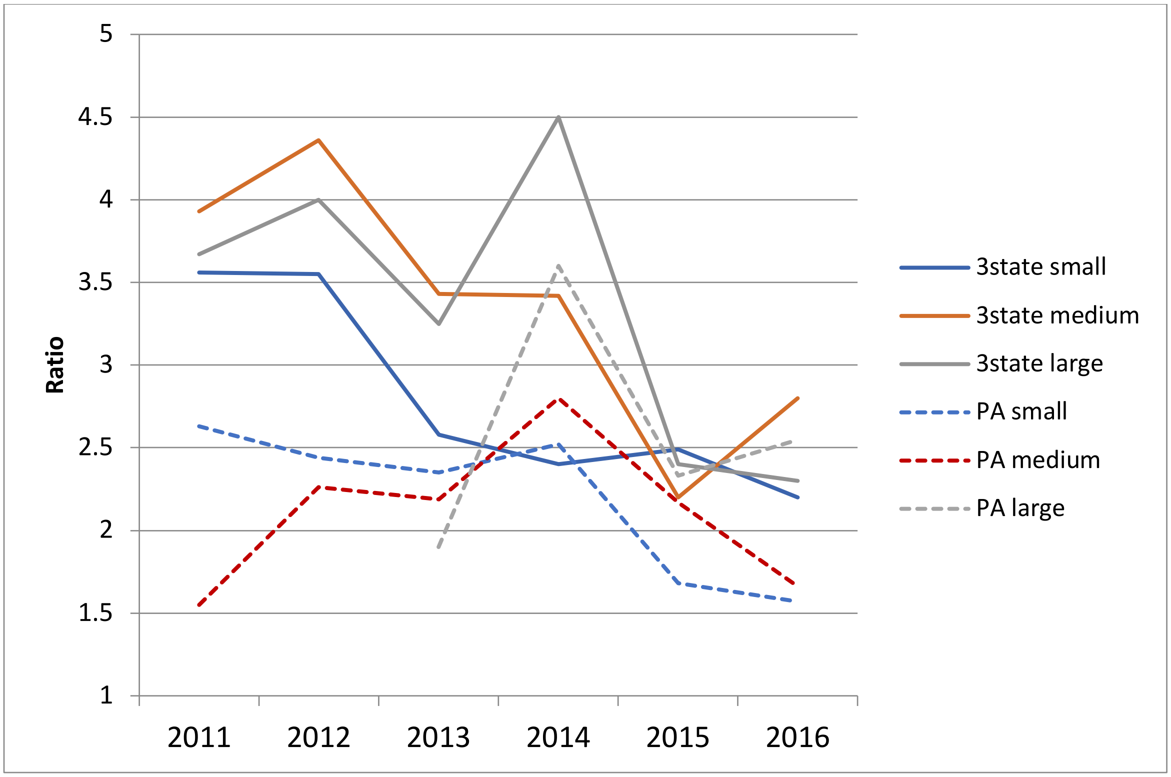

Figure 3.12. Average Current Ratio, Pennsylvania Compared to Average of Three Other States, by Herd Size Category, 2011 to 2016

Implications and Limitations

The foregoing analyses suggest that larger and more productive Pennsylvania farms do not, in general, have the same level of financial performance—and likely not the same degree of resilience in the face of financial stress—as larger and more productive farms in other states. As relevant as this comparative result is, there are two key limitations that could usefully be addressed by future analyses. First, these results in and of themselves do not identify the underlying causes of these differences, and thus provide limited direct guidance on what might be done from a managerial or programmatic perspective to improve performance. Second, the analysis does not include many of the more typical farms in each of the states, and this would be particularly important for Pennsylvania given the large number of smaller farms with lower milk per cow—for which these analyses may provide limited insights. Thus, a key recommendation is for further analysis of existing data, and implementation of a more comprehensive data collection and analysis mechanism that would track the financial performance of a broader range of farms over time, and allow more detailed assessment of underlying causes and potential responses. The *FarmBench* online data platform currently under development may serve as a centralized data collection effort that could provide these outcomes at minimal additional cost.

Appendix 3: Supplemental Materials to Describe the Distribution of Two Farm Financial Measures for N=112 Pennsylvania Dairy Farms in the AgChoice Farm Credit Dataset, 2016 Data

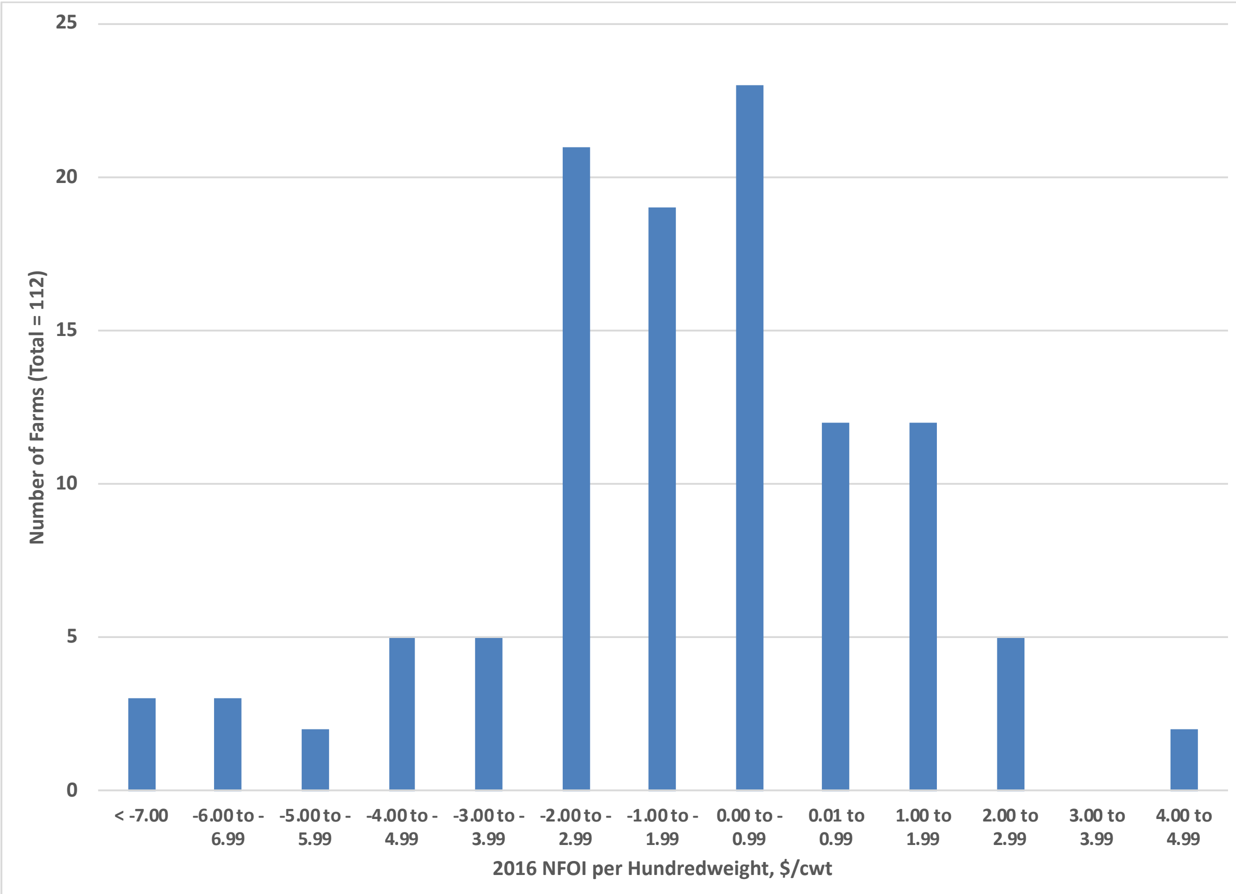

Figure A3.1. Distribution of NFOI per Hundredweight ($/cwt) for N=112 AgChoice Farm Credit Farms in Pennsylvania, 2016

This graph shows the distribution of NFOI per cwt of milk produced[24] for N=112 farms in the AgChoice Farm Credit dataset for 2016. There is a very large range, from less than -$8.00/cwt to more than $4.00/cwt. In that year, 28% of farms had NFOI/cwt values > 0 with a maximum value above $4.00/cwt. More than half of farms had NFOI/cwt between $0/cwt and $3.00/cwt.

[24] Because for most dairy farms, NFOI includes revenues and costs for products other than milk, this value is not specific to returns to milk production. However, it serves as a rough proxy and demonstrates the overall distribution of values in Pennsylvania.

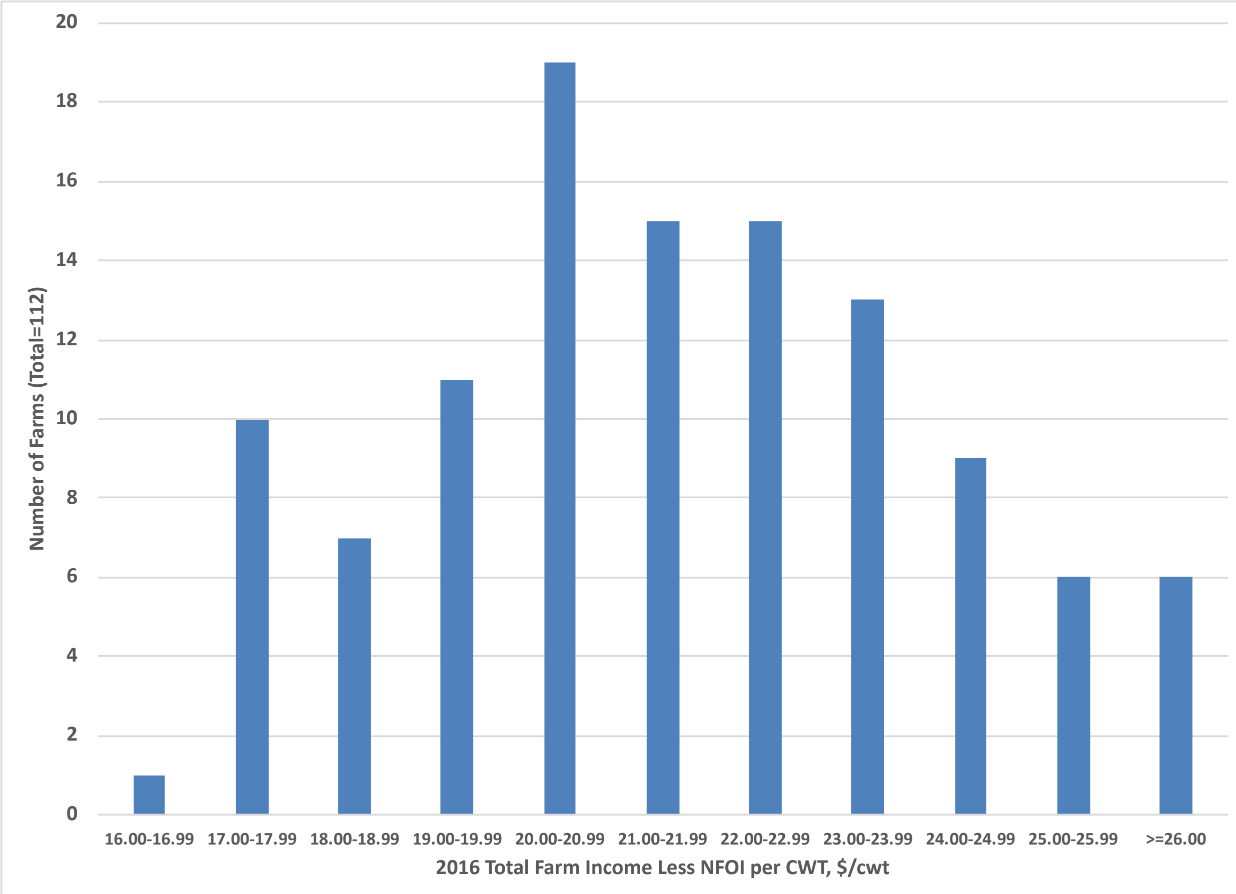

Figure A3.2. Distribution of Total Farm Income Less Net Farm Operating Income (NFOI) per Hundredweight ($/cwt) for N=112 AgChoice Farm Credit Farms in Pennsylvania, 2016

This graph shows the distribution of Total Income less NFOI per cwt of milk produced for N=112 farms in the AgChoice Farm Credit dataset for 2016. This is an approximation of production costs[25], which were not reported directly in the available data. There is a very large range, from less than $17.00/cwt to more than $39.00/cwt. In 2016, 26% of farms had values < $20.00/cwt. More than half of farms had values between $20.00/cwt and $24.00/cwt.

25 Because Total farm income typically includes revenues from sales of products other than milk and NFOI considers costs other than those for milk production, the calculated value is not specific to milk production costs, but serves as a rough proxy and demonstrates the overall distribution of values in Pennsylvania.

Chapter 4: Stakeholder Comments and Comparative Organizational Support for the Pennsylvania Dairy Industry

Chuck Nicholson, Mark Stephenson and Andrew Novakovic[26]

Executive Summary

This document summarizes information on three related topics: the feedback of key dairy industry stakeholders on issues related to the overall study on growth and competitiveness, the themes discussed at "listening sessions" during Fall 2017, and an overview of the comparative organizational support networks in Pennsylvania, New York and Wisconsin.

Our key findings are:

- Stakeholders have diverse views regarding the drivers of dairy industry growth in Pennsylvania, among them market access, regulation, farm structure, access to production resources, and professional development;
- The key data requirements include a set of broadly accessible information about farm financial performance and processing capacity, although future market opportunities and the benefits of existing programs were also mentioned;
- Most stakeholders indicate that existing programs and organizations provide support for dairy industry growth and competitiveness. The most frequently mentioned were the Center for Dairy Excellence and Penn State Extension programs;
- There were diverse opinions about how programs and organizations might be modified to better support growth and competitiveness. The development of a common vision and action plan for the future led by industry could be facilitated by additional capacity to assess programs and policies affecting dairy farms.
- A diverse set of themes and issues were discussed at listening sessions in Fall 2017. The most notable include those related to regulation (environmental and pricing), market outlets for farm milk and dairy products—and related processing capacity, the need to define metrics of success for the state's industry and to promote collaboration among all segments of the dairy supply chain. Few comments were received about how the state could support better decision making by dairy-related businesses;
- Pennsylvania has a diversity of organizations that provide support for dairy farms and dairy processors. However, our overview suggests that there are organizations and state-level programs in New York and Wisconsin that do not exist in Pennsylvania, and that might usefully be considered in greater detail to assess their effectiveness and appropriateness.

[26] The authors are, respectively, former Clinical Associate Professor of Supply Chain Management, Penn State University (now Adjunct Associate Professor, Cornell University), Director of Dairy Policy Analysis, University of Wisconsin, Madison, and E. V. Baker Professor of Agricultural Economics, Cornell University.

This document summarizes information on three related topics: the feedback of key dairy industry stakeholders on issues related to the overall study on growth and competitiveness, the themes discussed at “listening sessions” during Fall 2017, and an overview of the comparative organizational support networks in Pennsylvania, New York and Wisconsin.

Stakeholder Comments

The design of this study explicitly incorporated a mechanism to solicit feedback from key industry stakeholders, recognizing that this would improve the insights gained from the studies, raise awareness of issues and potential solutions and facilitate coordinated action. It was originally envisioned that stakeholders would base comments to a large extent on the draft study components made available online and from presentations related to the project (at, for example, listening sessions) in addition to personal experience. Although many of the stakeholder comments received appear to be based primarily on personal experience and the number of individuals and organizations submitting comments is small (N=9), the comments reflect key issues and the range of perspectives that may be useful for defining and addressing issues.

This section summarizes the stakeholder comments received and the themes discussed at industry listening sessions held during the Fall 2017.

The stakeholders were asked to respond to a series of questions related to factors affecting the growth and competitiveness of the Pennsylvania dairy industry. A complete listing of responses follows, but a summary of each is useful.

What do you view as the key drivers of growth and competitiveness for the dairy industry in Pennsylvania?

The key drivers mentioned include proximity and access to markets for milk and dairy products (including relevant infrastructure for processing, the potential for value-added and ways to increase demand), regulation (permitting for dairy farms and price regulation under the PMMB), access to production resources (land and labor), farm structure, farm profitability and professional development (attitudes and management skills for current and potential farmers). Labor laws and taxation were also mentioned as factors relevant to growth and competitiveness.

What data or information not currently available would be helpful to assess current status and future opportunities for the Pennsylvania dairy industry?

The key data or information that is not currently available includes accessible information about farm financial performance (including both prices and detailed costs) to support management decisions, information about the state’s processing capacity and utilization, the potential for new products to increase demand for farm milk and the functioning and merits of programs affecting dairy farmers (for example, the checkoff program and PA Preferred). It is worth noting that the first two of these were focal points for data collection efforts under this project, and there were considerable challenges in acquiring broad-based information.

Which current programs or policies help support growth and competitiveness? (These can be state level programs or policies, industry initiatives, or efforts of private businesses.)

A number of state and national programmatic efforts were mentioned, the most frequent of which were the Center for Dairy Excellence and Penn State's extension programs in dairy production and processing. (Please see the more detailed listing below, Table 1.)

Which current programs or policies might be modified (and how) to better support growth and competitiveness? (These can be state-level programs or policies, industry initiatives, or efforts of private businesses.)

There were a number of different answers to this question, indicating a lack of clear consensus about what might be changed (and how or why). Consistent with previous responses, suggestions included modification of the farm permitting process, concerns about the competitiveness of Pennsylvania farm milk given pricing regulation under the PMMB and the need for a discussion of supply management. One suggestion was for a reference/source for consumers to find where PA products are available (as a possible addition to PA Preferred). Another respondent thought that programs should focus more on supporting the state's small farms—although another comment focused on the need to support farms that want to grow. One respondent indicated the crucial importance of a strategic plan for the industry to coordinate the actions of the diverse industry stakeholders. A suggestion was made to evaluate the potential for a public-private industry partnership such as that in Wisconsin. Specific programmatic suggestions were made for CDE, PSU Extension, environmental programs and economic development programs.

Which current organizations help support growth and competitiveness? (These can be state level organizations, industry initiatives, or efforts of private businesses.)

There is a good deal of overlap between the responses to this question and those related to programs, which is reasonable given that the programs represent the implementation of activities by organizations. The most frequently mentioned organizations were the Center for Dairy Excellence, Penn State extension and farm credit organizations. However, three of the respondents indicated they were not sure or not aware of organizations that help support growth and competitiveness, which is to some extent a statement about awareness of the activities of the different organizations mentioned.

Which current organizations might be modified (and how) to better support growth and competitiveness? (These can be state-level organizations, industry initiatives, or efforts of private businesses.)

The responses to this question were also quite diverse. There were suggestions to streamline the permitting process, modify the PMMB (but it was not stated how to modify), create better partnerships to enhance promotion and marketing—particularly to communicate to school-aged populations the benefits of dairy products—to foster collaboration among industry organizations for data collection, analysis and development of industry benchmarking tools, and to focus more on small farms. One respondent favored a strategic orientation towards growing the state's industry for major programmatic efforts. Three respondents suggested that a common vision and action plan for the industry's future should be developed (with industry-led efforts the primary driver) and which would be facilitated by additional capacity to assess policies affecting dairy farms.

Table 4.1. Complete Listing of Stakeholder Responses

What do you view as the key drivers of growth and competitiveness for the dairy industry in Pennsylvania?

A more business competitive attitude at the farm level. Do what is best for your (PA Dairy) farm business and let the industry and the markets deal with the over-production issue.

Follow the recommendations of the PA Dairy Industry study. Let's get the cheese processing going to provide an additional market for PA milk.

The regulations and permitting to expand or build new dairy facilities are very burdensome in cost and time.

Our dairy farmers need an attitude which allows them to have a vision for the future.

Having a market for the milk produced in PA

A unique product, marketing approach, market or something to set PA dairy apart and increase the demand for PA dairy

Engaging young producers (return to farm)

Encouraging students to pursue dairy education (new to industry)

Location: being close to major markets

Lack of local processing has hurt the growth and competitiveness.

Disappearance of quality premiums and large quantity bonuses are killing the small farms

More infrastructure to process milk in concentrated areas, like Lancaster county. However, to encourage the industry to locate here we need to be able to provide them milk at a price that competes with other areas of the country.

We also need to stop propping up the price of consumer milk in supermarkets and allow them to run advertising specials for dairy products to boost demand. I question the relevance of the milk marketing board in the current dairy situation.

Increasing fluid milk consumption is the main one. Avoiding onerous regulations from EPA is also important; Pennsylvania's DEP has been much more willing to work with farms.

Proximity to market

Factors that will limit growth:

- Producer Outlook (Lack of producer focus on the business of operating a Dairy)
- Aging infrastructure on farm and off the farm
- Non-farm competition for land (residential, commercial, etc...)
- Available skilled labor for both on farm and processing
- Availability of educational programs (finance, marketing, skilled jobs, etc...)

Access to markets[27] is a key driver for growth and competitiveness of Pennsylvania's dairy industry. Pennsylvania has an advantage in processors being close to the market as well as an *opportunity for producers to provide value-added products* directly to consumers. In the past, our industry may have used these advantages as a crutch, resulting in our producers not making steps forward in other areas as dairy producers have done in other areas of the country.

Pennsylvania dairy producers need to improve p*rofitability (and more specifically, cost of production*) to remain competitive. This is likely a main reason why the industry has grown outside of Pennsylvania, instead of within our state which has other advantages. Our dairy producers need a better *business sense and one that focuses on growth* (can be growth in size or efficiency). Admittedly, the cost structure for PA dairy farms is different than in other areas of the country with higher investments in equipment, land, facilities, etc. *Access to land* is a disadvantage for PA producers because there are simply not the available land resources in large blocks that support large dairy farms. Our farms may need to look at opportunities for *partnership and collaboration* to help overcome some of these challenges in our area. Labor issues must also be considered in growth of farms. Our *labor laws and taxation* need to be advantageous so workers want to come to Pennsylvania dairy farms to work.

There is great opportunity to determine Pennsylvania's niche in the greater dairy industry. Our industry needs to find ways to *increase demand for milk produced in Pennsylvania*. Likely, this will come through adding value to products and/or producing new and innovative products. Our dairy industry will not grow if we do not grow the demand, which could be within Pennsylvania or within markets easily accessible from Pennsylvania.

What data or information not currently available would be helpful to assess current status and future opportunities for the Pennsylvania dairy industry?

Many of our dairy farms do not have good analysis of their profitability nor cost of production. These data help make significant management decisions and highly influence dairy farm business succession to the next generation.

Any new dairy products on the horizon which may provide new market opportunities could provide stimulus to grow the Pennsylvania dairy industry.

Not sure

It would be very interesting to see the spread in prices per cwt between large and small farms.

Lenders are becoming reluctant to support the industry. Any data that would build their confidence would be helpful.

Where are dairy farmers' milk check-off dollars spent? How do we increase transparency of those expenditures? Can we have a third party confirm the claims of huge returns to money spent on advertising?

Do we want to recover some of our lost fluid milk market? If so, how do we focus resources on that recovery? Who is willing to recover the fluid milk market? (I'm not convinced the national

[27] Drivers italicized by study authors for easier recognition.

co-ops or the PA milk marketing board or processors really want to deal with milk.)

No answer

Statewide farm level financial performance data for benchmarking purposes
Statewide data on available processing capacity and market demand
Clearing house for agricultural programs available statewide

A main area where we need more c*omprehensive data is on the financial aspects of Pennsylvania dairy farms*. The data needs to be representative of the entire Pennsylvania dairy industry in order to understand the industry as a whole. The current information provided by AgChoice likely comes with a bit of a bias to the data since it is a small dataset and also only includes farms who took the initiative to sign-up in the benchmark program and work with AgChoice. Additionally, it would be valuable to collect even greater detail on some of the costs on today's farms.

A second main area where more information is needed is *data on consumer wants*. Growth of Pennsylvania's industry is dependent on our ability to provide products that appeal to today's consumers. Wisconsin's industry supported a public-private product innovation and research center that seemed to spark interest and growth in the dairy industry with considerable support from producers. Would there be opportunity for something similar in Pennsylvania? We also need to understand if regional differentiation (PA Preferred dairy products) add value to our products.

After reading the reports, it is also evident that more information needs to be collected on the potential of adding cheese processing plants in Pennsylvania. Consideration needs to be taken on hauling costs and blend prices. Also, we question why State College was identified as a potential location due to limited milk acquisition (maybe better suited in Altoona or Hollidaysburg because of easy access to 'The Cove'?)[28]. Recent dairy processing plants that have been built have been partnerships between producers and processors; this should also be a consideration to the location of the plant.

Which current programs or policies help support growth and competitiveness? (These can be state level programs or policies, industry initiatives, or efforts of private businesses.)

PDA support for centers for excellence

I believe the profit, transition, and other team opportunities supported by the Center for Dairy Excellence provide business resources which our dairy farmers have not had before.

I also think that Pennsylvania has next generation, and dairy youth development programs which encourage careers in agriculture much more than many other states.

PA Preferred, partnerships with food banks

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[28] Author's note: The spatial modeling analysis includes only a limited number of city locations, and is best thought of as indicating general locations for plant facilities, with additional detailed assessment appropriate for specific plant location decisions, undertaken collaboratively. This is consistent with the comment above.

The recent changes to the MPP hopefully will help some. Don't think this is an answer to our industry problems but it's a least an attempt to try.

How can we grow when producers are limited by newly enacted quotas by co-ops with no place to go with the milk?

None that I am aware of

CDE profitability teams

Kerry E. Kaylegian, PSU dairy processing resource- she acts in an extension role for dairy processors in the state-really great resource!

PSU dairy extension webinars and staff available to provide input to producer questions. Much appreciated.

Center for Dairy Excellence (Funding source – Ag Excellence Line, PDA Budget)

Environmental Programs: Resource Enhancement and Protection grant program, State and County Conservations Commissions, Environmental Management Assistance program, Small Business Development Centers of PA

"Grow PA Ag" Industry-organized and lead group focused on growing Pennsylvania Agriculture

Farmland Preservation

Center for Dairy Excellence programs – DDCs, team programs, etc.

Penn State Extension Dairy Team – although see potential modification below

Benchmark programs – Progressive Dairy Benchmark Program

Lending organizations that support growth (Farm Credits, Fulton Bank, some other banks)

Pennsylvania currently has a strong dairy infrastructure in several areas of the state

Which current programs or policies might be modified (and how) to better support growth and competitiveness? (These can be state-level programs or policies, industry initiatives, or efforts of private businesses.)

If milk from PA is more expensive for out-of-state handlers and processors to purchase, then something ought to be done to make PA milk more attractive to those handlers.

Streamline the permitting process for new or remodeling dairy facilities.

Not sure who would oversee, but an easy reference/source for consumers to find where PA products are available (possible addition to PA Preferred?)

We really need to take a look at how we can help our small farms stay in business. Unfortunately, we are headed down the path of the pork and chicken industry that they traveled 30+ years ago.

PA Milk Marketing Board

Is it possible to eliminate the PA Milk Marketing Board? Probably not, since it is entrenched in Harrisburg; however, who can at least get them to eliminate over order pricing and minimum retail pricing?

"The next pound of milk" isn't more profitable if it doesn't have a market. As an industry, we may need to address supply management in order to protect our milk price.

Pennsylvania needs a strategic plan for agriculture and the dairy industry. This would allow all organizations to act with focus for a greater purpose.

State dairy marketing program: We question whether PA Preferred brings value to marketing dairy products or perhaps there is a better marketing approach?

Center for Dairy Excellence programs: These programs need to be modified and expanded to fit larger operations (mostly smaller operations have taken advantage of the programs in the past). Programs need to fit operations who already have some planning/budgeting in place. Programs should also support collaboration and joint venture opportunities. Consistent, assured funding for the Center would also encourage consistency of programs throughout the year and availability year-after-year.

Penn State Extension – Resources should be focused on growing the industry versus maintaining existing clientele.

Environmental programs – We should look at allowing some current programs (EQUIP, Chesapeake Bay grants, etc.) to be used for growth of operations versus maintaining the status quo. While some advancement has already been made in helping with environmental permitting challenges in Pennsylvania, this should be a continued focus to encourage growth in our state. Expanding dairies in neighboring states have 1/3 the cost and 1/10 the time of permitting as Pennsylvania.

Economic development: Consideration should be made to have tax advantages for dairy farms that grow or increase efficiencies (example: Wisconsin's Dairy Investment Tax Credit). Also, a focus should be on working with Team PA for economic development in the dairy processing sector in Pennsylvania.

Wisconsin's industry supported a public-private product innovation and research center that seemed to spark interest and growth in the dairy industry with considerable support from producers. Would there be opportunity for something similar in Pennsylvania?

Which current organizations help support growth and competitiveness? (These can be state level organizations, industry initiatives, or efforts of private businesses.)

The Center for Dairy Excellence - provides direct assistance to help farms understand the point above about needed data. Also provide opportunities for young people with hopes and dreams about being a part of the PA dairy industry.

Penn State Extension Dairy Team - continues to provide educational support to the dairy industry. Knowledge is still power.

The Center for Dairy Excellence

Ag Choice Farm Credit

The Penn State Dairy Extension team
PDMP

Not sure

No answers

Center for Dairy Excellence

None that I am aware of

CDE
PSU dairy extension team (see above)
The PA Milk Marketing Board protects the price that PA producers receive for their milk. It's not a popular organization in times of low milk price, but not all producers understand their function

Professional Dairy Managers of Pennsylvania
Center for Dairy Excellence
Penn State University Extension
University of Pennsylvania School of Veterinary Medicine
Pennsylvania Farm Bureau
Agricultural Lenders (Farm Credit, Regional Banks, Community Banks, etc...)

(Please see our response about the question related to programs and policies above).

Which current organizations might be modified (and how) to better support growth and competitiveness? (These can be state-level organizations, industry initiatives, or efforts of private businesses.)

Nothing to add

The Department of Environmental Protection needs to be much quicker in their permitting of new facility plans.

Strengthen partnerships with child care providers to disseminate education on the benefits of dairy products to parents through the children (programs
Penn State Extension Better Kid Care, Head Start, Penn State -Expanded Food and Nutrition Education Program)
Partner with school athletic programs or club sports for youth to promote dairy to young athletes

I feel like all the effort being put forth is focused at the wrong places. The large farms have no trouble staying in business managed properly. The state level organizations need to focus their attention on the small family farms instead of the large operations.

PA Milk Marketing Board

See the items under "programs".

Also, how do we get our message out to Congress? to the National Academies of Science and of Medicine (who provide our nutrition recommendations for cows and who apparently really dislike milk fat in fluid milk)?

How do we make 2% and whole milk desirable again?

Who is our main focus? Is anybody spending time or money determining that? (We spend money on research but have failed to do a good job of getting that data to people who appreciate it)

PA Farm Bureau should add Economic Analysis to their policy development process. It's not helpful to have farmers in opposition of each other in the policy arena- particularly when their policies aren't required to consider economic consequences.

Roles for new or existing organizations in the future:

- Collaboration with promotion and marketing campaigns
- Collaboration with data collection, analysis and development of industry benchmarking tools
- Collaboration with government entities:PA Department of Agriculture and PA Department of Economic and Community Development

Utilize the results of this study to develop and implement a common vision and plan with action steps

Industry growth needs to be driven by the industry not government

The entire agriculture (and dairy) industry must have a common vision (strategic plan) and voice. This will guide our industry moving forward as well as assist in influencing legislators on issues important to agriculture/dairy.

State Agencies (PA Department of Agriculture, DCED): state agencies need to have more of an industry growth role which can affect both dairy processing and dairy farms. The potential of having a funded position within Team PA to assist in these opportunities, particularly with dairy processing, will be a benefit.

PSU Extension, Center for Dairy Excellence and other industry organizations: All need to work together to support the industry. The Center’s main niche has been providing on-farm team resources to dairy farms. For Extension, perhaps there could be a focus on helping farms better manage those teams?

Themes in Stakeholder Listening Sessions

At listening sessions held in Lebanon, PA and Indiana, PA during Fall 2017, a variety of comments were received. These comments focused on diverse issues, but it was possible to put most of them into a smaller subset of categories as a way of summarizing this information. This does not directly indicate which themes are considered the most relevant or important by different industry stakeholders, but it suggests a set of issues that future actions might need or want to address. The theme areas mentioned in the meetings are:

- Regulations for permitting new dairy facilities (the complexity and length of the process) and its potential impacts on competitiveness of Pennsylvania dairy farms;
- Market outlets for farm milk and dairy products (including inter-regional movements of farm milk (to and from the Northeast), restricted access to markets for some producers, declining sales of fluid milk products, the role and effectiveness of promotion in expanding demand for dairy products, potential in export markets, the need for (or role of) additional processing capacity and seasonal balancing);
- The need to educate consumers about the benefits and healthfulness of milk, including removal of limits on school servings of milk;
- The role of cooperatives in facilitating growth and competitiveness in the region, managing milk supplies and related membership policies;
- The current and future structure of dairy farming in Pennsylvania (including proportion of milk coming from smaller herds and plain sect farms, costs of servicing and milk hauling) and how this will affect growth and competitiveness;
- The role of the Pennsylvania Milk Marketing Board, including its activities (should it regulate less and promote more?) costs and benefits;
- The need to define criteria for success for the industry (for example, growth in milk production versus a balanced milk supply, profitability of farms and processing facilities);
- Differences in production systems, producer outlooks, market opportunities and future growth potential for different regions of Pennsylvania;
- The need for the key players in the industry (from input suppliers, farms, processors, buyers to consumers) to communicate to increase understanding, define desirable and achievable goals and to work together to improve outcomes.

These are commonly-expressed themes, and some but not all of them were addressed by research undertaken for other study components (such as market outlets, processing capacity, export market potential, farm structure and performance, and price regulation under the Pennsylvania Milk Marketing Board). It is also common for discussions such as these to focus on factors external to management of individual farms or processing businesses. However, the themes and tone of the discussions seem to suggest a high degree of what is sometimes termed a "external locus of control"—success or failure of a business is attributed to factors beyond the control of the manager[29], rather than being determined by the managers' actions.

[29] People who base their success on their own work and believe they control their life have an **internal locus of control**. In contrast, people who attribute their success or failure to outside influences have an **external locus of control**. Source: https://study.com/academy/lesson/locus-of-control-definition-and-examples-of-internal-and-external.html.

For example, there was no mention of how the state might support improved decision making by managers of farm or processing businesses, although this is a focal point for efforts by CDE and PSU Extension. A number of stakeholder respondents, as indicated above, suggested that it would be useful to work towards modifying the mindset of managers to avoid a “Lack of producer focus on the business of operating a dairy.” This is not to say that these themes are unimportant to farm or processing business performance and should not be addressed by the state when possible and appropriate, but we believe that many would be difficult to substantively modify through state programs or policies.

Comparative Organizational Support in Key Dairy States

As noted in the stakeholder comments discussed above, many organizations provide support that is essential for the success of farm and processing businesses in Pennsylvania. A somewhat selective listing of these organizations identifies them as state-related, business and(or) advisory entities, and professional membership associations. In general, these types of organizations support dairy industry operations through the U.S. and internationally. It is beyond the scope of this study to undertake a detailed assessment of the role of these organizations and their efficacy related to their stated goals. However, it is useful to compare the listing of organizations in Pennsylvania to those in other states. The summary below is intended to provide a brief introduction to the differences in the landscape of organizational support for dairy. We would encourage additional exploration of the roles and effectiveness of selected programs and organizations in other states to assess their applicability in Pennsylvania.

We note that although the basic nature of the supporting organizations has some overlap among the three states, there are programs in New York and Wisconsin that do not seem to be present in Pennsylvania[30]. In New York, there appear to be more programs associated with environmental management, farmland preservation and energy (Table 2). The Dairy Acceleration Program, Excelsior Jobs Program, Linked Deposit Program, FarmNet, Flex Tech Review and Farm Viability Institute appear to have no direct counterparts in Pennsylvania.

Wisconsin organizations and programs include many that are similar to those in Pennsylvania (Table 3). Although the Center for Dairy Profitability and the Center for Dairy Research have some overlap with the responsibilities of the Center for Dairy Excellence and PSU Extension, these Wisconsin counterparts have a larger amount of resources and collaborate more closely with each other and with the Wisconsin Milk Marketing Board (WMMB). Despite the similarity of both having “Milk Marketing Board” in their names, the PMMB and WMMB have very different responsibilities. The WMMB is a producer-funded promotion organization and has no regulatory authority over milk pricing. Although a number of dairy processors operating in Pennsylvania are members of the Northeast Dairy Foods Association, the importance of cheese to Wisconsin’s dairy industry has resulted in the presence of both the Wisconsin Cheese Makers Association and the Wisconsin Dairy Products Association to represent and educate members.

[30] It is also worth noting that the information from New York and Wisconsin was easily available online in summary form. If this is not already the case for Pennsylvania, this would be recommended.

Table 4.2. Institutions and Organizations Supporting the Pennsylvania Dairy Industry[31]

State Related

- Center for Dairy Excellence
- Penn State Extension Dairy Team
- Penn State Food Science Processing Extension
- University of Pennsylvania New Bolton Center

Industry and Advising

- Pennsylvania Farm Bureau and the MSC Business Services
- Dairy One DHIA and Lancaster DHIA
- AgChoice Farm Credit
- MidAtlantic Farm Credit
- Private Banking Institutions (Fulton Bank, Univest, BBT, Mid-Penn, First Citizens Bank and other smaller ones)
- Feed Companies (Cargill, Land O'Lakes Purina, Hoober Feeds, etc.)
- Independent Nutritionist Groups
- Veterinary Clinics
- Milk Cooperatives (Land O'Lakes, Dairy Farmers of America, Maryland & Virginia, Lanco Pennland, Upstate Niagara, Organic Valley)
- Processors with independent producers (Schneiders, Turners, Harrisburg Dairies, Rutter's Dairy and others)
- Acuity Advisors
- Herebin & Associates
- Simon Lever
- Bruce Dehm and Associates
- Dairy Enterpriser Services

Industry Association

- Professional Dairy Managers of Pennsylvania
- Pennsylvania Holstein Association
- Pennsylvania Dairymen's Association

[31] This listing is designed to be representative, rather than all-inclusive, and was compiled by the study authors with the assistance of staff of the Center for Dairy Excellence.

Table 4.3. Contents of Brochure Summarizing State Government Support for New York’s Dairy Industry

NEW YORK STATE OF OPPORTUNITY. Agriculture and Markets

	State Agency	Ag Specific?	Type of Assistance	Competitive	% Cost Supported	Funding Limits	Availability
Agriculture Environmental Management Addresses environmental issues on farms, using progressive tiered planning and a strategic implementation approach, while maintaining economic viability of farms. http://www.agriculture.ny.gov/index.html	NYS Dept. of Ag & Markets	Yes	Technical Assistance	No, Open to All	N/A	N/A	Continuous, through County Soil & Water Conservation Districts
Agriculture Nonpoint Source Abatement & Control Program Helps prevent water pollution agricultural activities through planning and implementation grants to construct or apply on-farm best management practices. http://www.agriculture.ny.gov/index.html	NYS Dept. Ag & Markets	Yes	Grants in conjunction with AEM	Yes	Up to 87.5%	No Limits	Annually, through County Soil and Water Conservation Districts
Cattle Health Assurance Program Assists dairy and beef producers in implementing best management practices on the farm to increase profitability and productivity by addressing cattle health, comfort and welfare. http://www.agriculture.ny.gov/index.html	NYS Dept. Ag & Markets	No	Technical Assistance	No, Open to All	N/A	N/A	Continuous
Dairy Acceleration Program Provides funding to assist New York dairy farmers to address specific business needs necessary for expansion and growth. http://www.agriculture.ny.gov/index.html	NYS Dept. Ag & Markets	Yes	Grants	No	80%	$5,000	Continuous, through Cornell Cooperative Extension
Excelsior Jobs Program Provides tax credits for businesses that create jobs or make significant capital investments. Agricultural firms must create at least 10 new jobs; manufacturing firms must create at least 25. http://esd.ny.gov/BusinessPrograms/Excelsior.html	ESD	No	Tax Credits			N/A	Continuous

NEW YORK STATE OF OPPORTUNITY. | Agriculture and Markets

	State Agency	Ag Specific?	Type of Assistance	Competitive	% Cost Supported	Funding Limits	Availability
Farmland Protection Implementation Grants Assists municipalities, land trust and local conservation districts in purchasing the development rights on viable agricultural lands that are facing significant developme pressure and that serve as buffers to significant natural public resources. http://www.agriculture.ny.gov/index. html	NYS Dept. Ag & Markets	Yes	Grants	Yes	Up to 87.5%	No Limits	As funding is available.
Farmland Protection Planning Grants Supports municipalities, land trust and local conservation districts that develop agricultural and farmland protection plans http://www.agriculture.ny.gov/index.html	NYS Dept. Ag & Markets	No	Grants	No	Town 75% Counties 50%	Towns $25,000 Counties $50,000	Continuous
FlexTech Review Funding for energy audits for farms and food processors. http://www.nyserda.ny.gov/	NYSERDA	No	Grants	No, First come first served	Farms 100% Food Processors 50%	Maximum $2,500	Until funds expended
Linked Deposit Program Provides existing businesses with bank loans at reduced interest rates (2-3 percentage points) to improve market access, product development, modernize equipment, expand production, introduce new technologies; transition ownership, or create/retain jobs. http://www.esd.ny.gov/BusinessPrograms/LinkedDeposit.html	ESD		Bank loans at lower interest rates			Maximum $2,000.000 loan Maximum lifetime assistance $2 million	Continuous

NEW YORK STATE OF OPPORTUNITY. Agriculture and Markets

	State Agency	Ag Specific?	Type of Assistance	Competitive	% Cost Supported	Funding Limits	Availability
Cornell Pro-Dairy Program For 23 years Pro-Dairy has linked New York's dairy farmers and agribusiness professionals to critical research and resources, giving them the information needed to build and manage robust businesses. Pro-Dairy's contributions to educational programming and applied research have helped New York to continue to grow its milk production and remain among the top dairy states in the United States. http://prodairy.cals.cornell.edu/		Yes	Technical Assistance				
Cornell Cooperative Extension The Cornell Cooperative Extension Education System extends Cornell University's land-grant programs to citizens all across New York State. With a presence in every county and New York City, CCE puts research into practice by providing high value educational programs and university-backed resources that help solve real-life problems, transforming and improving New York families, farms, businesses and communities. http://www.cce.cornell.edu/Pages/Default.aspx		No	Technical Assistance				
Farm Net Provides farmers and their families with a network of contacts and support services to help them develop skills for dealing with life challenges and transitions, through personalized education, confidential consulting and referrals. http://nyfarmnet.org/farmlink/new-york-farmlink		Yes	Technical Assistance				
NY Farm Viability Institute Provides funding for agricultural research and education projects to help farmers become more profitable and improve the long-term economic viability and sustainability of New York farms. http://www.nyfvi.org/		Yes	Grants	Yes	N/A	No	As funding is available

	State Agency	Ag Specific?	Type of Assistance	Competitive	% Cost Supported	Funding Limits	Availability
New York Power Authority Recharge New York Through the state-wide CFA process, entities are eligible for power that has not yet been allocated through the Recharge NY program. http://www.nypa.gov/		No	Low cost power contract	Yes	N/A	Up to 50% of the demand of the customer	As power is available
New York Power Authority Expansion & Replacement Power, Preservation Power Entities that are within the 30-mile radius of NYPA's Niagara facility (**NIAGARA HYDROPOWER**) and those in the three counties (Jefferson, Franklin, St. Lawrence) **ST. LAWRENCE-FDR HYDROPOWER** around the St. Lawrence facility are eligible for low cost electric power. https://www.nypa.gov/services/economicdev/economic.htm		No	Low cost power contract	Yes	N/A	Up to 100% of the demand of the customer	As power is available
Tractor Rollover Program Provides funding to assist farmers to purchase and install rollover protective structures. https://www.nycamhoutreach.com/ropsr4u/ny/		Yes	Grants	No, First come First served	N/A	Maximum $500	As funding is available

Table 4.4 Agricultural Organizations Supporting Dairy in Wisconsin

Wisconsin agricultural organizations listed here also offer resources for dairy producers and processors.

Cooperative Network

Cooperative Network is committed to building Wisconsin's and Minnesota's cooperative businesses. Cooperative Network provides government relations, education, marketing, and technical services for a wide variety of cooperatives including farm supply, health, dairy marketing, consumer, financial, livestock marketing, telecommunications, electric, housing, insurance, worker-owned cooperatives, and more.

Dairy Business Association

DBA is an industry organization comprised of dairy producers, corporate and allied industry supporters. DBA promotes the growth and success of all dairy farms in Wisconsin by fostering a positive business and political environment.

Grassworks, Inc.

GrassWorks provides leadership, education and resources for grass-based farmers and regional organizations that support graziers. Grassworks increases awareness of the benefits of managed grazing among farmers, policy makers and the general public.

Professional Dairy Producers of Wisconsin

PDPW offers education and information valuable to dairy operations. PDPW connects you with helpful resources including other dairy producers, industry leaders and experts, world-class scientists and researchers, and preferred suppliers.

UW-Extension

The University of Wisconsin-Extension works in partnership with 26 UW System campuses, 72 Wisconsin counties, three tribal governments, and other public and private organizations to fulfill its public service mission. Through statewide outreach networks, UW-Extension connects university research to the specific needs and interests of residents and communities.

Wisconsin Center for Dairy Profitability

The University of Wisconsin Center for Dairy Profitability develops and delivers effective interdisciplinary education and applied research to dairy farms and dairy industry service providers resulting in sustainable profitable decisions, and a healthy and progressive dairy industry.

Wisconsin Center for Dairy Research

CDR's vision is to enhance the competitive position of the dairy industry. CDR will be the leader in innovative strategic dairy foods research, technology and applications development, training, and education.

Wisconsin Cheese Makers Association

Wisconsin Cheese Makers Association gives voice to Wisconsin dairy processors on national and state issues that impact our businesses. WCMA is advocate for fair and reasonable regulation and legislation, offers communication about the industry, and provides educational workshops, seminars and special services to member businesses.

Wisconsin Dairy Products Association

Wisconsin Dairy Products Association represents all segments of the dairy industry and offers educational opportunities for its members to improve their business operations. WDPA's primary goal is to represent its members in the formation and adoption of rules and regulations pertaining to the dairy products industry.

Wisconsin Farm Bureau Federation

The Wisconsin Farm Bureau Federation is the state's largest general farm organization representing farms of all sizes, commodities and management styles. The mission of Farm Bureau is to lead the farm and rural community through legislative representation, education, public relations and leadership development.

Wisconsin Farmers Union

Wisconsin Farmers Union is committed to enhancing the quality of life for family farmers, rural communities and all people through educational opportunities, cooperative endeavors and civic engagement.

Wisconsin Milk Marketing Board

The Wisconsin Milk Marketing Board (WMMB) is a nonprofit organization funded by Wisconsin dairy farmers. WMMB promotes the sale and consumption of the more than 600 varieties, types and styles of Wisconsin Cheese and other dairy products from America's Dairyland.

Wisconsin National Farmers Organization

National Farmers offers commodity marketing and ag risk management programs and services. National Farmers works to put profit in American farm enterprises.

Figure 4.1. Examples of Support Programs from Wisconsin

Today, Wisconsin is home to more than one million dairy cows and a growing segment of goats and sheep. Dairy production is by far the largest agricultural sector in the state, generating $43.4 billion annually for Wisconsin's economy. There's no other land where the dairy industry is more vital, supported and understood.

The **Wisconsin Farm Center**, part of the Department of Agriculture, Trade and Consumer Protection's Division of Agricultural Development, provides assistance to dairy farmers, without regard to size or type, focusing on creating long-term, sustainable operations. The Center, with its staff of professionals who come from diverse agricultural backgrounds, can provide dairy farmers and family members a wide range of information and outreach services. The center also serves as a resource to connect farmers with many state, university and federal programs. The staff and trained volunteers provide guidance and assistance to help people find the services and information they need.

Call DATCP's Grow Wisconsin Dairy Team toll free at (855) WIDAIRY [(855) 943-2479] or email GrowWisconsinDairy@wi.gov.

The Wisconsin Farm Center, part of DATCP's Division of Agricultural Development, provides assistance.

New: DATCP is accepting applications for Dairy Processor Grants through April 13, 2018. Click on the links for an application or for Requests for Proposals information.

Application

RFP information

DATCP Dairy Processor Grants

Request For Proposals (RFP)

Applications Due: Friday, April 13, 2018

INTRODUCTION

The Dairy Processor Grant strives to improve the long-term viability of Wisconsin's dairy industry through services to dairy processing plants. DATCP's Dairy Processor Grant is available to processors to facilitate operational changes, improve profitability and foster innovation and economic growth.

AVAILABLE FUNDS

Funds will be distributed through a competitive review process. Grants will be awarded for projects up to **$50,000** and up to two years in duration.

APPLICATION AND FUNDING TIMING

RFP is released	March 1, 2018
Applications due to WI DATCP	April 13, 2018
Applications scored and selected by review committee	May 1, 2018
Selected applications notified by WI DATCP	May, 2017
Approval Letters Issued by WI DATCP	May, 2017
Anticipated project start date	June 1, 2017
All projects must conclude no later than	June 30, 2019

ELIGIBLE PARTICIPANTS

Applicants must satisfy the following criteria to be deemed eligible for funding under the Dairy Processor Grant Program. An applicant must:

- Operate a licensed dairy processing plant engaged in pasteurizing, processing or manufacturing milk or dairy products that is located in WI
- Have a project(s) that will make operational improvements, improve profitability, and/or involve a new process or innovation
- Have no outstanding state penalties or violations and be in good standing with Wisconsin Department of Financial Institutions
- Employees of Wisconsin DATCP and immediate family members (i.e. mother, father, brother, sister, spouse, and children) are not eligible to receive a grant

ELIGIBLE PROJECTS

The Grow Wisconsin Dairy Processor Grant is designed to provide access to services and resources for proposed dairy processing plant projects that enhance or develop the current business, solve an existing problem or concern at the plant, improve production or profitability, and/or help the processor innovate. Focal areas for the grant are highlighted below. Projects could include multiple aspects from the following areas.

- Dairy plant modernization and expansion efforts to provide assistance with professional services costs related to: siting, engineering, design, layout of new facilities or production lines.
- Food safety: consulting services to help pass a food safety audit or certificate needed to meet a customer driven market requirement.
- Training of plant staff on food safety requirements, new technology, etc.
- Assistance for related professional services and consultants: developing new processes, wastewater treatment or handling, new uses for whey, or other innovations.

- Efforts to improve/enhance staff retention, training, and knowledge
- Other dairy processing projects may be considered.

Chapter 5: An Assessment of the Economic Impacts of the Pennsylvania Dairy Industry

Steven Deller, Mark Stephenson and Chuck Nicholson[32]

Executive Summary

To assess the contribution of dairy to the Pennsylvania state economy we use input-output analysis to construct a set of economic multipliers custom to the Pennsylvania economy and six sub-regions. To undertake this analysis, we use the economic modeling system IMPLAN and the base year data for 2015.

The key findings are:

- The state's dairy industry is a major contributor to overall economic activity, generating an estimated 52,000 jobs and $14.7 billion in economic activity in 2015;
- The Southeast, South-Central and Western regions contribute about 80% of total employment and income generated by the state's dairy industry;
- The Southeastern region contributes nearly half of the Labor Income (wages, salaries and proprietor income), in part reflecting the nature of farming operations in that part of the state;
- Both the farm and processing sectors are important contributors to employment and income. with farms contributing about 46% of dairy-industry employment and 36% of the total economic activity generated by the Pennsylvania dairy industry.
- Economic multiplier values for dairy farm activity range from near 2 to 3, which means that in addition to direct economic activity, dairy farms generate substantial additional jobs and income. Multiplier values are larger for dairy processing activity, ranging from near 2 to more than 5;
- Economic multiplier values vary by region, with larger impacts on the state's economy in areas that have a larger concentration of the state's dairy activity, such as the Southeast, South-Central and Western regions.

Overview and Study Objectives

To assess the contribution of dairy to the Pennsylvania state economy we use input-output analysis to construct a set of economic multipliers custom to the Pennsylvania economy and six sub-regions. To undertake this analysis, we use the economic modeling system IMPLAN and the base year data for 2015.

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[32] The authors are, respectively, Professor, Department of Agricultural and Applied Economics, Director of Dairy Policy Analysis, University of Wisconsin, Madison, and Adjunct Associate Professor, Cornell University.

Review of Methods and Definitions of Terms

As discussed in more detail in Appendix A, input-output analysis is based on a series of accounting relationships among the different sectors of an economy. The analysis provides an assessment of the current importance of an industry by indicators typically measured in dollar terms (for example, wages paid by dairy farms) or employment. However, it also provides a means to assess how *changes* in activity (measured in dollar terms or jobs) in one part of the economy resonate through a region's economy. For example, the expansion of dairy farms in a local economy[33] introduces new or additional levels of spending in that local economy. This new spending causes a ripple, or multiplier effect, throughout the overall economy, for reasons described more fully below. Using input-output analysis, we can measure the size and nature of this ripple effect to determine impacts on specific parts of the economy as well as the overall effect.

To continue with the dairy farms example, the economic impact of changes in activity by dairy farms is composed of three parts: the *direct*, *indirect,* and *induced* effects. The *direct* or *initial* effect captures the event that caused the initial change in the economy: for example, a new dairy farm beginning its operations or an expansion of an existing dairy operation would result in an initial, direct change in economic activity. The dairy farm contributes directly to the local economy by selling farm products, paying employees' wages and salaries (generating income) and proprietor income to the farmer. This additional dairy farm activity typically would result in higher levels for two types of expenditures, which result in indirect and induced impacts (multipliers). The first type, indirect effects, arises from business-to-business transactions, such as the purchase of feed from other farms or feed suppliers, fertilizer, seed and chemicals, veterinary services, trucking services to haul milk and livestock, electric and other utilities, insurance, interest and other financial services, land rent, farm and equipment repairs and maintenance, and many others. These business-to-business transactions represent *indirect* effects. In this situation, the purchase of feed by a dairy farmer results in income to a grain farmer, which allows the grain farm to pay farm operating expenses, make investments, or buy new equipment.

The second type of expenditure dairy farms introduce into the local economy are wages and salaries paid to employees as well as to the farmer themselves. When this income is spent in the local economy, it results in the *induced* effect. Dairy farmers and their employees spend their income at local grocery stores, movie theaters, restaurants and other retail outlets. The theater owner, then, could use part of the money spent on tickets by dairy farmers to pay theater employees, who then continue the cycle through their own expenditures on goods and services.

The combination of the *direct*, *indirect* and *induced* indicates the complete impact or contribution of any particular industry has on the whole of the economy. By looking at the *indirect* and *induced* impacts, we can gain insights into how the industry of interest is connected or linked into the local economy. For example, industries that tend to be labor intensive and offer high

[33] The "local economy" is defined based on the purpose of the analysis, but "local" could be defined as counties, multi-county regions in a state, or the entire state. Transactions between businesses that are both located in the region are considered "local", whereas transactions between businesses in different regions are not considered "local". "Local" transactions are directly linked to the multiplier effects described subsequently.

wages tend to have larger *induced* effects on the local economy. Industries that are more capital intensive or offer lower wages tend to have larger *indirect* effects. We can also gain additional insights into the make-up of the local economy by examining the relative size of the multiplier effects. Smaller economies tend to have smaller multiplier or ripple effects than larger economies. This is because the "leakages" out of the local economy (e.g., spending on goods and services outside the local economy) occurs faster in smaller economies. Larger economies have greater opportunities to keep those dollars within the local economy for a longer period of time, hence larger multiplier effects. Some smaller, more rural communities that have pursued tourism development have used multiplier analysis to better understand that simply bringing more tourists to the community is not sufficient: there must be opportunities for those tourists to spend their money in the local area and to source the goods and services for tourism from the local economy.

In this study, we report four measures of economic activity: employment, labor income, total income, and industrial revenues (sales). *Employment* here is simply the total number jobs and is *not* a full-time equivalent. For example, two part-time jobs created in the any sector is considered two jobs while one full-time job in any sector is considered one job. *Labor income* is the return to labor and includes wages, salaries and proprietor income. In the overall economy, most labor income comes in the form of wages and salaries, but in agriculture, many farmers take income in the form of proprietor income. This proprietor income is the farmer's return on their labor input into the farm. *Total income* includes labor income and other sources of income such as dividends, interest and rental payments as well as transfer payments such as social security payments. *Industry sales* or revenues are simply total revenues flowing to an industry.

These components of economic activity can be illustrated with a simple example. Consider a dairy farmer that has $1 million in revenues and two hired workers who are each paid $25,000. The farmer has structured the business to draw a $50,000 salary, but suppose in a given year the farm earns a $10,000 profit that the farmer takes as proprietor income. In this example, industry sales/revenue is $1 million, employment is three (two workers plus the farmer) and labor income is $110,000 (50,000 + 25,000 + 25,000 + 10,000). Now suppose that this farmer has crop acreage that is rented to a neighboring farmer for which the farmer receives $5,000 in rental income. The total income would thus be $115,000.

Structure of this Study

To better understand the effects of the dairy industry in different parts of the state, we have delineated six multi-country groupings (Table 5.1, Figure 5.1), in addition to assessing the impact statewide. These regions were selected to represent differences in topography, climate, other geographical characteristics and road access. This analysis uses input-output analysis to construct a set of economic multipliers custom to the Pennsylvania economy and six sub-regions. To undertake this analysis, we use the economic modeling system IMPLAN (http://www.implan.com) and data for 2015[34]. The analysis separates the impact of dairy farm

[34] As noted in the Phase I report for the Study to Support Growth and Competitiveness of the Pennsylvania Dairy Industry, a similar type of analysis of dairy processing (but not farm-level) impacts was sponsored by IDFA using data for 2014, with results reported by Congressional District rather than economic production regions.

and dairy processor economic activity (and does not include the impact of post-processing activities such as food retailing and food service).

Table 5.1 Multiple-County Regions for Economic Multiplier Impact Analysis

Eastern	Southeast	South Central	Central	Western	Northern Tier
Carbon	Berks	Adams	Bedford	Allegheny	Bradford
Columbia	Bucks	Cumberland	Blair	Armstrong	Elk
Lackawanna	Chester	Dauphin	Cambria	Beaver	Forest
Luzerne	Delaware	Franklin	Cameron	Butler	Lycoming
Monroe	Lancaster	Perry	Centre	Clarion	McKean
Montour	Lebanon	York	Clearfield	Crawford	Potter
Northumber-land	Lehigh	Fulton	Clinton	Erie	Sullivan
Pike	Montgomery	Juniata	Jefferson	Fayette	Susquehanna
Schuylkill	Northampton	Mifflin	Huntington	Greene	Tioga
Wayne	Philadelphia		Indiana	Lawrence	Warren
			Somerset	Mercer	Wyoming
			Snyder	Venango	
			Union	Washington	
				Westmoreland	

Note: These groupings were developed with the assistance of Alan Zepp of the Center for Dairy Excellence

Results of the Impact Analysis

The analysis confirms the importance of the Pennsylvania dairy industry to the state's economy, with a total employment of more than 52,000 jobs and economic activity valued at nearly $14.7 billion in 2015 (Table 5.2). About 40% of the employment and economic activity occur in the Southeastern part of the state, with the South-Central and Western regions comprising and additional 40%. Thus, these three regions of the state contribute about 80% of the employment and economic activity attributed to dairying. However, the share of labor income (wages, salaries and proprietor income) is even larger in the Southeastern region (45%), which likely reflects the structure of farms in the southeastern part of the state.

The analysis indicates that the farm-level contribution comprises about 25,000 jobs and $5.3 billion in total economic activity (Table 5.3), whereas post-farm dairy-processing activities account for 28,000 jobs and $9.4 billion in economic activity. These results underscore the importance of both farm and post-farm businesses to the state's economy. (Detailed results by region are presented in Tables 5.5 through 5.10.)

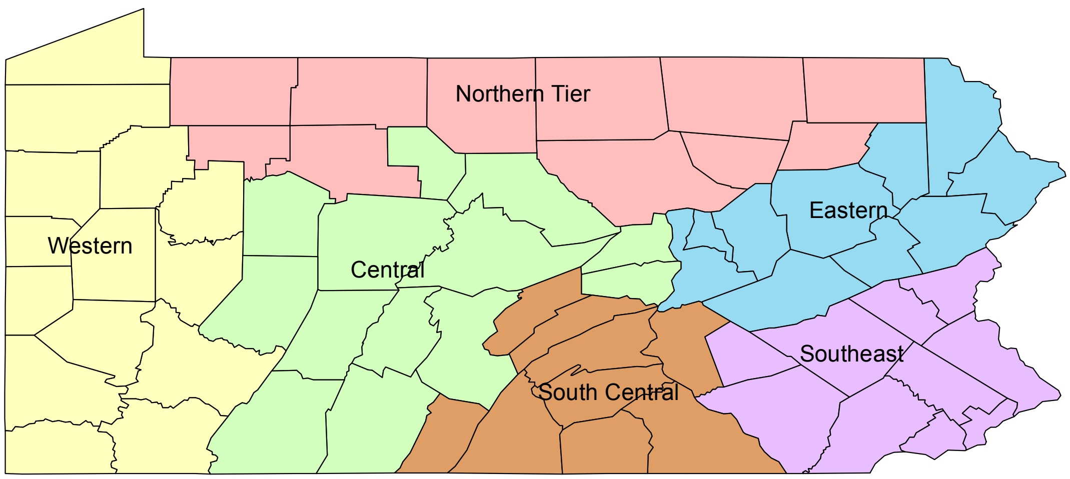

Figure 5.1. Multiple-County Regions for Economic Multiplier Impact Analysis

Table 5.2. Summary of Total Economic Impacts (Direct, Indirect and Induced) of Dairy Farming and Processing in Pennsylvania, By State Region

Region	Employment	Labor Income ($ mil)	Total Income ($ mil)	Total Industrial Sales ($ mil)
Eastern	2,298	117	188	581
Southeast	20,161	1,563	2,382	5,782
South Central	10,640	658	970	2,909
Central	6,422	366	551	1,521
Western	10,726	548	906	2,666
Northern Tier	2,509	123	212	728
Total	52,573	3,487	5,446	14,650

Table 5.3. Direct, Indirect and Induced Effects of Dairy Farm and Dairy Processing Activity in Pennsylvania, 2015

State (Penn)	Direct	Indirect	Induced	Total	Multiplier
All Dairy					
Employment	14,324	21,609	16,641	52,573	3.67
Labor Income (MM$)	1,222.4	1,422.9	841.3	3,486.5	2.85
Total Income (MM$)	1,820.1	2,213.4	1,412.6	5,446.1	2.99
Total Industrial Sales (MM$)	7,941.6	4,296.9	2,411.6	14,650.1	1.84
Dairy Farm					
Employment	9,109	7,637	7,540	24,286	2.67
Labor Income (MM$)	856.0	371.1	380.4	1,607.6	1.88
Total Income (MM$)	1,225.8	613.4	639.3	2,478.4	2.02
Total Industrial Sales (MM$)	2,780.5	1,394.7	1,092.2	5,267.4	1.89
Dairy Processing					
Employment	5,215	13,971	9,101	28,287	5.42
Labor Income (MM$)	366.4	1,051.8	460.8	1,879.0	5.13
Total Income (MM$)	594.3	1,600.0	773.3	2,967.7	4.99
Total Industrial Sales (MM$)	5,161.1	2,902.2	1,319.3	9,382.6	1.82

Note: The reported values are those for all Pennsylvania counties.

Note: Industry sales indicates total revenues, not margins or profitability because costs are not accounted for. Higher revenues for dairy processing than dairy farms do not directly account for payments to farmers (which are represented by the "Industry sales" at the farm level). In general, the value of sales increases as a product moves through the supply chain, representing value addition to farm milk.

As noted earlier, an input-output analysis indicates the current importance of the Pennsylvania dairy industry, but also suggests the effects of additional investment in the industry through the multiplier values. The multipliers approximate the additional indirect and induced effects on key outcomes that result from an initial change in that outcome (the direct effect). For example, for the industry as a whole, the creation of 1 job on a Pennsylvania dairy farm will result in the creation of 2.67 additional jobs due to the indirect and induced effects described above[35]. Similar interpretations apply to labor income, total income and total sales. An additional $1 of labor income on a dairy farm will generate an additional $1.88 of labor income in the Pennsylvania economy, whereas an increase of $1 in total income on a dairy farm will generate and additional $2.02 of total income in Pennsylvania. The total value of sales in the Pennsylvania economy will be increased by $1.89 for every $1 increase in the value of sales by dairy farms. One implication of this set of values is that in profitable years with high profitability, labor income, total income and total sales will be high, with a correspondingly larger contribution

[35] The Appendix notes that this is a somewhat simplistic interpretation of multiplier values, and a more complete analysis would need to include a restructuring of the basic transactions throughout the economy. However, for our purposes, this simplistic interpretation is useful as long as the limitations are noted.

to the Pennsylvania economy. During low-profitability times in the dairy price cycle, the impact of a reduction in labor income, total income and sales will be associated with a reduction in the contribution of the dairy industry to the state's economy. Thus, low-profitability years negatively affect not only dairy farmers and processors, but the state's broader economy.

Results by Region

As noted above, the largest contributions to the Pennsylvania economy by the dairy industry originate in the Southeast, South Central and Western regions (Table 5.4)[36]. These three regions account for about three-quarters of the direct employment, total income and total value of sales for the state. The economic impact of processing is somewhat more concentrated than that for farms, because more than 80% of employment, total income and sales arise in these three regions. (Additional details about the six regions are shown in Tables 5.5 to 5.10.)

Table 5.4. Direct Effects of Employment, Total Income and Total Sales, by Pennsylvania Region

Outcome, Industry Segment	East	South-east	South-Central	Central	Western	Northern Tier
Employment, jobs						
Farm	371	2,777	2,153	1,750	2,378	784
Processing	280	1,788	1,193	463	1,201	290
All Dairy	651	4,565	3,346	2,213	3,570	1,074
Total Income, $mil						
Farm	39.4	446.6	284.9	247.5	209.0	92.5
Processing	27.4	221.7	138.3	45.5	128.3	33.0
All Dairy	66.8	668.3	423.3	293.0	337.4	125.6
Total Sales, $mil						
Farm	89.3	1,013.1	646.3	561.4	474.2	209.9
Processing	250.0	1,811.0	1,211.2	415.0	1,141.3	332.5
All Dairy	339.4	2,824.1	1,857.5	976.4	1,615.5	542.4

Consistent with the idea that multiplier values tend to be larger for areas with larger economic activity, the multiplier values generally are larger for those regions of the state with greater economic activity in dairy, such as the Southeast, South-Central and Western regions (Figure 5.2). It is also the case the multiplier values tend to be larger for dairy processing than for dairy farms, consistent with the larger contribution to total sales in Pennsylvania's economy from dairy processing for outcomes other than employment.

[36] Thjs does not suggest that other parts of the state are not important contributors to economic outcomes. However, it is relevant to understand the differences by region.

Figure 5.2 Overall (Farm and Processing) Economic Multiplier Values for Pennsylvania Regions, by Multiplier Type

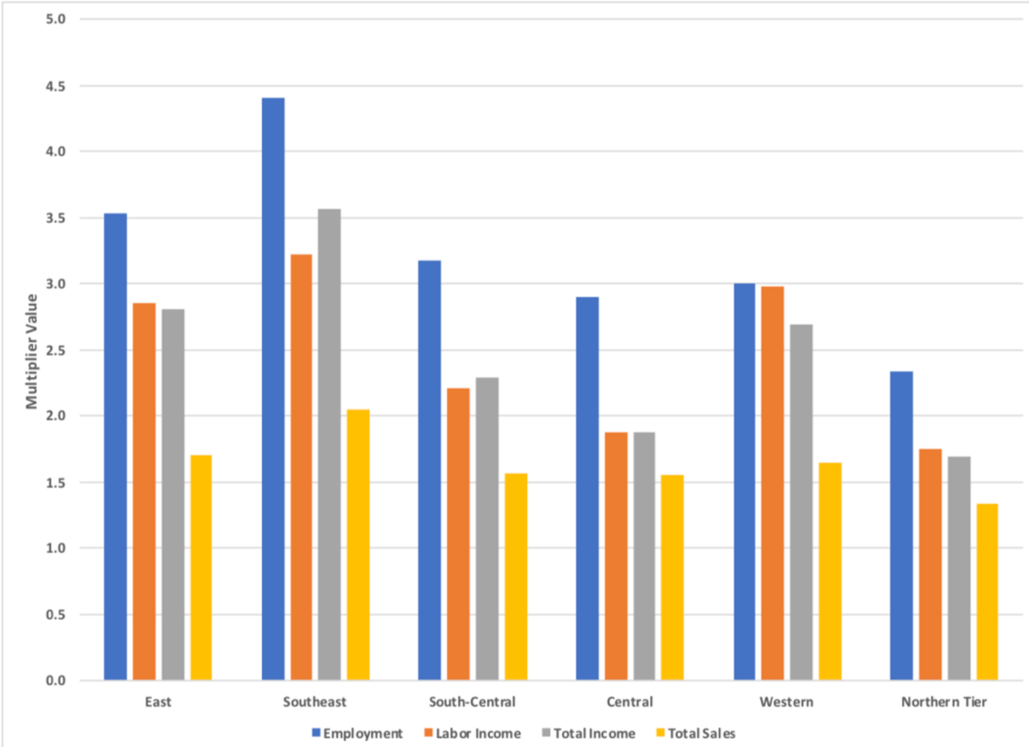

Table 5.5. Direct, Indirect and Induced Effects of Dairy Farm and Dairy Processing Activity in the Eastern Region Pennsylvania, 2015

Eastern Penn Region	Direct	Indirect	Induced	Total	Multiplier
All Dairy					
Employment	651	1,105	541	2,298	3.53
Labor Income (MM$)	40.9	54.0	21.7	116.5	2.85
Total Income (MM$)	66.8	83.5	37.4	187.8	2.81
Total Industrial Sales (MM$)	339.4	173.3	68.4	581.1	1.71
Dairy Farm					
Employment	371	262	177	810	2.18
Labor Income (MM$)	23.7	7.1	7.1	37.9	1.60
Total Income (MM$)	39.4	11.9	12.2	63.5	1.61
Total Industrial Sales (MM$)	89.3	29.3	22.3	140.9	1.58
Dairy Processing					
Employment	280	843	365	1,488	5.31
Labor Income (MM$)	17.1	46.9	14.6	78.7	4.59
Total Income (MM$)	27.4	71.7	25.2	124.3	4.53
Total Industrial Sales (MM$)	250.0	144.0	46.1	440.1	1.76

Note: The reported values are those for Carbon, Columbia, Lackawanna, Luzerne, Monroe, Montour, Northumberland, Pike, Schuylkill and Wayne counties.

Table 5.6. Direct, Indirect and Induced Effects of Dairy Farm and Dairy Processing Activity in the Southeastern Region Pennsylvania, 2015

Southeastern Penn Region	Direct	Indirect	Induced	Total	Multiplier
All Dairy					
Employment	4,565	8,867	6,729	20,161	4.42
Labor Income (MM$)	484.7	706.0	371.9	1,562.6	3.22
Total Income (MM$)	668.3	1,092.9	620.7	2,382.0	3.56
Total Industrial Sales (MM$)	2,824.1	1,933.9	1,024.0	5,781.9	2.05
Dairy Farm					
Employment	2,777	2,161	2,740	7,678	2.76
Labor Income (MM$)	347.4	140.4	151.1	638.9	1.84
Total Income (MM$)	446.6	229.8	252.3	928.7	2.08
Total Industrial Sales (MM$)	1,013.1	465.6	415.9	1,894.6	1.87
Dairy Processing					
Employment	1,788	6,706	3,989	12,483	6.98
Labor Income (MM$)	137.2	565.7	220.9	923.8	6.73
Total Income (MM$)	221.7	863.1	368.4	1,453.3	6.55
Total Industrial Sales (MM$)	1,811.0	1,468.3	608.1	3,887.4	2.15

Note: The reported values are those for Berks, Bucks, Chester, Delaware, Lancaster, Lebanon, Lehigh, Montgomery, Northampton, Philadelphia counties.

Table 5.7. Direct, Indirect and Induced Effects of Dairy Farm and Dairy Processing Activity in the South-Central Region Pennsylvania, 2015

Southcentral Penn Region	Direct	Indirect	Induced	Total	Multiplier
All Dairy					
Employment	3,346	4,225	3,070	10,640	3.18
Labor Income (MM$)	297.6	224.9	134.9	657.5	2.21
Total Income (MM$)	423.3	318.1	229.0	970.3	2.29
Total Industrial Sales (MM$)	1,857.5	652.6	399.2	2,909.3	1.57
Dairy Farm					
Employment	2,153	1,272	1,524	4,949	2.30
Labor Income (MM$)	212.3	47.2	66.9	326.3	1.54
Total Income (MM$)	284.9	72.5	113.7	471.1	1.65
Total Industrial Sales (MM$)	646.3	176.1	198.0	1,020.4	1.58
Dairy Processing					
Employment	1,193	2,953	1,545	5,691	4.77
Labor Income (MM$)	85.3	177.8	68.1	331.2	3.88
Total Income (MM$)	138.3	245.6	115.3	499.2	3.61
Total Industrial Sales (MM$)	1,211.2	476.6	201.1	1,888.9	1.56

Note: The reported values are those for Adams, Cumberland, Dauphin, Franklin, Perry, York, Fulton, Juniata and Mifflin counties.

Table 5.8. Direct, Indirect and Induced Effects of Dairy Farm and Dairy Processing Activity in the Central Region Pennsylvania, 2015

Central Penn Region	Direct	Indirect	Induced	Total	Multiplier
All Dairy					
Employment	2,213	2,577	1,632	6,422	2.90
Labor Income (MM$)	194.6	108.1	63.0	365.7	1.88
Total Income (MM$)	293.0	149.1	109.2	551.2	1.88
Total Industrial Sales (MM$)	976.4	345.6	199.0	1521.1	1.56
Dairy Farm					
Employment	1,750.0	1,341.4	1,105.7	4,197.0	2.40
Labor Income (MM$)	166.9	36.7	42.7	246.3	1.48
Total Income (MM$)	247.5	56.7	74.0	378.2	1.53
Total Industrial Sales (MM$)	561.4	149.3	134.8	845.6	1.51
Dairy Processing					
Employment	463.0	1,235.6	526.3	2,224.9	4.81
Labor Income (MM$)	27.7	71.4	20.4	119.4	4.31
Total Income (MM$)	45.5	92.4	35.2	173.1	3.81
Total Industrial Sales (MM$)	415.0	196.3	64.2	675.5	1.63

Note: The reported values are those for Bedford, Blair, Cambria, Cameron, Centre, Clearfield, Clinton, Jefferson, Huntington, Indiana, Somerset, Snyder and Union counties.

Table 5.9. Direct, Indirect and Induced Effects of Dairy Farm and Dairy Processing Activity in the Western Region Pennsylvania, 2015

Western Penn Region	Direct	Indirect	Induced	Total	Multiplier
All Dairy					
Employment	3,579	4,494	2,653	10,726	3.00
Labor Income (MM$)	183.5	237.0	127.2	547.7	2.98
Total Income (MM$)	337.4	354.0	215.0	906.4	2.69
Total Industrial Sales (MM$)	1,615.5	681.0	368.9	2,665.5	1.65
Dairy Farm					
Employment	2,378.0	1,731.6	893.2	5,002.8	2.10
Labor Income (MM$)	104.4	37.7	42.7	184.8	1.77
Total Income (MM$)	209.0	64.9	72.3	346.3	1.66
Total Industrial Sales (MM$)	474.2	142.8	124.0	741.0	1.56
Dairy Processing					
Employment	1,201.0	2,762.5	1,759.9	5,723.4	4.77
Labor Income (MM$)	79.2	199.4	84.5	363.0	4.59
Total Income (MM$)	128.3	289.0	142.7	560.1	4.36
Total Industrial Sales (MM$)	1,141.3	538.2	245.0	1,924.5	1.69

Note: The reported values are those for Allegheny, Armstrong, Beaver, Butler, Clarion, Crawford, Erie, Fayette, Greene, Lawrence, Mercer, Venango, Washington and Westmoreland counties.

Table 5.10. Direct, Indirect and Induced Effects of Dairy Farm and Dairy Processing Activity in the Northern Tier Region Pennsylvania, 2015

Northern Tier Penn Region	Direct	Indirect	Induced	Total	Multiplier
All Dairy					
Employment	1,074	946	489	2,509	2.34
Labor Income (MM$)	70.1	34.5	18.3	122.9	1.75
Total Income (MM$)	125.6	54.0	32.1	211.7	1.69
Total Industrial Sales (MM$)	542.4	125.9	59.3	727.7	1.34
Dairy Farm					
Employment	784	485	294	1,563	1.99
Labor Income (MM$)	50.3	12.4	11.0	73.6	1.46
Total Income (MM$)	92.5	20.3	19.3	132.1	1.43
Total Industrial Sales (MM$)	209.9	50.1	35.6	295.6	1.41
Dairy Processing					
Employment	290	461	195	947	3.26
Labor Income (MM$)	19.8	22.1	7.3	49.3	2.48
Total Income (MM$)	33.0	33.8	12.8	79.6	2.41
Total Industrial Sales (MM$)	332.5	75.8	23.7	432.0	1.30

Note: The reported values are those for Bradford, Elk, Forest, Lycoming, McKean, Potter, Sullivan, Susquehanna, Tioga, Warren and Wyoming counties.

Appendix 5: Input-Output Modeling

Basics of Input-Output Modeling

We present a simple non-technical discussion of the formulation of input-output (IO) modeling in this section. An example of similar descriptive treatments would be Shaffer, Deller and Marcouiller (2004). An example of a more advanced discussion of input-output would be Miernyk (1965), and Miller and Blair (1985). As a descriptive tool, IO analysis represents a method for expressing the economy as a series of accounting transactions within and between the producing and consuming sectors. As an analytical tool, IO analysis expresses the economy as an interaction between the supply and demand for commodities. Given these interpretations, the IO model may be used to assess the impacts of alternative scenarios on the region's economy.

Transactions Table

A central concept of IO modeling is the interrelationship between the producing sectors of the region (e.g., manufacturing firms), the consuming sectors (e.g., households) and the rest of the world (i.e., regional imports and exports). The simplest way to express this interaction is through a regional transactions table (Table A1). The transactions table shows the flow of all goods and services produced (or purchased) by sectors in the region. The key to understanding this table is realizing that one firm's purchases are another firm's sales and that producing more of one output requires the production or purchase of more of the inputs needed to produce that product.

Table A1: Illustrative Transaction Table

	Purchasing Sectors (Buyers/Demand)			Final Demand		
Processing Sectors (Sellers/Supply)	**Agr**	**Mfg**	**Serv**	**HH (labor)**	**Exports**	**Output**
Agr	10	6	2	20	12	50
Mfg	4	4	3	24	14	49
Serv	6	2	1	34	10	53
HH (labor)	16	25	38	1	52	132
Imports	14	12	9	53	0	88
Inputs	50	49	53	132	88	372

The transactions table may be read from two perspectives: reading down a column gives the purchases by the sector named at the top of the column from each of the sectors named at the left. Reading across a row gives the sales of the sector named at the left of the row to those named at the top. In the illustrative transaction table for a fictitious regional economy (Table 1), reading down the first column shows that the agricultural firms buy $10 worth of their inputs from other agricultural firms. The sector also buys $4 worth of inputs from manufacturing firms and $6 worth from the service industry. Note that agricultural firms also made purchases from non-processing sectors of the economy, such as the household sector ($16) and imports from other regions ($14). Purchases from the household sector represent value added, or income to people in the form of wages and investment returns. In this example, agricultural firms purchased a total of $50 worth of inputs.

Reading across the first row shows that agriculture sold $10 worth of its output to agriculture, $6 worth to manufacturing, $2 worth to the service sector. The remaining $32 worth of agricultural output was sold to households or exported out of the region. In this case $20 worth of agricultural output was sold to households within the region and the remaining $12 was sold to firms or households outside the region. In the terminology of IO modeling, $18 (=$10+$6+$2) worth of agricultural output was sold for intermediate consumption, and the remaining $32 (=$20+$12) worth was sold to final demand. Note that the transactions table is balanced: total agricultural output (the sum of the row) is exactly equal to agricultural purchases (the sum of the column). In an economic sense, total outlays (column sum, $50) equal total income (row sum, $50), or supply exactly equals supply. This is true for each sector.

The transactions table is important because it provides a comprehensive picture of the region's economy. Not only does it show the total output of each sector, but it also shows the interdependencies between sectors. It also indicates the sectors from which the region's residents earn income as well as the degree of openness of the region through imports and exports. In this example, households' total income, or value added for the region is $132 (note total household income equals total household expenditure), and total regional imports is $88 (note regional imports equals regional exports). More open economies will have a larger percentage of total expenditures devoted to imports. As discussed below, the "openness" of the economy has a direct and important impact on the size of economic multipliers. Specifically, more open economies have a greater share of purchases, both intermediate and final consumption purchases, taking the form of imports. As new dollars are introduced (injected from exports) into the economy they leave the economy more rapidly through leakages (imports).

Direct Requirements Table

Important production relationships in the regional economy can be further examined if the patterns of expenditures made by a sector are stated in terms of proportions. This means that the proportions of all inputs needed to produce one dollar of output in a given sector can be used to identify linear production relationships. This is accomplished by dividing the dollar value of inputs purchased from each sector by total expenditures. Or, each transaction in a column is divided by the column sum. The resulting table is called the direct requirements table (Table A2).
The direct requirements table, as opposed to the transactions table, can only be read down each column. Each cell represents the dollar amount of inputs required from the industry named at the left to produce one dollar's worth of output from the sector named at the top. Each column essentially represents a `production recipe' for a dollar's worth of output. Given this latter interpretation, the upper part of the table (above households) is often referred to as the matrix of technical coefficients. In this example, for every dollar of sales by the agricultural sector, 20 cents worth of additional output from itself, 8 cents of output from manufacturing, 12 cents of output from services, and 32 cents from households will be required.

In the example region, an additional dollar of output by the agricultural sector requires firms in agriculture to purchase a total of 40 cents from other firms located in the region. If a product or service required in the production process is not available from within the region, the product must be imported. In the agricultural sector, 28 cents worth of inputs are imported for each dollar of output. It is important to note that in IO analysis, this production formula, or technology (the column of direct requirement coefficients), is assumed to be constant and the same for all establishments within a sector. This assumption holds regardless of input prices or production levels.

Table A2: Illustrative Direct Requirements Table

	Purchasing Sectors (Buyers/Demand)		
Processing Sectors (Sellers/Supply)	**Agr**	**Mfg**	**Serv**
Agr	**0.20**	**0.12**	**0.04**
Mfg	**0.08**	**0.08**	**0.06**
Serv	**0.12**	**0.04**	**0.02**
HH (labor)	**0.32**	**0.51**	**0.72**
Imports	**0.28**	**0.24**	**0.02**
Inputs	**1.00**	**1.00**	**1.00**

Assuming the direct requirements table also represents spending patterns necessary for additional production, the effects of a change in final demand of the output on the other of sectors can be predicted. For example, assume that export demand for the region's agricultural products increases by $100,000. From Table 2, it can be seen that any new final demand for agriculture will require purchases from the other sectors in the economy. The amounts shown in the first column are multiplied by the change in final demand to give the following figures: $20,000 from agriculture, $8,000 from manufacturing, and $12,000 from services. These are called the direct effects and, in this example, they amount to a total impact on the economy of $140,000 (the initial change [$100,000] plus the total direct effects [$40,000]). For many studies of economic impact the direct and initial effects are treated as the same although there are subtle differences.
The strength of input-output modeling is that it does not stop at this point, but also measures the indirect effects of an increase in agricultural exports. In this example, the agricultural sector increased purchases of manufactured goods by $8,000. To supply agriculture's new need for manufacturing products, the manufacturing sector must increase production. To accomplish this, manufacturing firms must purchase additional inputs from the other regional sectors.

Continuing our $100,000 increase in export demand for a region's agricultural products, for every dollar increase in output, manufacturing must purchase an additional 12 cents of agricultural goods ($8,000 x .12 = $960), 8 cents from itself ($8,000 x .08 = $640), and 4 cents from the service sector ($8,000 x .04 = $320). Thus, the impact on the economy from an increase in agricultural exports will be more than the $140,000 identified previously. The total impact will be $140,000 plus the indirect effect on manufacturing totaling $1,920 ($960 + $640 + $320), or $141,920. A similar process examining the service sector increases the total impact yet again by $1,440 ([$12,000 x .04] + [$12,000 x .06] + [$12,000 x .02] = $1,440).

The cycle does not stop, however, after only two rounds of impacts. To supply the manufacturing sectors with the newly required inputs, agriculture must increase output again, leading to an increase in manufacturing and service sector outputs. This process continues until the additional increases drop to an insignificant amount. The total impact on the regional economy, then, is the sum of a series of direct and indirect impacts. Fortunately, the sum of these direct and indirect effects can be more efficiently calculated by mathematical methods. The methodology was developed by the Noble-winning economist Wassily Leontief and is easily accomplished using computerized models.

Total Requirements Table

Typically, the result of the direct and indirect effects is presented as a total requirements table, or the Leontief inverse table (Table A3). Each cell in Table 3 indicates the dollar value of output from the sector named at the left that will be required in total (i.e., direct plus indirect) for a one dollar increase in final demand for the output from the sector named at the top of the column. For example, the element in the first row of the first column indicates the total dollar increase in output of agricultural production that results from a $1 increase in final demand for agricultural products is $1.28. Here the agricultural multiplier is 1.28: for every dollar of direct agricultural sales there will be an additional 28 cents of economic activity as measured by industry sales.

Table A3: Illustrative Total Requirements Table

	Purchasing Sectors (Buyers/Demand)		
Processing Sectors (Sellers/Supply)	**Agr**	**Mfg**	**Serv**
Agr	**1.28**	**0.17**	**0.06**
Mfg	**0.12**	**1.11**	**0.07**
Serv	**0.16**	**0.07**	**1.03**
Inputs	**1.56**	**1.35**	**1.16**

An additional interpretation of the transactions table, as well as the direct requirements and total requirements tables, is the measure of economic linkages within the economy. For example, the element in the second row of the first column indicates the total increase in manufacturing output due to a dollar increase in the demand for agricultural products is 12 cents. This allows the analyst to not only estimate the total economic impact but also provide insights into which sectors will be impacted and to what level.

Highly linked regional economies tend to be more self-sufficient in production and rely less on outside sources for inputs. More open economies, however, are often faced with the requirement of importing production inputs into the region. The degree of openness can be obtained from the direct requirements table (Table 2) by reading across the imports row. The higher these proportions are, the more open the economy. As imports increase, the values of the direct requirement coefficients must, by definition, decline. It follows then that the values making up the total requirements table, or the multipliers, will be smaller. In other words, more open economies have smaller multipliers due to larger imports. The degree of linkage can be obtained by analyzing the values of the off- diagonal elements (those elements in the table with a value of less than one) in the total requirements table. Generally, larger values indicate a tightly linked economy, whereas smaller values indicate a looser or more open economy.

Basics of Input-Output Multipliers

Through the discussion of the total requirements table, the notion of external changes in final demand rippling throughout the economy was introduced. The total requirements table can be used to compute the total impact a change in final demand for one sector will have on the entire economy. Specifically, the sum of each column shows the total increase in regional output resulting from a $1 increase in final demand for the column heading sector. Retaining the agricultural example, an increase of $1 in the demand for agricultural output will yield a total increase in regional output equal to $1.56 (Table 3). This figure represents the initial dollar increase plus 56 cents in direct and indirect effects. The column totals are often referred to as output multipliers.

The use of these multipliers for policy analysis can prove insightful. These multipliers can be used in preliminary policy analysis to estimate the economic impact of alternative policies or changes in the local economy. In addition, the multipliers can be used to identify the degree of structural interdependence between each sector and the rest of the economy. For example, in the illustrative region, a change in the agriculture sector would influence the local economy to the greatest extent, while changes in the service sector would produce the smallest change. The output multiplier described here is perhaps the simplest input-output multiplier available. The construction of the transactions table and its associated direct and total requirements tables creates a set of multipliers ranging from output to employment multipliers. Input-output analysis specifies this economic change, most commonly, as a change in final demand for some product. Economists sometimes might refer to this as the "exogenous shock" applied to the system. Simply stated, this is the manner in which we attempt to introduce an economic change.

The complete set includes:

Type Definition	
1. Output Multiplier	The output multiplier for industry *i* measures the sum of direct and indirect requirements from all sectors needed to deliver one additional dollar unit of output of *i* to final demand.
2. Income Multiplier	The income multiplier measures the total change in income throughout the economy from a dollar unit change in final demand for any given sector.
3. Employment Multiplier	The employment multiplier measures the total change in employment due to a one unit change in the employed labor force of a particular sector.

The income multiplier represents a change in total income (employee compensation plus proprietary income plus other property income plus indirect business taxes) for every dollar change in income for any given sector. The employment multiplier represents the total change in employment resulting from the change in employment in any given sector. Thus, we have three ways that we can describe the change in final demand.

Consider, for example, a dairy farm that has $1 million in sales (industry output), pays labor $100,000 inclusive of wages, salaries and retained profits, and that employs three workers, including the farm proprietor. Suppose that demand for milk produced at these farm increases 10 percent, or $100,000 dollars. We could use the traditional output multiplier to determine what the total impact on output would be. Alternatively, to produce this additional output the farmer may find that they need to hire a part-time worker. We could use the employment multiplier to examine the impact of this new hire on total employment in the economy. In addition, the income paid to labor will increase by some amount and we can use the income multiplier to see what the total impact of this additional income will have on the larger economy.

How are these income and employment multipliers derived if the IO model only looks at the flow of industry expenditures (output)? In the strictest sense, the IO does not understand changes in employment or income, only changes in final demand (sales or output). To do this we use the fact that the IO model is a “fixed proportion” representation of the underlying production technologies. This is most clear by reexamining the direct requirements table (Table 2). For every dollar of output (sales) inputs are purchased in a fixed proportion according to the production technology described by the direct requirements table. For every dollar of output there is a fixed proportion of employment required as well as income paid. In our simple dairy farm example, for every dollar of output there are .000003 (= 1,000,000 ÷ 3) jobs and $.10 (= 1,000,000 ÷ 100,000) in income. We can use these fixed proportions to convert changes in output (sales) into changes in employment and income.

Graphically, we can illustrate the round-by-round relationships modeled using input-output analysis. This is found in Figure A1. The direct effect of change is shown in the far left-hand side of the figure (the first bar (a)). For simplification, the direct effect of a $1.00 change in the level of exports, the indirect effects will spill over into other sectors and create an additional 66 cents of activity. In this example, the simple output multiplier is 1.66. A variety of multipliers can be calculated using input-output analysis.

While multipliers may be used to assess the impact of changes on the economy, it is important to note that such a practice leads to limited impact information. A more complete analysis is not based on a single multiplier, but rather, on the complete total requirements table.

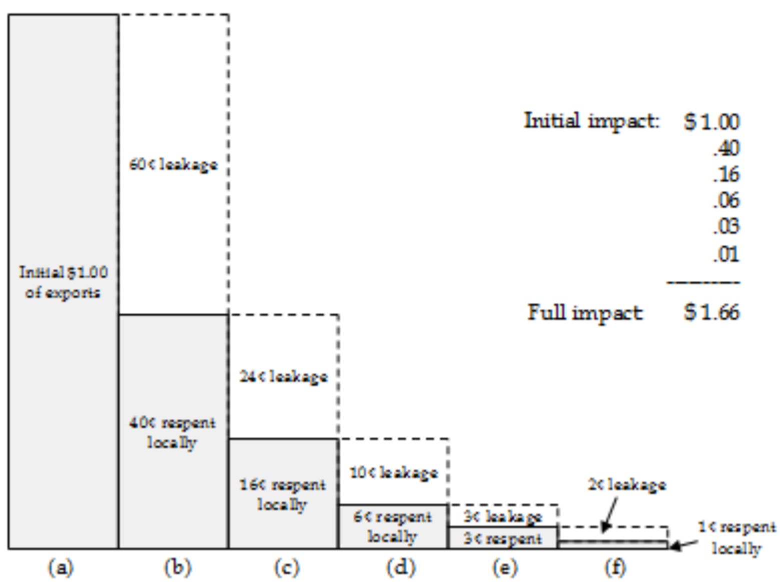

Figure A1. Illustration of Round-by-Round Multiplier Relationships

Initial, Indirect and Induced Effects

The input-output model and resulting multipliers described up to this point presents only part of the story. In this construction of the total requirements table (Table 3) and the resulting multipliers, the production technology does not include labor. In the terminology of IO modeling, this is an "open" model. In this case, the multiplier captures only the initial effect (initial change in final demand or the initial shock) and the impact of industry to industry sales. This latter effect is called the indirect effect and results in a Type I multiplier. A more complete picture would include labor in the total requirements table. In the terminology of IO modeling, the model should be "closed" with respect to labor. If this is done, we have a different type of multiplier, specifically a Type II multiplier, which is composed of the initial and indirect effects as well as what is called the induced effects.

The Type II multiplier is a more comprehensive measure of economic impact because it captures industry to industry transactions (indirect) as well as the impact of labor spending income in the economy (induced effect). In the terminology of IO analysis, an "open" model where the induced effect is not captured, any labor or proprietor income that may be gained (positive shock) or lost (negative shock) is assumed to be lost to the economy. In our simple dairy farm example, any additional income (wages, salaries and profits) derived from the change in output (sales) is pocketed by labor and is not re-spent in the economy. This clearly is not the case: any additional income resulting from more labor being hired (or fired) will be spent in the economy thus generating an additional round of impacts. This second round of impacts is referred to as the induced impact.

Insights can be gained by comparing and contrasting the indirect and induced effects. For example, industries that are more labor intensive will tend to have larger induced impacts relative to indirect. In addition, industries that tend to pay higher wages and salaries will also tend to have larger induced effects. By decomposing the Type II multiplier into its induced and indirect effects, one can gain a better understanding of the industry under examination and its relationship to the larger economy.

Chapter 6: Analysis of Dairy Export Potential Through the Port of Philadelphia

Chuck Nicholson, Mark Stephenson and Andrew Novakovic[37]

Executive Summary

This component of the *Study to Support Dairy Growth and Competiveness* describes the current capabilities of the Port of Philadelphia (branded *PhilaPort* as of March 2017) to support growth in dairy product exports, assesses the port's historical role in dairy product exports from the US and the mid-Atlantic, and estimates selected economic impacts of reallocation of dairy product exports from other ports to *PhilaPort.*

Our key findings are:

- *PhilaPort* appears to have the capabilities, capacity and relationships with relevant shippers (dairy product exporters) and service providers (such as steamship lines) to support substantial growth in dairy product exports. This capability will be enhanced further by expansions funded by state government and currently under implementation;
- Dairy product exports from the Philadelphia Port District included a wide range of dairy products and a diverse set of country destinations—more than 80 countries received product shipped from the ports in the district during 2007 to 2016;
- Despite extensive capabilities and historical product and market diversity, the share of US dairy exports departing from the Philadelphia Port District has been small—less than 1% on a value basis during 2007 to 2016. They comprise only about 6% of exports from mid-Atlantic ports (New York, Norfolk, Baltimore and Washington, DC);
- In 2016, the Philadelphia Port District ranked 17th of 41 US port districts in the value of dairy product exports, with the largest districts (Los Angeles, San Francisco, Laredo, TX, Seattle and El Paso, TX) accounting for nearly two-thirds of total US dairy product exports on a value basis;
- The product mix exported and country destinations for exports through the Philadelphia Port district differ from those for the US as a whole. Ice cream and processed cheese were more important for the Philadelphia Port District during 2007 to 2016, and the principal export destinations were Australia, New Zealand, and Latin America. Relatively small amounts of key US exports such as NDM or dry whey were shipped through the Philadelphia Port District, and essentially no product shipped from the ports in the district went to major US export markets such as Mexico, Canada, or Asian countries;
- A relatively small number of country-product combinations accounted for the majority of the value of dairy product exports from the Philadelphia Port District during 2007 to 2016. Twelve country-product combinations accounted for more than 60% of the value

[37] The authors are, respectively, former Clinical Associate Professor of Supply Chain Management, Penn State University (now Adjunct Associate Professor, Cornell University), Director of Dairy Policy Analysis, University of Wisconsin, Madison, and E. V. Baker Professor of Agricultural Economics, Cornell University.

of dairy product exports during these years. Ten country destinations accounted for more than 80% of the value of exports from the Philadelphia Port District;

- Reallocation of 2016 dairy product exports to *PhilaPort* rather than other mid-Atlantic ports would increase farm-level milk values, reduce the costs of milk assembly to processing plants, and reduce product distribution costs. The total net benefit is estimated to be about $1.8 million per year, excluding economic multiplier impacts. This net benefit is about $0.02/cwt on all milk produced in Pennsylvania.

Background and Study Objectives

Access to cost-effective transportation and logistics services is essential for competitiveness in global dairy markets. The Port of Philadelphia (now branded PhilaPort) provides a substantive resource for Pennsylvania and northeast dairy companies to access dairy export markets. This component of the overall study to support dairy growth and competitiveness examines the historical role of PhilaPort and assesses the impacts if a larger volume of dairy product exports from the mid-Atlantic region would flow through PhilaPort rather than alternatives. The specific objectives of this component include:

- Description of the capacities of *PhilaPort* that facilitate dairy product exports from Pennsylvania and the northeast region;
- Assessment of the volumes of dairy product exports by US port district, to place *PhilaPort* into the broader national context;
- Description of dairy product exports from the Philadelphia Port District[38] during 2007 to 2016;
- Analysis of the impacts on farm milk prices, milk assembly costs and product distribution costs of increased use of the *PhilaPort* for dairy product exports based on 2016 volumes.

Capabilities of *PhilaPort* to Support Dairy Product Exports

The Port of Philadelphia (*PhilaPort*) has made a number of presentations to meetings organized by the Center for Dairy Excellence that highlight its strong capabilities to support dairy product exports and food product exports more generally. Our analyses draw on this information, which undoubtedly could be complemented with additional information from *PhilaPort* marketing personnel.

One general advantage for *PhilaPort* includes its central location, for example, being the closest port location to most dairy processing facilities in Pennsylvania, and shorter rail access from selected US cities. The port has significant capacity for food exports (Figure 1), including facilities (extensive temperature controlled storage capacity and on-dock “reefer plugs” to provide electricity to perishables containers). The port’s labor force is “experienced in the special needs of sensitive, high-value agricultural goods”, and partners with providers who

[38] The Philadelphia Port district includes other ports in addition to *PhilaPort,* extending over a broader geographical area. (See Appendix Table 1.) This broader coverage is considered relevant for the purposes of this analysis, and the majority of export volumes pass through *PhilaPort*.

provide high quality support services in transportation, storage and marketing of food products. The port's staff indicate that it can facilitate access to hundreds of firms that provide cold storage warehousing, food import and brokerage services, freight forwarding and refrigerated trucking.

In March 2017, the port announced major plans for expansion based in part on a $300 million investment by the Wolf administration. These investments will upgrade ship berths, buy new cranes, and update and relocate warehouses. The activity is expected to double cargo-handling space and create 2,000 waterfront jobs, and nearly 7,000 total jobs for truckers, rail workers, suppliers, and port-related businesses. The Port Authority's Board Chairman, Gerard Sweeney, noted the importance and implications of these investments in a March 20, 2017 press release:

> *"The governor saw a real opportunity to give the port, finally, the right tools so that we could become competitive and market the port to bring business in from other ports, and be in a position for a trans-Pacific line that never would have looked at Philadelphia before because we couldn't handle it."*[39]

He indicated that Philadelphia will "now be in the mix with New York, Baltimore, and Norfolk." The port also announced the purchase of additional land in June 2017,

A key component of decision making for shippers of dairy products is accessibility to key export markets through relevant shipping companies. Steamship lines serving *PhilaPort* include some of the world's largest and best known (for example, Maersk and Hapag-Lloyd), providing services to many regions (Figure 2) although with an emphasis on eastern South America, Central America, Australia and New Zealand[40].

Many well-known US dairy companies have used *PhilaPort* for dairy product exports in recent years (Figure 3). The usage of the port, along with its stated capabilities and expansion plans suggests that the port has the capabilities to provide a broad range of services and capacity to support substantial growth in dairy product exports from the state.

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[39] Source: http://www.philaport.com/port-philadelphia-to-get-new-cranes-bigger-ships-more-cargo-more-jobs/.

[40] These routings appear to align reasonably closely with the principal destinations for dairy product exports from the Philadephia Port District, as will be noted subsequently.

Philadelphia Regional Port Authority

The Port of Philadelphia and Food Cargos

The Greater Philadelphia port complex is one of the leading gateways for food products in the United States. The three-state Port system is a national leader in the importation of perishable goods, receiving about **$5 billion** in agriculture cargos each year. This includes over **$2 billion** in fruit imports.

Our Port community is currently benefiting from close to $1 billion is active or planned infrastructure investments made by public and private entities to enhance the flow of agricultural commerce. Our labor is experienced in the special needs of sensitive, high-value agricultural goods. This commitment to agriculture and prepared foods has resulted in the following successes for the Delaware River Port complex:

- #1 in the USA for importing bananas
- #1 in the USA for importing Chilean fruit
- #1 in the USA for importing Australian meat
- #1 in the USA for importing New Zealand dairy products
- #1 in the USA for cocoa beans
- US leader in meat importation
- Among the nation's leaders for forest products (export and import)
- The Philadelphia Wholesale Produce Market is the largest refrigerated building in the USA; the Market's merchants earn about $1 billion per year in annual sales.
- Live Pennsylvania cattle are exported from the region

More broadly, the states of Pennsylvania, New Jersey and Delaware have extensive prepared foods industries. Pennsylvania's snack food and confectionery industries alone generate more than $5.1 billion in sales annually. Food exports are increasing due to the global popularity of high quality, trusted US food products.

Our Philadelphia area supply chain service providers are widely recognized as among the most knowledgeable in the nation concerning the transportation, storage, and sale of food products. Additionally, the University of Pennsylvania's School of Veterinary Medicine and the St. Joseph's University Food Marketing Program are world leaders in their respective fields.

Importing or exporting your food cargos via the Port of Philadelphia is the smart choice. Our location in the heart of a major agriculture and prepared foods center will ensure that your precious food cargos get to market safely and efficiently.

Source: Philadelphia Regional Port Authority Marketing November 30, 2016

Figure 6.1. Capabilities of *PhilaPort* for Food Product Exports and Imports

Figure 6.2. Steamship Lines Serving PhilaPort

Source: Presentation by J. M. Fox at Center for Dairy Excellence Annual Dairy Financial and Risk Management Conference.

Port Philadelphia Dairy Exports: Leading Companies

KRAFT FOODS BETHLEHEM REEFER	3,745	25.50%
FONTERRA USA	3,099	21.10%
NESTLE USA	2,068	14.08%
GLOBERUNNERS	1,112	7.57%
SEA SHIPPING LINE	644	4.38%
KRAFT FOODS QUAKERTOWN	639	4.35%
KRAFT FOODS WAREHOUSE BETHLEHEM	527	3.59%
HELMSMAN FREIGHT SOLUTIONS	443	3.02%
TRANSNOW	420	2.86%
KRAFT FOODS EXPORTS	210	1.43%

Grand Total: 14,690 Metric Tons Source: PIERS

Figure 6.3. Major Dairy Product Exporters Using *PhilaPort*

Source: Presentation by J. M. Fox at Center for Dairy Excellence Annual Dairy Financial and Risk Management Conference.

Volume of Dairy Product Exports by US Port District

Although *PhilaPort* has quite substantive resources to support dairy product exports, its current and historical share of overall exports is small relative to other US and mid-Atlantic ports. During the period 2007 to 2016, the value of dairy product exports shipped from the Philadelphia Port District (which includes *PhilaPort* and other ports) was $259 million, with $34 million of that total occurring in 2016 (Table 1)[41]. The Philadelphia Port District ranked 17th of 41 US port districts, and accounted for less than 1% of the value of total US dairy product exports during 2007 to 2016. The five largest US port districts (Los Angeles, San Francisco, Laredo, TX, Seattle, and El Paso, TX) accounted for nearly two-thirds of US dairy product exports during this period. The largest port in the mid-Atlantic region, New York, accounted for about 6% of US dairy product exports during the past decade. The regional share of the Philadelphia Port District is larger than its national share; it accounted for 6% of the value of exports from mid-Atlantic port districts (New York, Norfolk, VA, Baltimore, MD and Washington, DC, which can be considered reasonable competitors with the Philadelphia Port District) during 2016 and 5% during 2007 to 2016.

Although the share of overall exports from the Philadelphia Port District is small compared to other ports, the value of dairy exports from the district has grown considerably since 2007, and at a rate faster than the overall national average (Table 1 and Figure 4) although mirroring overall regional growth in dairy product exports. The share of dairy exports also varies by product, with the Philadelphia Port District having larger shares of ice cream and yogurt than other products during 2016 (Figure 5).

Determining the reasons for the relatively small share of exports from the Philadelphia Port District is beyond the scope of this assessment, but certain factors could be further analyzed. As noted above, *PhilaPort* has adequate capacity and expertise to handle significantly increased volumes of dairy product exports, has working relationships with key shippers (dairy product companies) and transportation service providers for both in-bound and out-bound shipments, and a similarly favorable location for exports to major export markets compared to other mid-Atlantic region competitors. Factors that could be further explored include relative landed costs to export destinations, shipping schedules and lead times to key export destinations, and institutional arrangements that favor continuation of historical service relationships.

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41 It is very important to note that these values do NOT indicate the total amount of dairy product manufactured in the state of Pennsylvania that was exported, because not all product produced in Pennsylvania would be exported through the Philadelphia Port District. Similarly, not all dairy products exported from the Philadelphia Port District are manufactured in Pennsylvania. Available data do not, in general, allow detailed analysis of the specific geographical origins of US dairy product exports.

Table 6.1. Value of Dairy Product Exports and Market Shares by US Port District, 2007 to 2016

Port District	2016 Value of Exports, $000	% of 2016 Total	2007 to 2016 Total Value of Exports, $000	% of 2007 to 2016 Total	% Change 2007 to 2016
Anchorage, AK	820	0.0%	13,745	0.0%	271.0%
Baltimore, MD	42,707	0.8%	214,267	0.4%	693.5%
Boston, MA	1,113	0.0%	80,506	0.2%	-89.0%
Buffalo, NY	55,716	1.1%	399,171	0.8%	118.4%
Charleston, SC	32,012	0.6%	330,559	0.7%	79.2%
Charlotte, NC	204	0.0%	7,268	0.0%	55.7%
Chicago, IL	21,942	0.4%	172,476	0.4%	29.9%
Cleveland, OH	2,091	0.0%	11,552	0.0%	343.0%
Columbia-Snake, OR	499	0.0%	235,728	0.5%	-98.9%
Dallas-Fort Worth, TX	14,117	0.3%	49,273	0.1%	2589.0%
Detroit, MI	384,502	7.5%	2,761,559	5.6%	94.3%
Duluth, MN	14,214	0.3%	97,906	0.2%	16.1%
El Paso, TX	452,188	8.9%	3,157,002	6.5%	316.1%
Great Falls, MT	7,970	0.2%	41,941	0.1%	210.7%
Honolulu, HI	4,134	0.1%	15,283	0.0%	6790.0%
Houston-Galveston, TX	90,114	1.8%	1,405,537	2.9%	-28.3%
Laredo, TX	611,923	12.0%	6,959,508	14.2%	-5.8%
Los Angeles, CA	983,245	19.3%	10,912,742	22.3%	93.6%
Miami, FL	237,317	4.6%	1,633,970	3.3%	254.5%
Milwaukee, WI	-	0.0%	1,686	0.0%	-100.0%
Minneapolis, MN	252	0.0%	2,742	0.0%	100.0%
Mobile, AL	6,410	0.1%	67,711	0.1%	-9.1%
New Orleans, LA	5,001	0.1%	39,290	0.1%	25.2%
New York, NY	321,946	6.3%	3,042,757	6.2%	88.4%
Nogales, AZ	7,042	0.1%	83,945	0.2%	2.8%
Norfolk, VA	160,953	3.2%	1,709,434	3.5%	48.0%
Ogdensburg, NY	64,542	1.3%	567,379	1.2%	73.1%
Pembina, ND	70,289	1.4%	448,145	0.9%	316.3%
Philadelphia, PA	**34,519**	**0.7%**	**259,211**	**0.5%**	**346.2%**
Portland, ME	1,641	0.0%	17,321	0.0%	152.1%
San Diego, CA	160,205	3.1%	1,084,140	2.2%	101.0%
San Francisco, CA	654,619	12.8%	6,480,620	13.2%	104.9%

Port District	2016 Value of Exports, $000	% of 2016 Total	2007 to 2016 Total Value of Exports, $000	% of 2007 to 2016 Total	% Change 2007 to 2016
San Juan, PR	12,115	0.2%	86,083	0.2%	1221.2%
Savannah, GA	88,993	1.7%	432,661	0.9%	1039.9%
Seattle, WA	486,170	9.5%	5,613,545	11.5%	12.3%
St. Albans, VT	31,282	0.6%	242,437	0.5%	48.9%
Tampa, FL	11,045	0.2%	127,406	0.3%	57.0%
Washington, DC	498	0.0%	5,236	0.0%	344.6%
Total	5,103,758	100.0%	48,925,370	100.0%	68.4%
Philadelphia Total	34,519		259,211		
Philadelphia Share	0.68%		0.53%		
Mid-Atlantic Ports[a]	560,623		5,230,905		
Philadelphia Share	6.16%		4.96%		

Source: Calculations from US Census Bureau data, accessed through the US International Trade Commission Dataweb (https://dataweb.usitc.gov/scripts/user_set.asp).

[a] For the purposes of this analysis, mid-Atlantic ports include New York, Norfolk, VA; Baltimore, MD; and Washington, DC in addition to Philadelphia.

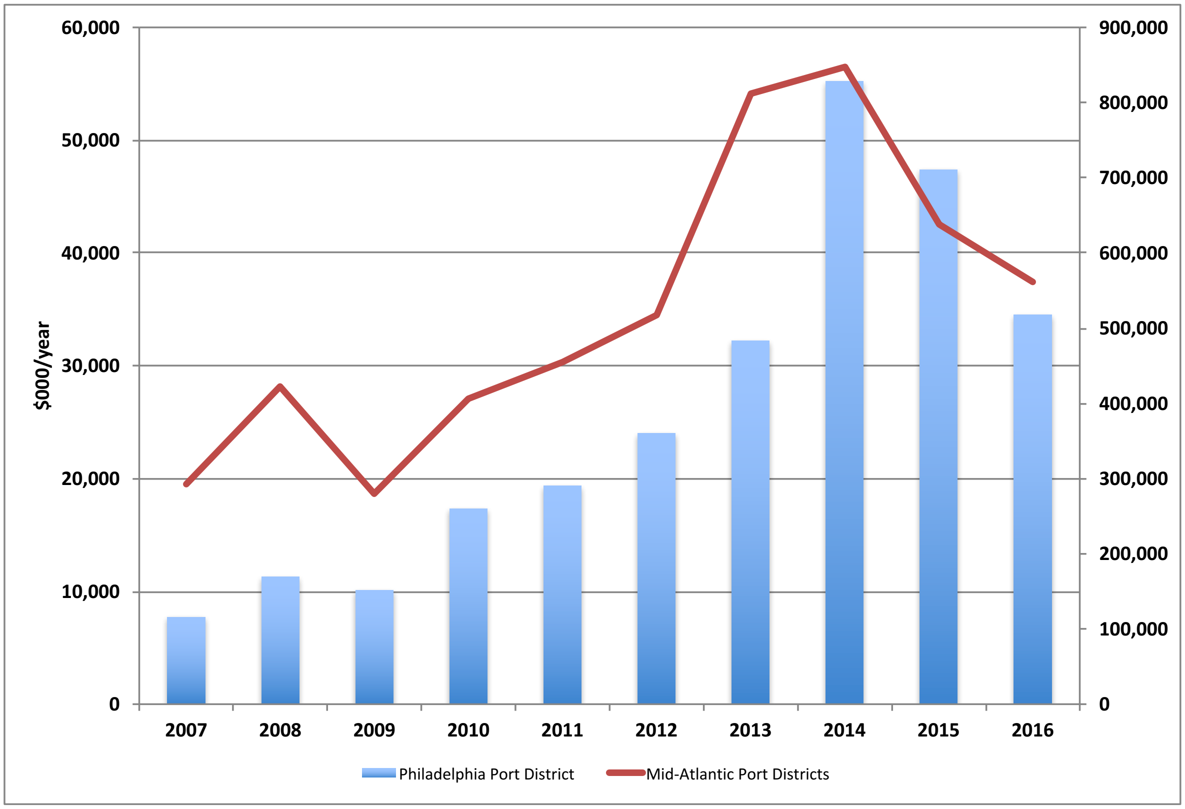

Figure 6.4. Value of Dairy Product Exports from Philadelphia Port District (Left Axis) and Mid-Atlantic Port Districts (Right Axis), 2007 to 2016

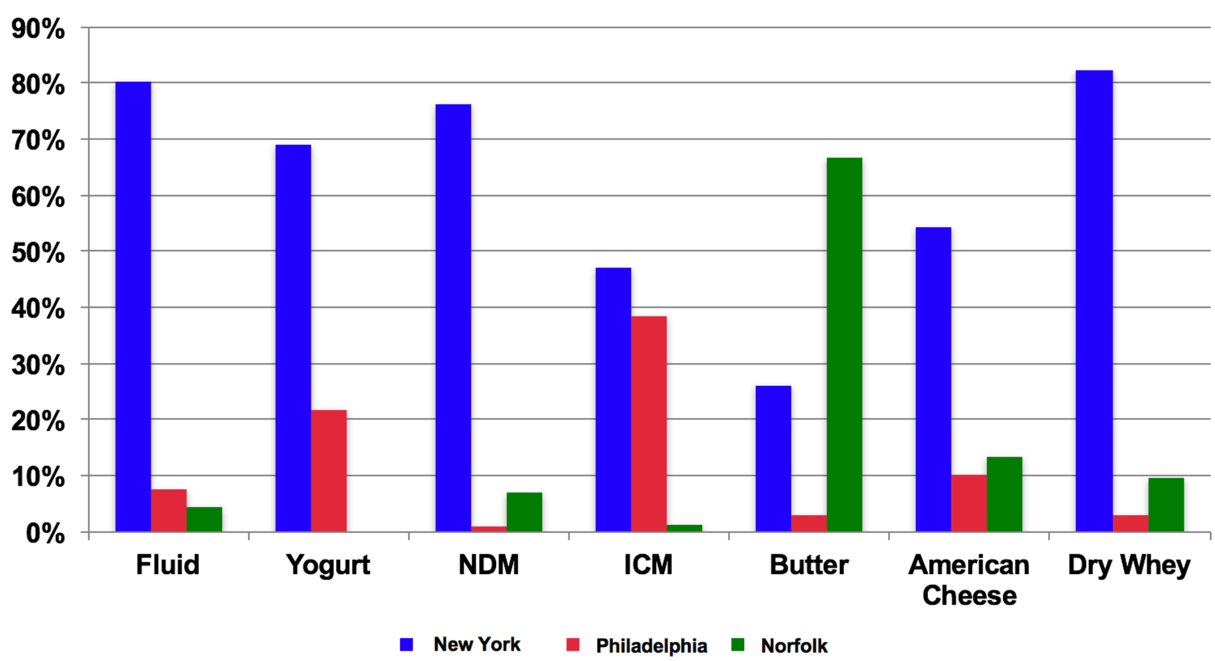

Figure 6.5. Share of 2016 Export Volume, Selected Dairy Products, Three Mid-Atlantic Port Districts

Descriptive Analysis of Dairy Product Exports from the Philadelphia Port District

A diverse set of products was exported through the Philadelphia Port District during the past decade (Table 2), to more than 80 different country destinations. The largest value shares of exports from the port were for ice cream, protein concentrates (both those in chapter 21 of the Harmonized Tariff Schedule (HTS) and in chapter 4), and fresh, processed and other cheeses. The growth rates of exports for these products has been impressive during the past decade, reflecting in part the growing role of the US as a dairy exporter.

The product mix exported from the Philadelphia Port District differs somewhat from that exported by the US overall. Ice cream product exports from the Philadelphia Port District accounted for one-third of the total export value during 2016, compared to only about 4% for the US as a whole[42] (Figure 6). The Philadelphia Port District also exported a larger share of processed cheese than the US, more than 10% of total value compared to less than 2% for the US overall. The five product categories in Figure 6 accounted for more than three-quarters of the value of exports from the Philadelphia Port District in 2016, but only about one-third of the total value of US exports. Product categories that were important for the US overall that are under-represented in Philadelphia Port District exports include milk powders and whey products. These products accounted for more than 35% of total US exports (by value) in 2016, but only about 5% of exports from the Philadelphia Port District. These differences in product mix undoubtedly represent the outcomes of differences in both regional production, proximity to export markets, and investments in export market relationships by dairy product companies. (It is important to note that the above does NOT imply the extent to which these products were manufactured in and "exported" from Pennsylvania because not all product originating in Pennsylvania was exported through the Philadelphia Port District, and not all product exported from the Philadelphia Port District was manufactured in Pennsylvania.)

The key export destinations for dairy products exported from the Philadelphia Port District include, perhaps unexpectedly, Australia and New Zealand (Table 3)[43]. These two countries accounted for close to half of the value of exports from the Philadelphia Port District during 2007 to 2016, although only 40% in 2016 (and most in this year to Australia). Most of the other key export destinations (other than the Netherlands) are in Central or South America. The share of exports to the most important destinations from the Philadelphia Port District differs quite a bit from the share of exports to these destinations from the US as a whole (Figure 7). Notably absent from the destinations served by the Philadelphia Port District in 2016 were nine of the top ten US export destinations (Mexico, Canada, China, Korea, Philippines, Japan, Indonesia, Vietnam and Taiwan) although *PhilaPort*'s ability to serve those markets will likely be

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[42] One reason *PhilaPort* is strong in ice cream exports is its general strength in frozen food imports, which facilitates outbound frozen food shipments. *PhilaPort* is the largest port in the USA for Australian meat imports; it maintains 13 USDA certified meat re-inspection warehouses for imported meat, compared to only 3 such facilities for the port of North Jersey / New York. This gives *PhilaPort* a large amount of freezer warehouse capacity which is essential for ice cream exports.

[43] *PhilaPort* exports dairy products to Australia and New Zealand because the port imports large quantities of meat and dairy products from those countries, so returning ships are sailing back with a lot of empty space.

strengthened in the near future[44]. (Again, this does not mean that product from Pennsylvania did not reach these export markets, just that any product that did was not shipped through the Philadelphia Port District.)

The products shipped to each of the top ten export destinations from the Philadelphia Port District vary. The most important destinations for ice cream in 2016 were Australia, Brazil and Bermuda (Table 4). Chile was the largest destination for fresh cheese, and Bermuda the largest destination for other cheese. The largest destination for processed cheese was Austrailia, and the largest destinations for protein concentrates (chapter 26 of HTS) were the Netherlands and Colombia. These results suggest that relatively few export destinations account for the majority of product value shipped from the Philadelphia Port District in a given year—63% of total 2016 value is represented by the country-product combinations mentioned in this paragraph.

This pattern that a relatively small number of country-product combinations accounts for a majority of the value of dairy product exports also applies to the value of exports from 2007 to 2016. The five largest export products by value during this time were ice cream, other cheese, protein concentrates (chapter 26 HTS), processed cheese and MPC, which together accounted for 65% of the export value from the Philadelphia Port District. Exports to Australia and Bermuda accounted for more than 50% of total value during this decade. These two countries accounted for 97% of other cheese exports, 80% of processed cheese exports and (with Brazil also) 98% of ice cream exports. New Zealand was the destination for 99% of MPCs exported from the Philadelphia Port District during these 10 years, and was also a major destination for protein concentrates (chapter 21 HTS). When combined with Australia, Colombia and the Netherlands, these four countries accounted for 96% of the value of protein concentrate exports. Overall, the 12 country-product combinations described above accounted for 62% of the value of exports from the Philadelphia Port District from 2007 to 2016.

In sum, the Philadelphia Port District served as the export location for a wide variety of products that were shipped to 86 different destinations during 2007 to 2016. This suggests that expansion of export value is possible, although historically the exports have been concentrated on a relatively small number of country-product combinations. The destinations served by the Philadelphia Port District have not necessary been among the most important or fastest growing, nor do the products exported represent those exported by the US overall. The extent to which these present constraints on future growth of dairy exports from the District might be usefully considered.

[44] *PhilaPort* expects to get an Asian service once their Port Development Plan is completed, with the construction to be finished in the next 2 years or so. This should give *PhilaPort* access to many of the major export markets mentioned above (Personal communication, Dominic O'Brien, Senior Marketing Representative for *PhilaPort*).

Table 6.2. Value of Dairy Product Exports from the Philadelphia Port District, 2007 to 2016, by Product

HTS Number	Short Description	2016 Value of Exports, $000	% of 2016 Total	2007-2016 Value of Exports, $000	% of 2007 to 2016 Total	% Change 2007 to 2016
040110	Milk & Cream, < 1%	61	0.2%	86	0.0%	a
040120	Milk & Cream, 1-6%	0	0.0%	29	0.0%	-100.0%
040140	Milk & Cream, 6-10%	0	0.0%	4	0.0%	a
040210	NDM/SMP	343	1.0%	6,645	2.4%	-44.9%
040221	WMP	223	0.6%	9,778	3.6%	-86.5%
040229	WMP, Sweetened	3	0.0%	832	0.3%	-98.2%
040291	Concentrated Milk	145	0.4%	433	0.2%	a
040299	Sweetened Concentrated Milk	54	0.2%	865	0.3%	38.5%
040310	Yogurt	290	0.8%	1,031	0.4%	9566.7%
040390	Buttermilk	3	0.0%	481	0.2%	-99.2%
040410	Whey Products	1,403	4.1%	20,694	7.6%	6.7%
040490	MPC Low	36	0.1%	24,800	9.1%	1100.0%
040510	Butter	99	0.3%	11,039	4.1%	-97.9%
040520	Dairy Spreads	83	0.2%	778	0.3%	176.7%
040590	Fats/Oils/AMF	11	0.0%	1,163	0.4%	-95.2%
040610	Cheese, Fresh	3,205	9.3%	19,934	7.3%	12720.0%
040620	Grated/Powdered Cheese	1,626	4.7%	11,368	4.2%	194.6%
040630	Processed Cheese	3,920	11.4%	28,145	10.3%	566.7%
040640	Blue-veined Cheese	1,198	3.5%	2,026	0.7%	a
040690	Other Cheese	1,746	5.1%	31,540	11.6%	19.6%
170211	Lactose	76	0.2%	3,304	1.2%	a
170219	Lactose NESOI	52	0.2%	395	0.1%	333.3%
190110	Infant Formula	1,065	3.1%	3,294	1.2%	8775.0%
210500	Ice Cream	11,394	33.0%	47,741	17.6%	3136.9%
210610	Protein Concentrates	6,443	18.7%	40,354	14.8%	2776.3%
350110	Casein	816	2.4%	1,464	0.5%	a
350190	Caseinates	0	0.0%	468	0.2%	a
350220	MPC High	240	0.7%	3,320	1.2%	a
	Total	**34,535**	100.0%	**272,011**	100.0%	180.6%

[a] No % change value calculated because 2007 value equals zero.

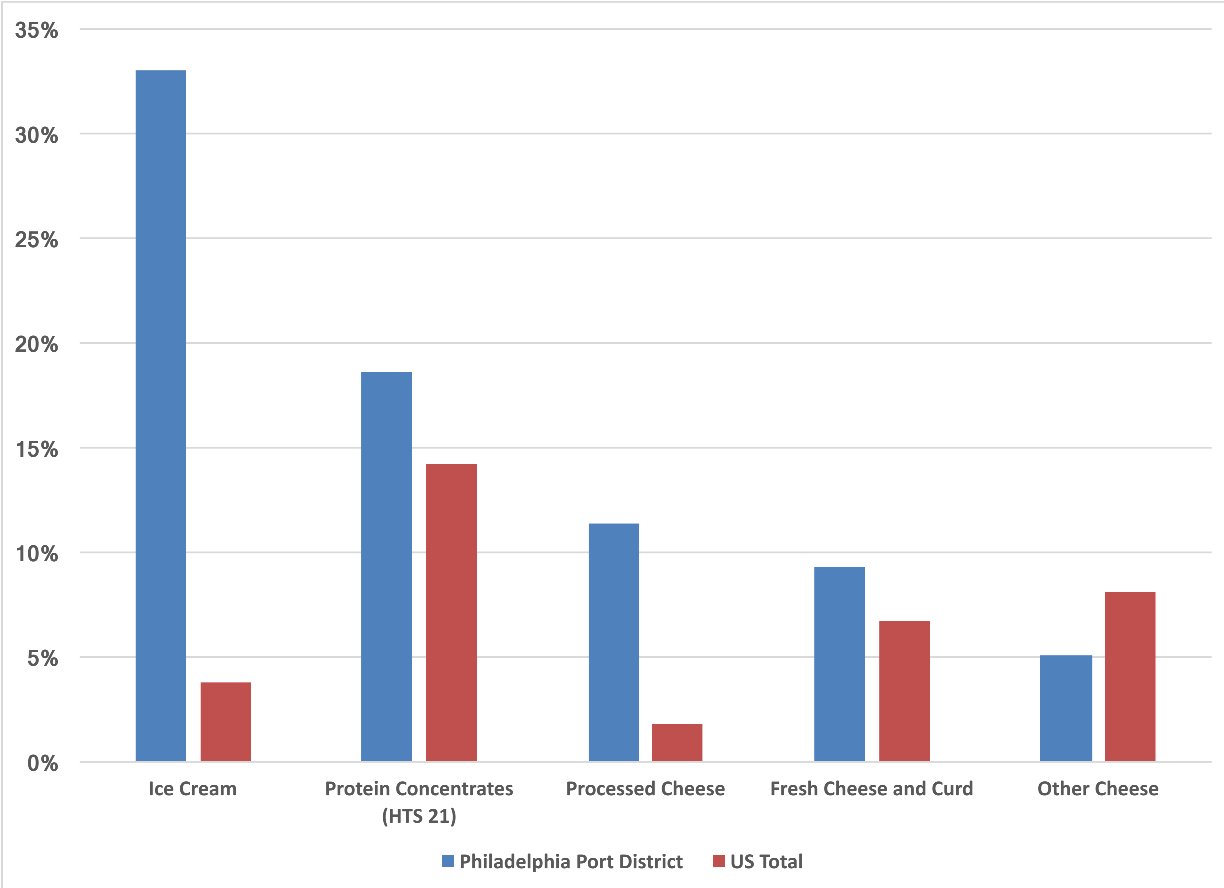

Figure 6.6. Share of Export Value for Philadelphia Port District and Total US, by Top Five Products Exported, 2016

Table 6.3. Value of Dairy Product Exports from the Philadelphia Port District, 2007 to 2016, by Top 10 Destination Countries

Country	2016 Export Value, $000	% of 2016 Total	2007-2016 Total Export Value, $000	% of 2007 to 2016 Total	% Change 2007 to 2016	Maximum % of Exports During 2007 to 2016	Maxi-mum % Exports Year
Australia	12,803	37.1%	81,240	29.9%	12832%	37.1%	2016
New Zealand	765	2.2%	44,302	16.3%	-83%	36.8%	2007
Bermuda	3,192	9.2%	29,060	10.7%	26%	20.7%	2007
Costa Rica	1,906	5.5%	13,973	5.1%	89%	10.7%	2009
Honduras	631	1.8%	13,310	4.9%	38%	13.2%	2009
Colombia	1,874	5.4%	8,830	3.2%	a	7.6%	2015
Chile	1,489	4.3%	8,023	2.9%	1631%	5.8%	2012
El Salvador	897	2.6%	7,200	2.6%	30%	10.6%	2008
Netherlands	1,667	4.8%	7,180	2.6%	2825%	5.4%	2013
Brazil	4,039	11.7%	6,220	2.3%	a	11.7%	2013

[a] No % change value calculated because 2007 value equals zero.

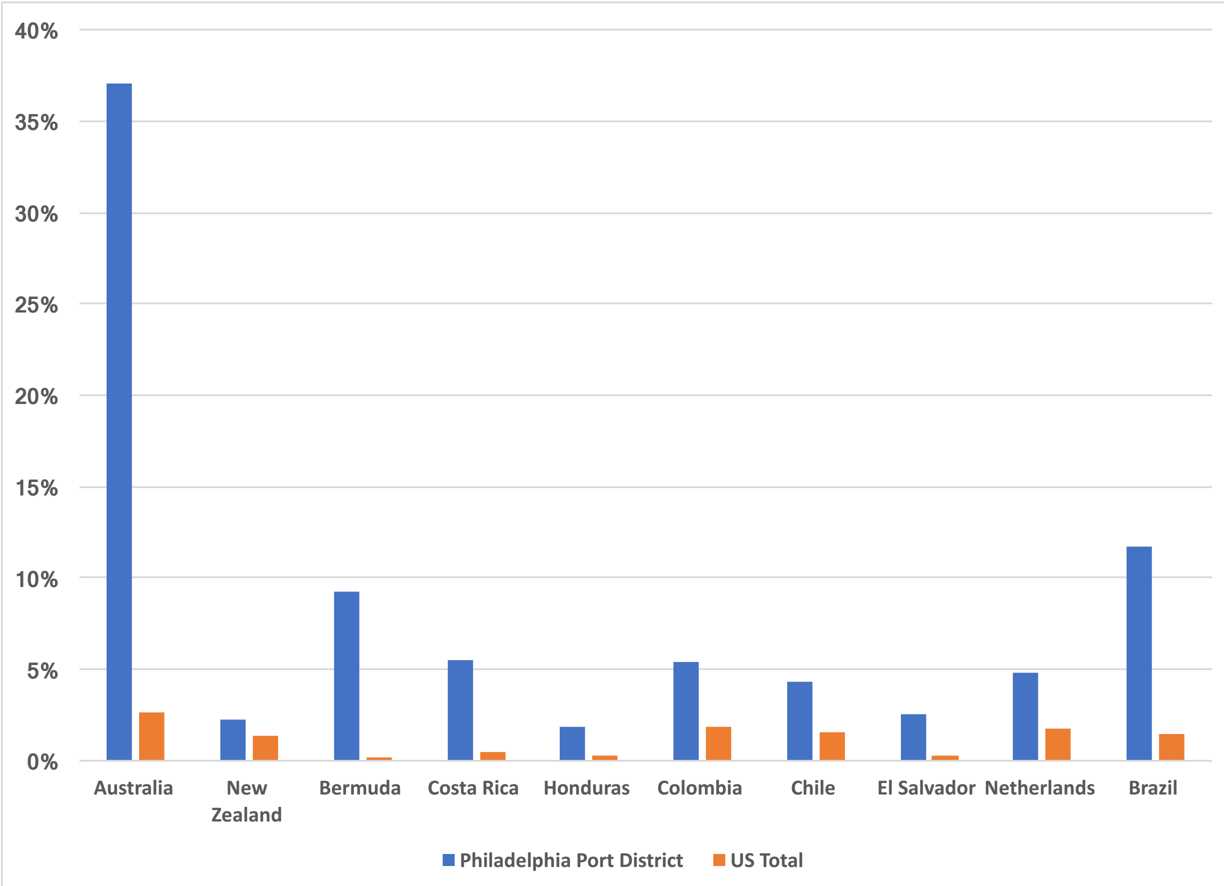

Figure 6.7. Share of Export Value for Philadelphia Port District and Total US, by Top Ten Export Destinations, 2016

Table 6.4. Value of Dairy Product Exports from the Philadelphia Port District, 2016, by Product and Top 10 Destination Countries, $000

Product	Australia	Bermuda	Brazil	Chile	Colombia	Costa Rica	El Salvador	Honduras	Nether-lands	New Zealand	Total
Blue-veined Cheese	1,198					0					1,198
Butter		17	0						0	0	17
Buttermilk		0									0
Casein	811		0						0		811
Caseinates	0	0							0		0
Cheese, Fresh	300	212		1,332		438	197	313		248	3,040
Concentrated Milk		46					99	0			145
Dairy Spreads		83				0					83
Fats/Oils/AMF		8				0		0			8
Grated/Powdered Cheese	1,186	415		0	0	0		0	0	0	1,601
Ice Cream	5,670	625	3,945	0	59	0		88	0	0	10,387
Infant Formula	0	16	94		213	120	30	117	22		612
Lactose	76			0	0					0	76
Lactose NESOI	52	0	0	0		0				0	52
Milk & Cream, < 1%							51				51
Milk & Cream, 1-6%		0									0
MPC High	0			0		240				0	240
MPC Low	0	0		0	0	0		33		0	33
NDM	0	57		0	202	4	50	19			332
Other Cheese	393	974		0	0	0	0			0	1,367
Processed Cheese	2,981	334		0	0	415		0			3,730
Protein Concentrates	23	20		157	1,347	0		42	1,636	517	3,742
Sweetened Concentrated Milk		54						0			54

Product	Australia	Bermuda	Brazil	Chile	Colombia	Costa Rica	El Salvador	Honduras	Nether-lands	New Zealand	Total
Whey Products	113	38		0	0	689	470	19	9	0	1,338
WMP	0	6		0	53	0	0	0			59
Yogurt	0	287									287
Total	**12,803**	**3,192**	**4,039**	**1,489**	**1,874**	**1,906**	**897**	**631**	**1,667**	**765**	**29,263**

Table 6.5. Value of Dairy Product Exports from the Philadelphia Port District, 2007 to 2016, by Product and Top 10 Destination Countries, $000

Product	Australia	Bermuda	Brazil	Chile	Colombia	Costa Rica	El Salvador	Honduras	Nether-lands	New Zealand	Total
Blue-veined Cheese	2,012					10					2,022
Butter		539	4						3	4,304	4,850
Buttermilk		360									360
Casein	811		393						16		1,220
Caseinates	4	8							3		15
Cheese, Fresh	1,614	1,394		5,995		770	634	5,065		2,108	17,580
Concentrated Milk		249					99	58			406
Dairy Spreads		751				22					773
Fats/Oils/AMF		8				47		529			584
Grated/Powdered Cheese	4,820	2,421		7	16	1,135		971	29	346	9,745
Ice Cream	31,958	5,241	5,701	122	122	18		564	27	71	43,824
Infant Formula	27	227	94		870	146	30	117	177		1,688
Lactose	142			208	179					2,614	3,143
Lactose NESOI	121	3	28	34		3				86	275
Milk & Cream, < 1%							51				51
Milk & Cream, 1-6%		11									11
MPC High	331			49		2,884				56	3,320
MPC Low	23	4		38	26	106		33		23,822	24,052
NDM	1,022	182		156	276	4	417	32			2,089
Other Cheese	13,571	12,594		555	91	204	31			56	27,102
Processed Cheese	12,923	3,309		12	29	1,454		2,751			20,478
Protein Concentrates	4,133	249		738	7,090	34		42	6,900	7,299	26,485
Sweetened Concentrated Milk		404						341			745

Product	Australia	Bermuda	Brazil	Chile	Colombia	Costa Rica	El Salvador	Honduras	Nether-lands	New Zealand	Total
Whey Products	1,947	161		67	52	7,099	4,753	2,633	25	1,759	18,496
WMP	5,776	17		42	79	37	1,185	174			7,310
Yogurt	5	928									933
Total	81,240	29,060	6,220	8,023	8,830	13,973	7,200	13,310	7,180	42,521	217,557

Analysis of Selected Economic Impacts of Expanded Dairy Product Exports Through *PhilaPort*

Given the interest in facilitating dairy product exports from Pennsylvania and the investments made by *PhilaPort* in infrastructure and marketing, it is relevant to consider the economic impacts of increases in dairy product exports through the port[45]. In principle, it would be appropriate to develop and analyze alternative scenarios for future export growth and to assess their economic impact[46]. In practice, we opt for a simpler approach that uses a spatial economic model[47] to assess the impacts of reallocating export shipments from other mid-Atlantic ports to *PhilaPort* based on data from March and September 2016. The spatial model currently uses actual export volumes by port district as export demand in these two months. To assess the impact of increased dairy product exports through *PhilaPort,* we assume that the entire volume of exports other from mid-Atlantic ports (New York, Baltimore, Washington, DC and Norfolk) is allocated as export demand to *PhilaPort*—and the volumes shipped from these other mid-Atlantic ports is set equal to zero. (Figure 8 depicts the scenario graphically.) Although this is an extreme and rather unrealistic scenario (and other less extreme reallocations could easily be envisioned), it was selected to illustrate the maximum possible impact of reallocation of export demand from other ports to *PhilaPort.* The model does not indicate how this reallocation would be achieved, nor do the results illustrate the impacts of general growth in exports.

We examine the impact that reallocation of export demand to *PhilaPort* has on milk assembly costs, and regional milk location values (which can be thought of as location-related or market premiums), on total milk processed and product volumes in Pennsylvania, and on product distribution costs (from processors to customers) in March and September 2016. Together these values provide a partial estimate of the economic benefits of greater use of *PhilaPort* compared to alternative export locations. We do not include in this analysis an estimate of economic multiplier effects on overall economic activity and employment in Pennsylvania, although these benefits could also be important.

Results

Increased use of *PhilaPort* during March and September 2016 would have increased farm milk values, reduced farm milk assembly costs, decreased product distribution costs, and modified to some extent the state's dairy product manufacturing mix (Table 6). Farm milk values would be increased by about $1.1 million per year (about $0.01/cwt for all Pennsylvania milk), and farm

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[45] Please note that this is different than assessing <u>how</u> exports through *PhilaPort* (or from Pennsylvania more generally) might be increased, outcomes which depend on overall growth in exports from the region and the benefits of *PhilaPort* use relative to other port facilities, not assessed in this report.
[46] Future export growth for major product categories will be assessed as one component of this study, but for the US as a whole, not for specific ports. However, overall growth in exports tends to be associated with increases in exports from the Philadelphia Port District.
[47] The model is described in detail in the component of this report assessing the economic impact of additional processing capacity in Pennsylvania. As noted there, the United States Dairy Sector Simulator (USDSS) has a twenty-year history of development, and has been used in the assessment of spatial pricing surfaces for Class I milk, impacts of dairy plant closures, assessment of the potential for and impacts of localization of dairy supply chains, and the optimal locations for new processing capacity.

milk assembly costs would decrease by about $320,000[48]. Product distribution costs would also be reduced by about $320,000. The net benefit of a large re-allocation of dairy product exports from other mid-Atlantic ports to *PhilaPort* would be about $1.8 million per year, or about $0.02/cwt for all Pennsylvania milk. This represents that maximum benefit that might be achieved through re-allocation alone.

Use of *PhilaPort* for all mid-Atlantic exports would also provide incentives for re-allocation of milk produced in Pennsylvania[49]. Somewhat more milk would be shipped out of the state (7.5 million lbs per year—about 0.1% of total annual milk production) primarily to Delaware, close to the port. The reallocation would provide incentives for additional production of ice cream, dry whey, fluid milk, and evaporated/condensed/dried products in Pennsylvania, and reductions in the state's butter, cottage cheese, NDM and other cheese.

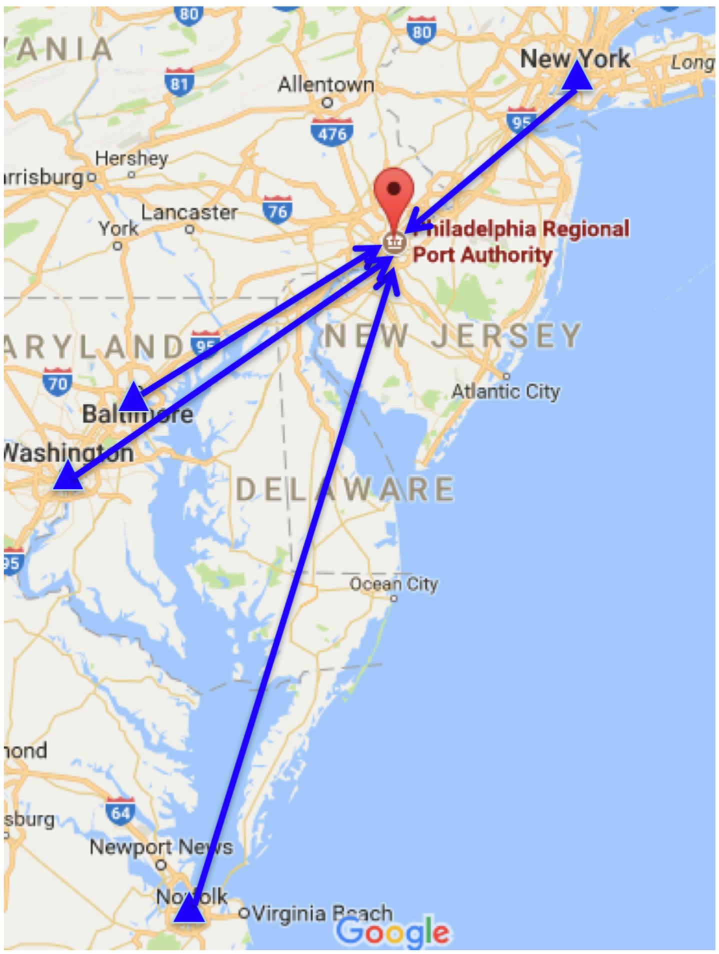

Figure 6.8. Graphical Depiction of Spatial Economic Analysis Re-Allocating 2016 Dairy Product Exports from Mid-Atlantic Ports to *PhilaPort*

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48 These aggregated values are relevant, but the effects differ somewhat for different locations in the state—farms closer to *PhilaPort* would see a larger share of these benefits.
49 The USDSS determines the spatial organization of the US dairy industry minimizes the costs of milk assembly, processing (including inter-plant product transfers) and distribution for the US as a whole. Changes to the location of export demand thus can affect the least-cost location for processing of dairy production, milk assembly to plants and distribution routes.

Table 6.6. Estimated Economic Impacts of Increased Exports of Dairy Products from *PhilaPort*, March and September 2016 Export Volumes

Impact of Increased *PhilaPort* Exports	March[a]	September[a]	Annual Average[b]
Change in milk processed in PA, mil lbs	-0.1	-1.2	-7.5
Change in production, mil lbs			
Butter	-0.1	-0.2	-2.1
Cheese	0.0	0.0	0.0
Cottage Cheese	0.0	-0.1	-1.1
Dried Buttermilk	0.0	0.0	0.0
Dry Whey	0.3	0.8	6.4
Evaporated Condensed Dried	0.4	0.4	4.6
Fluid	0.2	0.2	2.4
Greek Yogurt, Thickened	0.0	0.0	-0.1
Ice Cream	1.0	0.2	7.3
NDM	-0.1	0.0	-0.6
Other Cheese	0.0	-0.1	-0.4
Yogurt	0.0	0.0	0.0
Impact on Farm Milk Value, $/cwt	0.01	0.01	0.01
Change in Farm Milk Value, $	80,268	109,932	1,141,200
Change in Total Farm Milk Assembly Costs, $	-1,812	-51,205	-318,102
Change in Product Distribution Costs, $	-12,451	-40,445	-317,376
Net Benefit, $	94,531	201,582	1,776,678
Net Benefit, $/cwt	0.01	0.02	0.02

[a] Indicates values per month (other than values per cwt)
[b] Indicates values per year (other than values per cwt). Estimated as the average of the March and September values times 12.

Implications and Limitations

The foregoing suggests that the Philadelphia Port District and *PhilaPort* more specifically have significant experience in the export of a wide range of dairy products to a diverse set of countries. Although the current market share for the Port District is small compared to other mid-Atlantic ports and major dairy export locations, it has a notable share of ice cream exports and apparent potential for future growth for a variety of product categories. The limited shipments during the past decade from the Philadelphia Port District to major and more rapidly-growing export markets (Mexico, Canada, China and other Asian countries) may affect the ability of the port to grow export market share—if not the total volume of exports—in coming years, although the port is making investments to expand its capacity to serve those markets. Growth in export market share for PhilaPort would have positive impacts for Pennsylvania farmers and processors, but are probably modest under realistic scenarios.

This analysis is limited in the sense of not fully exploring the reasons underlying the current small market share and the product mix that differs from that of the US as a whole. Factors that likely affect this include, as previously noted, relative landed costs to export destinations, shipping schedules and lead times to key export destinations, and institutional arrangements between dairy companies, shipping lines and buyers. We also do not, in this analysis, project future US exports, which would affect the opportunities for additional volumes to be shipped from *PhilaPort,* although subsequent analyses will provide an assessment of likely export growth for the US as a whole. Our assessment of the economic impacts is limited in that is considers only re-allocation of export demand for two months in one year, but is suggestive of the magnitude of benefits that could accrue to the Pennsylvania dairy industry if greater use were made of *PhilaPort* for dairy exports—which is different than the impacts of growth in export demand overall.

Appendix Table 6.1. Ports Included in the Philadelphia Port District

Code	Port in District
1101	PHILADELPHIA, PA
1102	CHESTER, PA
1103	WILMINGTON, DE
1104	PITTSBURGH, PA
1105	PAULSBORO, NJ
1106	WILKES-BARRE/SCRANTON, PA
1107	CAMDEN, NJ
1108	PHILADELPHIA INTERNATIONAL AIRPORT, PA
1109	HARRISBURG, PA
1113	GLOUCESTER CITY, NJ
1119	ALLENTOWN, PA (LEHIGH VALLEY INTERNATIONAL AIRPORT)
1182	ATLANTIC CITY REGIONAL AIRPORT, NJ
1183	TRENTON/MERCER COUNTY AIRPORT, NJ
1195	UPS, PHILADELPHIA, PA

Source: US Bureau of the Census, https://www.census.gov/foreign-trade/schedules/d/dist.txt

Chapter 7: Projections of Prices, Farm Profitability and US Dairy Product Exports for 2018 to 2025 and Implications for Pennsylvania Farms and Processors

Chuck Nicholson, Cornell University[50]
Mark Stephenson, University of Wisconsin

Executive Summary

This component of the *Study to Support Dairy Growth and Competiveness* assesses likely future outcomes for milk prices, farm profitability and the potential for expansion of US dairy product exports. We use a simulation model of the global dairy supply chain to project these values from 2018 to 2025. Although these projections (and any projections of dairy industry outcomes over this time horizon) are rather uncertain, the results suggest general trends and possible opportunities that should be monitored going forward. These projections can provide a basic context for farm-level planning, processing capacity investments and programmatic efforts to achieve a greater degree of growth and competitiveness for the Pennsylvania dairy industry.

Our key findings are:

- Milk and dairy product prices are expected to have markedly higher average values during 2018 to 2025 than during 2015 to 2017;
- Milk and dairy product prices will vary throughout the period 2018 to 2025, with a cycle of about three years in length, consistent with the average of previous cycles;
- The pattern of milk prices projected for the next eight years is roughly consistent with the pattern observed during 2010 to 2017, except that it projects higher prices in 2022 to 2025 than those observed during 2016 and 2017;
- Higher average milk prices, combined with projected relatively stable feed costs and growth in average cows per farm will result in higher levels of average profitability as measured by Net Farm Operating Income (NFOI), and this is true for all four of the farm sizes analyzed;
- The value of US dairy product exports is predicted to grow during 2018 to 2025 compared to 2017, but with fluctuations related to the relative prices of US dairy products due the cyclical behavior noted above;
- Domestic butterfat values—which underlie much of the projected farm milk price strengthening—are projected to be higher than those in global dairy markets, consistent with observed patterns in 2014 to 2016. This provides incentives that could alter the mix of US dairy product exports from products with higher butterfat content (for example, butter and cheese) and towards protein products (including MPCs and casein products);
- Despite overall growth in the value of US dairy product exports, products for which PhilaPort has larger export market shares among Northeast ports (for example, ice cream) are not indicated to provide major growth opportunities.

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[50] Chuck Nicholson is former Clinical Associate Professor of Supply Chain Management at Penn State University, now Adjunct Associate Professor at Cornell University. Mark Stephenson is Director of Dairy Policy Analysis at the University of Wisconsin, Madison.

Overview and Study Objectives

This component of the *Study to Support Dairy Growth and Competiveness* assesses likely future outcomes for milk prices, farm profitability and the potential for expansion of US dairy product exports. We use a simulation model of the global dairy supply chain to project these values from 2018 to 2025. Although these projections (and any projections of dairy industry outcomes over this time horizon) are rather uncertain, the results suggest general trends and possible opportunities that should be monitored going forward. These projections can provide a basic context for farm-level planning, processing capacity investments and programmatic efforts to achieve a greater degree of growth and competitiveness for the Pennsylvania dairy industry. The specific objectives for this component include:

- Evaluate the likely patterns of US farm milk prices, dairy product prices and dairy farm profitability from 2018 to 2025;
- Assess likely volume and value of US dairy product exports from 2018 to 2025 for a selected number of major dairy product categories;
- Discuss the implications of these projections for farm-level and processor decision making and programmatic efforts.

Historical Overview

U.S. farm milk prices and margins have been cyclical for at least the past twenty years, with a typical cycle lasting a bit longer than three years[51] (Figure 1). The length and amplitude (high-to-low spread) of each cycle will differ—and the current low farm-milk-price period indicates a longer than average cycle. However painful the past few years have been for US dairy farmers, it is important to keep in mind that low-price part of the cycle will come to an end—and key questions are when that will occur and what will the higher-price part of the cycle look like? Although the answers to these questions are always somewhat uncertain, projections of future price patterns can be helpful for planning purposes for both dairy producers and processors. Although U.S. dairy product exports are not really a driver of price cycles[52], dairy exports have been increasing markedly in value since 2000 (Figure 2). They reached a peak value of nearly $10 billion per year in 2014, before declining somewhat since then. This growth in export sales has supported the overall growth of the US dairy industry and has enhanced prices, at least in the short term. The growth of the US role in export markets presents both opportunities and challenges for the US, and it is thus important to consider the overall magnitude of future export sales and the mix of products that are most competitive in global dairy product markets.

[51] The pattern of recent price cycles is explored further in Nicholson, C. F. and M. W. Stephenson. 2015. "Margins During the Dairy Price Cycle: Will This Time Be Different?" Program on Dairy Markets and Policy, June. [Information Letter 15-03] http://dairymarkets.org/PubPod/Pubs/IL15-03.pdf
[52] Nicholson and Stephenson's 2015 article "Price Cycles in the U.S. Dairy Supply Chain and Their Management Implications" in *Agribusiness* indicates that trade quantities were not statistically associated with cyclical US farm milk price behavior.

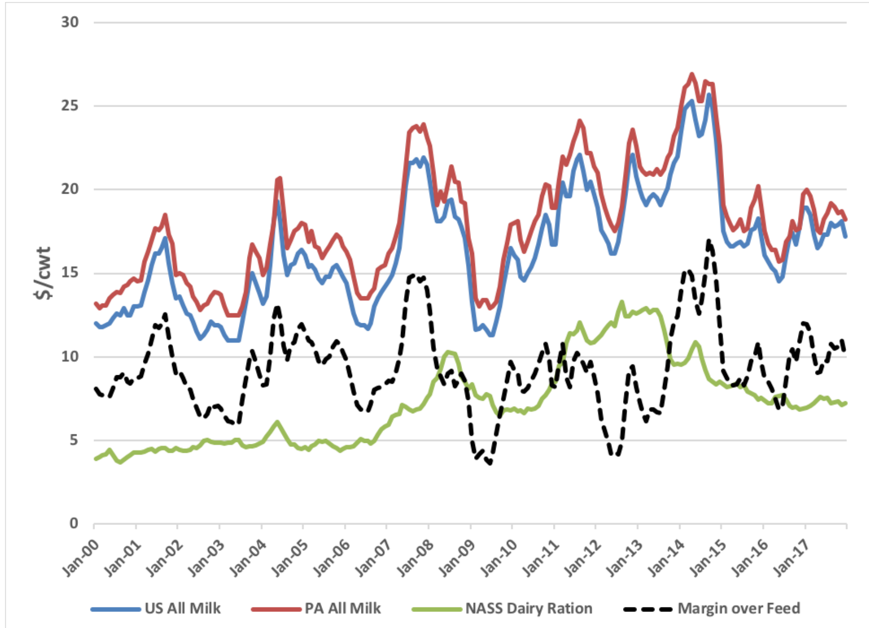

Figure 7.1. US All-Milk Price, Pennsylvania All-Milk Price, NASS Dairy Ration Value and Margin Over Feed Costs, 2000 to 2017

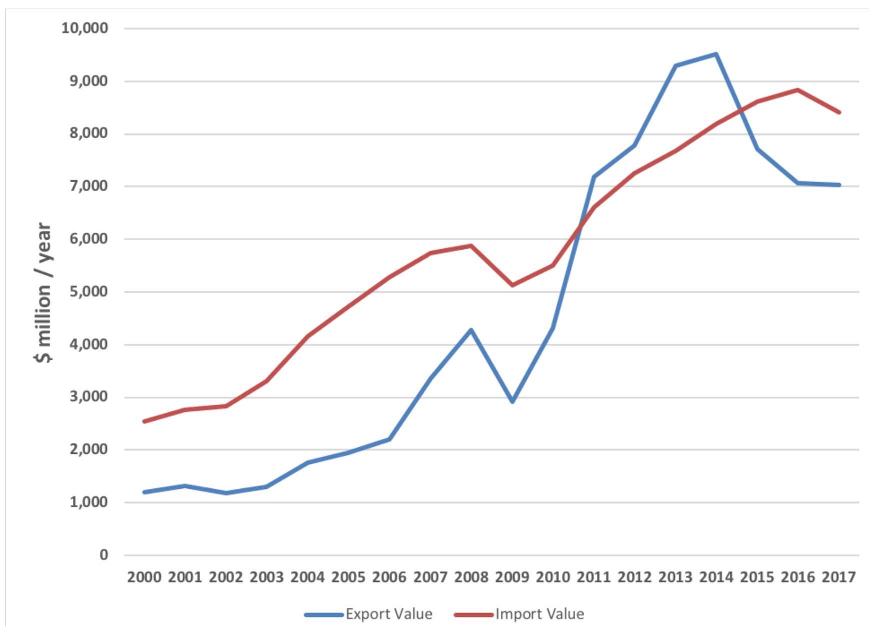

Figure 7.2. Total Value of US Dairy Product Imports and Exports, Annual Data 2000 to 2017[53]

[53] 2017 values include only the months of January to November.

Methods for Projections and Caveats

Our assessment of future prices, profitability and trade uses a detailed empirical system dynamics model of the global dairy supply chain adapted from the commodity supply chain model described in Sterman (2000), which builds on an initial formulation by Meadows (1970). This model has been developed and adapted to the U.S. dairy industry during the past 15 years, extended to global coverage beginning in 2015. More detailed description of the model is provided in the Appendix, but the model covers 15 regions (covering all countries) and incorporates 23 total products (20 "final" products that have explicit demand curves and 13 "intermediate" products that are used in the manufacture of other dairy products). The base year for the model is 2013, meaning that 2013 data on milk production and dairy product consumption and trade are used to initialize the model. The model simulates monthly outcomes from 2013 to the end of 2025. The model comprises modules that represent farm milk supply, farm milk pricing, dairy product processing, inventory management and trade, and dairy policies including the margin insurance implemented in the US in 2014 and the phase-out of European Union quotas through 2015. Model development was supported in part by the U.S. International Trade Commission (USITC). Model refinement and calibration is still underway, but the model is sufficiently developed and tested to provide projections of basic trends in prices, profitability and trade.

As with all models and projections (particularly for more than five years into the future and for a complex global dairy industry), the precise values are less important than the indicated general trends. Our analysis also assumes continuation of existing domestic US support policies (e.g., MPP-Dairy) and trade policies (e.g., those under NAFTA) that may be changed in the reasonably near future. We also do not include analysis of supply or demand "shocks" (such as the combined effects of high milk prices in 2014 followed by a global fall-off in dairy product demand). Such changes and shocks could be substantive enough to modify the future patterns predicted here, as could other events such as drought in major production regions.

Price and Profitability Projections

The projections of the global dairy supply chain model suggest that recovery from the current low-price (low-margin) part of the cycle will be slow through 2018 but begin to strengthen more substantively during 2019 (Figure 1 and Table 1). The model projects cyclical behavior of the US All-milk price through 2025—with a more muted three-year cycle—but with overall higher average prices than in recent years. In fact, the pattern of prices is reminiscent of prices during 2010-2017 (Figure 2), although without the drop-off in prices that has characterized the period after the 2014 price peak and demand shock. The higher US prices arise in part from growing global demand, but also from domestic demand—particularly for butterfat—which results in higher US butter prices.

With higher longer-term price projections and projected relatively stable feed prices, farm profitability as measured by Net Farm Operating Income[54] (NFOI) is projected to improve substantially in the years 2018 through 2024 (Table 1). US Farms will also grow in average size over the eight-year period, which also contributes to larger NFOI values for all farm size categories. As for milk prices, NFOI values fluctuate during the period, largely due to the cycle in milk prices.

Although caution is appropriate with any longer-term projection of prices and profitability, our results suggest marked and reasonably well sustained improvements overall in farm financial performance compared to the current market situation.

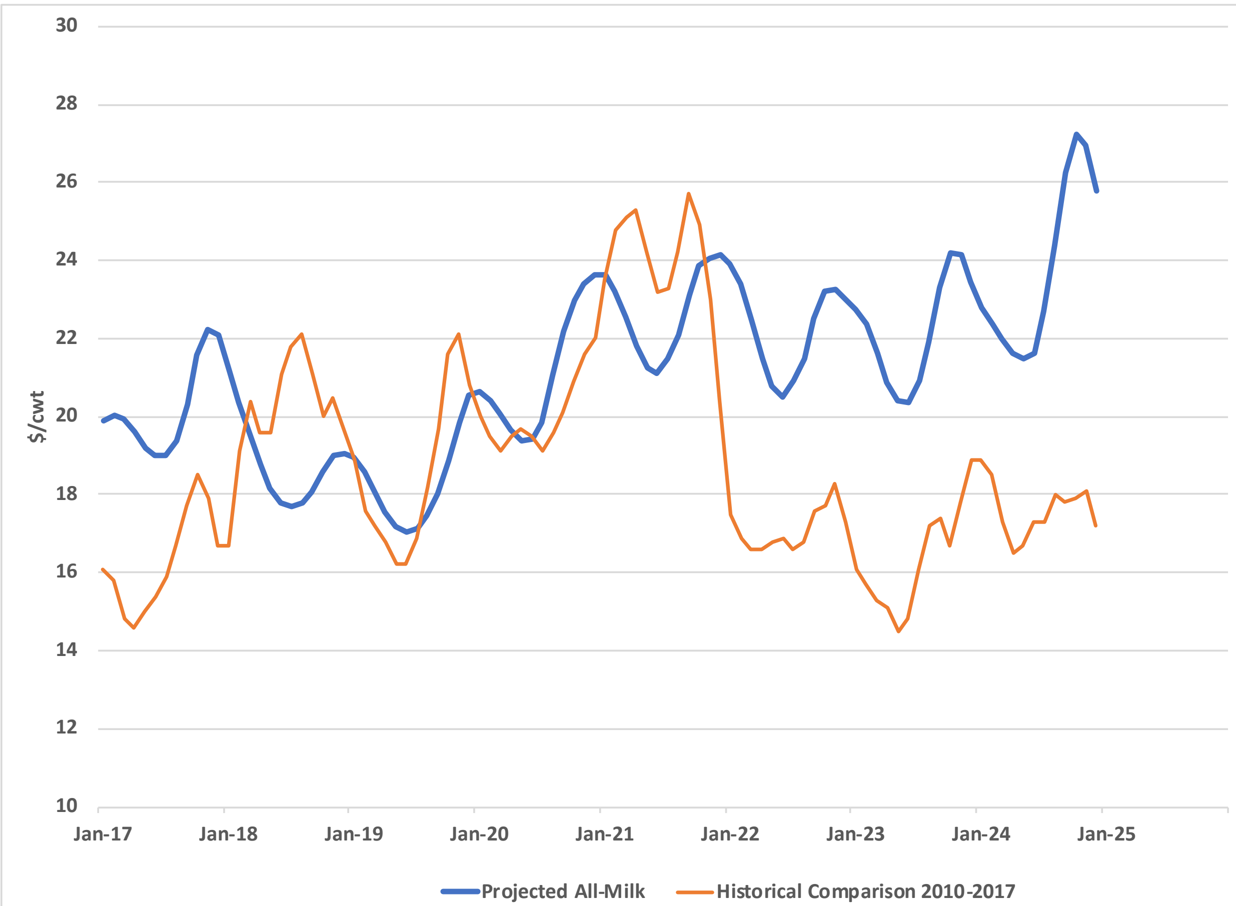

Figure 7.3. Projected All-Milk Price 2017-2025, and Historical Comparison Data from 2010 to 2017

[54] Net Farm Operating Income is defined as gross revenues from sales of milk and livestock plus any program payments less operating costs for feed, labor, replacements and other. Thus, it assumes cash-based accounting and does not include fixed or administrative costs. Positive NFOI values do not necessarily mean that farms are covering all costs or would be considered profitable based on other measures such as Return on Assets (ROA).

Table 7.1. Projected Price and Profitability Outcomes for the US Regions Other than California[55], Annual Averages 2017 to 2025

Financial Outcome	2017	2018	2019	2020	2021	2022	2023	2024
All-Milk Price, $/cwt	16.88	20.19	18.83	18.27	21.06	22.69	22.24	22.19
NFOI, $/farm/year								
Small[a]	58,265	34,080	33,657	65,819	103,335	103,927	113,896	183,067
Medium[a]	168,769	67,951	67,956	177,491	298,301	302,034	332,123	523,668
Large[a]	690,542	385,579	382,156	617,356	822,136	799,842	830,222	1,127,413
Extra Large[a]	3,059,438	2,045,845	1,831,162	2,287,570	2,646,087	2,268,056	2,125,970	2,406,780
Product Prices, $/lb								
Butter								
NDM	1.76	1.54	1.56	1.94	2.09	2.08	2.08	2.15
American Cheese	1.52	1.40	1.32	1.45	1.53	1.40	1.29	1.30
Dry Whey	1.77	1.71	1.66	1.86	2.00	1.96	1.91	1.96
	0.59	0.56	0.53	0.53	0.54	0.54	0.55	0.55
Class Prices, $/cwt								
Class I								
Class II	21.61	20.29	19.62	21.88	23.26	22.72	22.21	22.72
Class III	18.94	17.22	16.36	19.03	20.53	19.41	18.47	18.83
Class IV	18.09	17.26	16.60	18.69	20.17	19.79	19.33	19.89

[a] Small farms averaged 73 cows, medium farms averaged 248 cows, large farms averaged 597 cows and extra-large farms averaged 1992 cows during the simulation period from 2013 to 2025, although there is growth in average number of cows per farm for all categories through 2025.

[55] The global dairy supply chain model includes two regions for the US, California the "rest of the US". This was done to represent California's state milk marketing order provisions, which differ from those in the other Federal Milk Marketing Orders. The all-milk and NFOI values above are for the "rest of the US" region.

Export Projections

The value of US exports is highly variable for individual products and for the overall value, so it is challenging to make accurate projections for the longer term. Thus, our results are more usefully considered as general tendencies over time rather than as values for each specific year. The volume of exports indicates potential sales volumes. The value is determined by both the US selling price and the volume, so values can change in a manner different than export volumes.

Our projections indicate generally stable export volumes for whey products (a key US export), growing volumes for fluid, and generally lower volumes of cheese, NDM and butter exports (Table 1). The lower export volumes in later years for cheese, NDM and butter are driven by the higher prices in the US relative to export market competitors, particularly due to higher butterfat values[56]. The higher prices for butterfat are a key driver of higher milk prices, which ultimately results in higher milk production. This additional milk provides nonfat solids that are more cost competitive than products with butterfat, which suggests increasing opportunities for exports of milk protein products (MPC, casein, caseinates) from the US. Although our projections show exports of some products as reaching very low levels, this is better thought of as indicating reduced incentives for exports of these products[57].

The overall value of US exports is projected to increase during 2017 to 2025, but consistent with the projected changes in export volumes described above, the share of value arising from different product categories will change over time. In 2017, our projected values indicate that NDM, cheese and butter provide more than 50% of total dairy export values. By 2025, the share of export value in protein products is projected to grow, consistent with the projected increase in export volumes. As might be expected, the overall value of exports fluctuates with US milk and product prices, with smaller export values in years with higher milk prices.

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[56] US trade policy maintains the strictest import controls on products with butterfat (butter, AMF, cream), which allows for large differences between US and world market prices for these products. This phenomenon was observed during 2014 to 2016, when US butter prices were sometimes more than double those in the European Union and Oceania.

[57] Trade in branded dairy products (such as yogurt and ice cream) will be driven by factors other than relative prices as is assumed in our modeling framework. Thus, very low values are unlikely to occur, although our results likely indicate less attractive future opportunities for these products.

Table 7.2. Projected US Exports of Dairy Product Categories, Annual Averages 2017 to 2024

Product Category	2017	2018	2019	2020	2021	2022	2023	2024
	------- (million lbs / year) -------							
American Cheese	720	423	511	669	576	554	648	689
Other Cheese	537	336	249	179	142	146	205	201
Dry Whey	526	494	485	499	513	527	543	559
WPC34	207	195	191	191	189	186	183	181
WPC80	65	54	46	42	41	41	42	44
Other Whey	692	657	650	650	650	635	618	603
NDM	2,040	1,954	2,051	1,793	1,123	786	720	703
Other Evaporated, Condensed and Dried	367	130	69	65	37	15	10	10
Fluid	339	264	225	213	170	157	172	174
Yogurt	199	153	147	119	62	32	20	13
Ice Cream	387	263	177	124	73	40	26	19
Butter	539	287	310	129	32	10	3	1
MPC Low	583	654	736	834	912	987	1,059	1,143
MPC High	271	354	445	537	611	681	748	813
Casein	123	169	285	404	482	557	627	691
Caseinates	488	588	715	856	968	1,079	1,194	1,307

Table 7.3. Projected US Exports of Dairy Product Categories, Annual Averages 2017 to 2024

Product Category	2017	2018	2019	2020	2021	2022	2023	2024
	------- ($ million / year) -------							
American Cheese	1,274	726	847	1,244	1,154	1,084	1,236	1,353
Other Cheese	970	590	419	332	282	284	394	403
Dry Whey	310	276	259	266	276	287	297	308
WPC34	291	256	239	241	245	246	247	248
WPC80	97	82	70	64	62	63	64	66
Other Whey	485	453	454	475	493	489	475	465
NDM	3,096	2,737	2,699	2,580	1,716	1,098	929	917
Other Evaporated, Condensed and Dried	190	74	34	34	22	9	6	6
Fluid	126	95	78	80	67	61	66	70
Yogurt	215	159	147	129	72	36	21	15
Ice Cream	258	174	113	85	53	29	18	13
Butter	912	440	485	229	64	19	6	2
MPC Low	455	446	461	511	551	590	625	664
MPC High	346	376	416	475	520	560	598	634
Casein	238	278	410	549	617	679	735	786
Caseinates	1,735	1,791	1,968	2,256	2,467	2,668	2,873	3,075

Implications and Limitations

Our dynamic simulation modeling analysis suggests a number of positive developments for farm profitability, and enhanced dairy product exports (albeit with a change in the product mix) over the next eight years. Although our farm-level results do not apply specifically to Pennsylvania farms (being a composite of farms in the US outside of California), the projected improvements in farm milk prices and profitability would likely benefit farms in Pennsylvania also. The most important implications of this are the ability of farms to recover from the recent low-profitability years, recoup farm equity and reduce debt. If the projected improvements in profitability occur, these would provide welcome breathing space and financial resources for business planning decisions to improve future productivity and profitability. Thus, this higher-margin period would provide a strategic opportunity to individual farm businesses to define their plans for the years after 2025. It would likely also facilitate the ability to discuss and implement modifications to the support provided to Pennsylvania's dairy industry, as producers would have less need to focus on addressing the challenges that come with low profitability.

Our export market projections suggest a growing but fluctuating opportunity for US dairy product exports, with greater opportunities for protein products than exist currently. A crucial condition for these projections to represent future realities is the increased value of butterfat in US markets and the existing US import restrictions for butterfat. As these are both rather uncertain, it is difficult to reach conclusions about appropriate next steps based on these projections. Although our projections do not suggest strong growth in products that have been exported through *PhilaPort* (such as ice cream, see the complementary project report on *PhilaPort* export volumes) the overall growth in export markets should provide opportunities to Pennsylvania dairy product manufacturers and, thus, Pennsylvania dairy farms. It is worth noting, however, that is not so much growth in exports per se that underlies the higher milk prices and profitability—that appears to be driven primarily by policies restricting US butterfat imports.
As has been noted above, making highly accurate projections of milk prices and export volumes over the period of nearly a decade is challenging, for a variety of reasons. The patterns we indicate will undoubtedly be affected by climate events (drought) and perhaps by alterations in trade policy that are difficult to predict. The predictions still have use as general indicators of likely future outcomes, but planning decisions should be made on the basis additional monitoring of developments and with limited emphasis on the values of prices or export volumes in specific years. Our work to further refine the dynamic global dairy supply chain model is ongoing, and future work may see somewhat altered conclusions from those reported here.

Appendix 7: Global Dairy Trade Model Description

Our assessment of the future prices, profitability and trade uses a detailed empirical system dynamics model of the global dairy supply chain adapted from the commodity supply chain model described in Sterman (2000), which builds on an initial formulation by Meadows (1970). This model has been developed and adapted to the U.S. dairy industry during the past 10 years, and the feedback structure relevant for this analysis was discussed below (Figure 1). More detailed description of the model is provided in the below, but the basic structure for key model components is described below. The base year for the model is 2013, meaning that 2013 data on milk production and dairy product consumption and trade are used to initialize the model. The model simulates monthly outcomes from 2013 to the end of 2025[58]. The model comprises modules that represent farm milk supply, farm milk pricing, dairy product processing, inventory management and trade, and dairy policies including the margin insurance implemented in 2014). Each of these is discussed in detail below.

Model Regions

The Dynamic Global Dairy Supply Chain Model includes representations for 15 regions, two for the US (California and Rest of US), and 13 non-US regions including the ASEAN countries (10 countries), Oceania (Australia and New Zealand), the EU (28 countries), Russia, China, Mexico, India, Canada, former Soviet Union countries (11 countries), Middle East and North Africa (MENA; 19 countries), major South American milk producers (Brazil, Argentina, Uruguay), Other Net Importing Countries (described below) and Other Net Exporting Countries (described below).

Farm Milk Supply

The milk supply components of the model are based on up to four farm-type categories based per region. In the US, farm-types are based on numbers of cows owned for both the rest of U.S. and California. (California is modeled separately because it is the largest milk producing state and maintains a state-level system of milk price regulation different from the rest of the U.S.) For each farm-type category, the total number of farms is modeled[59], as is the average financial situation (both elements of the income statement and the balance sheet) for each farm category. The cost structure of farms in the different herd size categories is different, as is the responsiveness to profitability signals. Based on genetic improvement rates over the past 20 years, milk per cow[60] is assumed to grow at a potential rate of 2% per year, but is adjusted in the short run based on the margin between farm milk prices and feed prices. This is similar to the approach in Bozic et al., (2012), who used a linear trend in yield, but the yield increment varied with margins.

The number of cows for each farm size category is treated as a productive asset, and the evolution of cow numbers depends on heifers entering the herd (which depends on previous breeding decisions) and culling decisions (which can be voluntary or involuntary). Involuntary culling rates depend on the desired number of cows for each farm size category, which is modeled using an "anchoring and adjustment" approach based on Sterman (2000). This

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[58] Because the model simulations begin with 2013, this is why 2017 values are called "projections" rather than "actual values" in the tables and discussion above.
[59] For some regions, the number of farms is assumed to be one, effectively aggregating the country's milk production response.
[60] The model also represents buffalo milk production for India and Pakistan in addition to milk from cattle.

anchoring and adjustment mechanism assumes that desired cow numbers for each farm size category respond to expectations of future Net Farm Operating Income (NFOI) relative to a benchmark NFOI, both of which are updated over time. NFOI equals total revenues less variable costs for feed, labor, and other expenses. When the desired number of cows changes, the voluntary culling rate is adjusted. Changes in the culling rate in response to profitability changes are asymmetric: proportional changes in the voluntary culling rate are larger when desired cow numbers are below current cow numbers than when current cow numbers are larger than current cow numbers.

Farm Milk Pricing

The U.S. government and many other countries maintain regulations that set minimum allowable farm milk prices based on market prices of dairy product prices and the product for which the farm milk is used. The details for the US are provided in Nicholson and Stephenson (2010) and are not discussed here. For other countries, we assume that milk prices will be derived from dairy product prices, in a manner similar to that in the US but without minimum classified prices based on milk use. Milk prices affect both milk per cow and NFOI and therefore influence cow numbers. A standard measure of the farm milk price in the U.S. is the "All-milk" price reported for the entire U.S. (including California) by the National Agricultural Statistics Service, and this is included in the model as a benchmark price, with a similar indicator price calculated for other countries.

Dairy Processing

The dairy-processing component of the dynamic model incorporates 23 products, 20 of which are "final" products (have explicit demand curves) and 13 of which are "intermediate" products that are used in the manufacture of other dairy products (Table 1). Non-storable products (fluid, yogurt, ice cream and cottage cheese) are assumed manufactured in the month in which they are consumed. Storable products have inventories, and the value of inventory in each region relative to sales (called "inventory coverage") is used in setting prices for these products. Milk is allocated preferentially to fluid, soft and cheese manufacturing, with the remaining milk allocated to nonfat dry milk (NDM) and butter manufacture. The model explicitly tracks skim milk and cream quantities to ensure component (mass) balance between sources (farm milk) and uses (dairy product demand). To represent potential substitutability among intermediate products as relative prices change, the lowest cost of three potential ingredient combinations (for example, NDM versus milk protein concentrates (MPC) used in cheese manufacturing) is calculated and adjustments in intermediate product use occur over the course of a month following a change in the lowest-cost combination. The proportional utilization of existing manufacturing capacity for storable products depends on current profit margins, calculated on an aggregated enterprise basis. The manufacturing capacity for each U.S. region was assigned based on production shares in California and the U.S. in 2013. Capacity for cheese and whey products changes over time in response to long-term changes in profitability for those products.

Table A7.1. Dairy Product Categories Included in the Dynamic Global Dairy Supply Chain Model

Product Category	Final Product	Inter-mediate Product	Tradable Product
Fluid Milk	X		X
Yogurt	X		X
Frozen Desserts	X		X
Cottage Cheese	X		
American-type Cheeses	X		X
Other Cheeses	X		X
Fluid Whey		X	
Separated Whey		X	
Whey Cream		X	
Dry Whey	X	X	X
Whey Protein Concentrate 34% Protein	X	X	X
Whey Protein Concentrate 80% Protein	X	X	X
Lactose	X	X	X
Butter	X		X
Anhydrous Milk Fat (AMF)	X		X
Nonfat Dry Milk	X	X	X
Infant Formula	X		X
Condensed Skim Milk	X	X	
Other Evaporated, Condensed & Dry products	X		X
Casein	X	X	X
Caseinates	X	X	X
MPC, < 50% protein	X	X	X
MPC, >= 50% protein	X	X	X

Dairy Product Demand

Dairy product demand for final products is represented separately for each region. U.S. fluid milk consumption is based on fluid utilization from California and sales from the Federal regulatory bodies that determine minimum regulated farm milk prices using data for 2013. Consumption of other products was calculated as national U.S. commercial disappearance (production + imports – exports – dairy industry use) and allocated on the basis of regional population. The impacts of product prices on demand are modeled using constant elasticity demand functions, which also are assumed to shift over time in response to population and income growth. Intermediate product demand is determined by the use of dairy components in the production of other dairy products, based on relative costs. Cross-price effects for intermediate products are included for NDM, MPC products, casein products and whey products but not for others. The quantity demanded adjusts over time in response to price changes, rather than instantaneously, to account for delays required for buyers to form price expectations, find substitutes, redesign products or for the expiration or renegotiation of contractual obligations with suppliers. Retail prices for fluid milk products, yogurt, cottage cheese and ice cream are modeled using constant proportional mark-ups over milk ingredient costs. Wholesale prices for storable products, as noted earlier, depend on inventory coverage.

Dairy Product Trade

The model includes a detailed international trade component, consistent with its purpose. Imports and exports are represented for 18 tradable dairy product categories (Table 1). Imports for each region are calculated separately for each origin (exporting region) and based on whether imports were subject to Tariff Rate Quota (TRQ) or "over-quota" restrictions. The TRQ specify a total annual amount of allowable imports at a relatively low tariff rate. We have ignored the country- and region-specific import restrictions (e.g., import licenses or TRQ allocations) associated with some products imported into the US. "Over-quota" imports are not limited in quantity but generally face higher tariff rates. Both *ad valorem* (percentage based on value) and specific (per unit) tariffs are represented for both categories of imports. The model uses 2013 trade data as base, and imports and exports in future years are determined based on the growth in demand in the ROW, relative prices in the importing and exporting regions, transportation costs and import restrictions. Total exports for each region and product are calculated as the sum of the product imported by all other regions from the origin region.

Dairy Policies

The post-2014 suite of U.S. dairy policies is represented in the model, including the MPP-Dairy margin insurance program. We also include U.S. policies unchanged by the Agricultural Act of 2014, such as minimum farm milk price regulation under federal and California milk marketing orders, including relevant timing of pricing decisions. For regions other than the U.S., dairy policy (other than trade policy) is represented by intervention purchase programs in the EU, and supply management programs in the EU and Canada (for which more details are provided below); other policies and programs related to dairy in other countries are ignored. We include the policy structure of the model to account for the major impacts of MPP-Dairy in the U.S.

Data Sources

The data used to develop the structure and parameter values for the model are from diverse sources, including NASS publications, U.S. Census Bureau (for trade statistics) previous modeling studies (e.g., Bishop, 2004; Pagel, 2005), other industry documents, and in some cases, judgment of dairy industry decision makers and analysts. This use of a broad range of sources is common for dynamic simulation models, and is consistent with the three types of data needed according to Forrester (1980): numerical, written and mental (professional knowledge) data.

Appendix 7 References

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Chapter 8: Analysis of the Impacts of the Pennsylvania Milk Marketing Board on Fluid Milk Retail Prices and Processing Volumes

Chuck Nicholson, Mark Stephenson and Andrew Novakovic[61]

Executive Summary

This component of the *Study to Support Dairy Growth and Competiveness* reviews evidence regarding two hypothesized effects of the PMMB: price enhancement that could reduce fluid milk sales and incentives to process fluid milk products outside of Pennsylvania.

Both retail prices and supply chain sourcing, processing and distribution decisions are influenced by many factors unrelated to price regulation under the PMMB, so it is challenging to provide a definitive assessment of either with existing data. To provide a context for assessment of the impact of PMMB regulation on retail fluid milk prices, we compare retail fluid milk prices available monthly for 2007 to 2017 in Philadelphia and Pittsburgh to prices observed in three comparison markets for each of these cities, also controlling for differences due to selected transportation and processing costs. We use a detailed national-level spatial economic model to assess the incentives for farm milk assembly and packaged milk distribution across state boundaries in the Northeast assuming a perfectly competitive (cost-minimizing) supply chain for the months of March and September 2016, and compare these outcomes to data about the retail sales and farm milk actually priced under the PMMB.

Our key findings are:

- We find no definitive evidence that suggests that price regulation under the PMMB is a major cause of declining fluid milk sales or decisions about the location of fluid milk processing, and thus, no evidence that major modifications to the PMMB would result in substantive improvement in sales of fluid milk or differences in processing location for same;
- However, we note that assessment of the impacts of PMMB pricing regulation on retail fluid milk prices and fluid milk processing in Pennsylvania is difficult because many factors other than price regulation affect these outcomes and data availability is limited;
- The difference between retail fluid milk prices between Philadelphia and comparison cities (Washington, DC, Baltimore and New York City) varied over time, but the average prices during the 11-year time period analyzed are similar for the four cities for both whole and reduced-fat fluid milk;
- The difference in retail fluid milk prices between Pittsburgh and comparison markets also varied over time, but average retail fluid milk prices in Pittsburgh were generally higher (by about 10%) than in the most relevant comparison city of Cleveland. However, some of this price difference may occur due to "loss-leader" pricing strategies used by retailers in Cleveland and other comparison cities (Cincinnati and Detroit);

[61] The authors are, respectively, former Clinical Associate Professor of Supply Chain Management, Penn State University (now Adjunct Associate Professor, Cornell University), Director of Dairy Policy Analysis, University of Wisconsin, Madison, and E. V. Baker Professor of Agricultural Economics, Cornell University.

- Price enhancement due to the PMMB does not appear to be a major factor in the observed reduction of fluid milk sales in recent years. Our estimates suggest that the impact of retail pricing regulation under the PMMB at most accounts for less than one-fifth of the decline in fluid milk sales observed in the past five years. Limited impact reflects the fact Pennsylvania prices were either generally lower than those in comparison markets (Philadelphia) or the differences were smaller (Pittsburgh) during the past five years (when the rate of decrease in fluid sales has been somewhat larger than during 2007 to 2013);
- Spatial economic modeling indicates that there are economic incentives other than PMMB regulation for flows of farm and packaged milk across state boundaries in the Northeast and Mideast. Analysis of Pennsylvania, New York and Ohio for March and September 2016 indicated that none of these states would be "self-sufficient" in the sense that all packaged milk sales would be from farm milk produced and processed within the same state;
- Economic incentives in the absence of price regulation would imply that not all farm milk processed at fluid milk plants in Pennsylvania should come from within the state, and about 20% of packaged milk sales in Pennsylvania would be sourced outside the state during March and September 2016. Our modeling predicts that some Pennsylvania farm milk would be processed at fluid plants outside the state and shipped back to Pennsylvania as packaged milk in the absence of price regulation, so the existence of such product movements is not, in and of itself, evidence that PMMB price regulation is an underlying cause;
- A detailed assessment of farm milk assembly to fluid processing plants and distribution flows to Pennsylvania demand locations in March and September 2016 predicted based on spatial economic incentives alone indicates that about three-quarters of fluid milk sales in Pennsylvania would be from milk produced processed and distributed within the state (thus meeting basic criteria for minimum farm milk price regulation by PMMB). However, the proportion of Pennsylvania farm milk production used in these fluid milk sales was less than one-fifth of the total: 18% in March 2016 and 16% in September 2016;
- The volume of Pennsylvania farm milk priced by the PMMB has declined from 2007 to 2016, but these declines are largely in line with declines in fluid milk sales reported by the Northeast and Mideast Federal Milk Marketing Orders and for the US as a whole, which suggests that factors other than price regulation under the PMMB are more important drivers of the observed reductions in fluid milk sales[62];
- The percentage of Pennsylvania farm milk priced under the PMMB during 2007 to 2016 is roughly consistent with the predictions of our spatial economic model, again suggesting that the impact of the PMMB on fluid milk processing locations and volumes is limited and is only one of a number of factors that will influence these outcomes;

Background and Study Objectives

The purpose of this document is to assess evidence about the impact the pricing regulation under the Pennsylvania Milk Marketing Board on retail fluid milk prices and the volume of fluid

[62] It is also worth reiterating that in the Phase I report, we note that the total utilization of Pennsylvania farm milk in Class I has remained roughly constant during the past decade. Although this stability cannot be attributed solely to the PMMB, it would be consistent with the fact that the PMMB has limited impact on the allocation of Pennsylvania farm milk to Class I use.

milk processing in the state. This assessment can complement a broader and more qualitative discussion of the likely impacts and benefits of the PMMB, but focuses more specifically on two issues frequently mentioned in discussion of the PMMB. This assessment is challenging because many factors other than PMMB pricing regulation will affect these two outcomes. In addition, institutional arrangements may be affected by PMMB regulation over time, which makes it difficult to separate the effects of PMMB pricing regulation from the path-dependent evolution of industry structure and its impact on outcomes. Ideally, a comprehensive analysis would integrate detailed statistical analyses with a dynamic systems simulation model that would allow a "counterfactual" assessment of what would have happened over time in the absence of PMMB regulation. Given both data and resource constraints, this more comprehensive approach was not possible for this assessment, but a more partial approach still helps to put the potential impact of the PMMB into an appropriate context.

Estimated Retail Fluid Price Impacts of the PMMB

Because the PMMB regulates minimum retail prices for fluid milk sold within Pennsylvania, this might result in price enhancement (relative to prices that would exist in the absence of the PMMB) and negatively affect demand for fluid milk (and thus, Class I utilization of Pennsylvania farm milk).

Assessment of the impacts of minimum retail price regulation under the PMMB is challenging because many factors affect the retail price of fluid milk, including but not limited to, overall supply chain costs and retail pricing strategies. Supply chain costs include milk acquisition costs (influenced by PMMB and Federal Milk Marketing Order regulation, but also the nature of service contracts, say, between cooperatives and fluid milk processors), transportation costs (based on specific farm milk origins, plant destinations and final demand locations), processing costs (determined by locational factors such as wages and utilities, as well as plant volumes). The landed cost of a gallon of fluid milk at a retailer thus depends on many factors, only some of which are directly related to price regulation. And, because of the importance and characteristics of dairy product demand, there are a variety of strategies employed by retailers with dairy product pricing.[63] Wages and utilities costs at retailers will also determine decisions about in-store product pricing, although the relationship to fluid milk prices is less direct because a typical food retailer sells many thousands of "Stock Keeping Units" (SKU, distinctly priced items). The relationship between the landed cost of packaged milk at a retailer and the retail price is also not a simple one. Retailers use different pricing strategies (for example, the so-called 'loss leader' approach would keep retail fluid milk prices close to the acquisition cost to attract customers), and also tend not to fully or immediately transmit increases or decreases in underlying milk costs to consumers in the form of retail prices. If data were available on these various factors over a sufficiently-long time period, a more specific assessment of the impacts of price regulation could be undertaken, although this is still complicated by the degree to which

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[63] Russo, David and Edward McLaughlin. "Dairy Product Sales Determined by More Than Price". *Smart Marketing*. Cornell University, March, 1992.

price regulation has affected decisions that in turn determine costs and pricing strategies (so-called institutional factors).

However, because most of the data mentioned above are not readily available, we adopt the simpler approach of comparing observed retail fluid milk prices in cities in the Northeast region. This approach is less rigorous in the sense of not controlling for other factors that would influence differences in fluid milk prices among the cities—and thus, differences cannot be definitively attributed to price regulation—but we control for selected cost factors by assessing differences in the wholesale value (landed cost) of fluid milk at the cities included in the analysis using U.S. Dairy Sector Simulator (USDSS, a large-scale spatial economic model), which accounts for differences in transportation and processing costs. We can also qualitatively assess the impacts on landed per-gallon cost of differences in Class I differentials in the region. These observed price differences provide some context for assessment of the impacts of price regulation under PMMB, but can also provide a response to the question "Are retail fluid milk prices in selected Pennsylvania cities different from those in other cities in the Northeast (and Mideast) region?"

The data used for this comparison are monthly average prices for selected regional cities (Figure 1) collected and reported by Federal Milk Market Administrators in different federal order milk marketing areas. As noted in the documentation for these price series, the data are defined as:

> *As collected by Federal milk order market administrators based on a survey conducted one day between the 1st and 10th of each month (excluding Fridays and weekends) in selected cities or metropolitan areas. One outlet of the largest and second largest food store chains and the largest convenience store chain are surveyed. The price represents the most common brand in nonreturnable plastic containers[64].*

Thus, these are not comprehensive statistical assessments of all retail fluid milk prices, but attempt to capture what is in essence a weighted average price most commonly paid by consumers. Data are reported for both whole milk and reduced fat (2%) milk products. The two Pennsylvania cities included are Philadelphia and Pittsburgh, which based on demand calculations for the USDSS model in 2016, account for 30% and 24% of total Pennsylvania consumption of fluid milk, respectively. We analyze data for the 11 years from 2007 to 2017, because we believe this longer-term perspective is necessary to provide an appropriate perspective on potential impacts.

[64] "Retail Milk Prices Report", USDA, Agricultural Marketing Service, Market Information Branch, December 15, 2017. (RMP-1217).

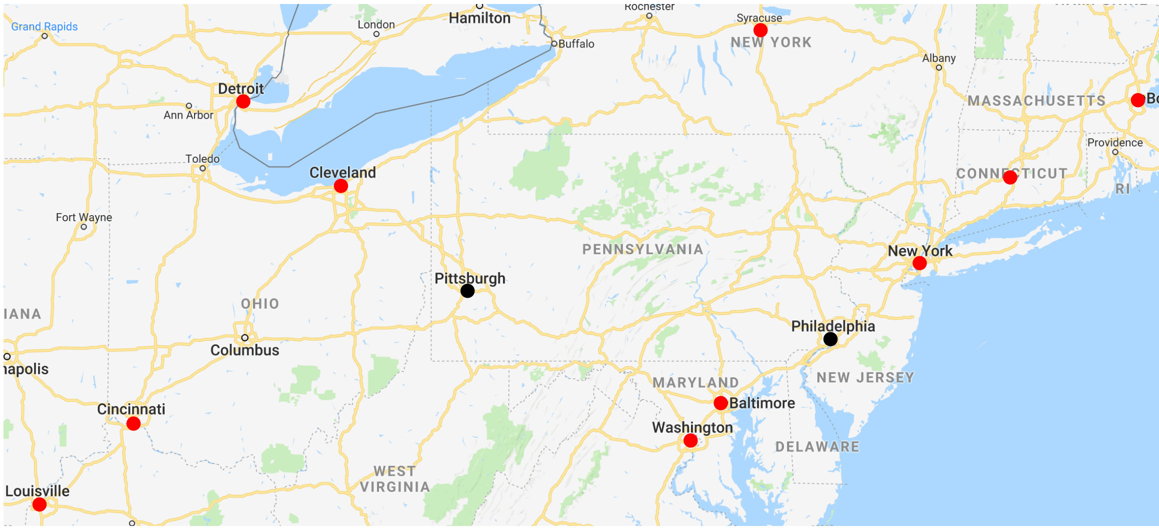

Figure 8.1. Cities Considered in the Fluid Milk Retail Price Comparison

Based on geographical designations defining Federal Milk Marketing Orders (the Northeast and Mideast orders), we compare Philadelphia retail fluid milk prices to those other in three other Northeast Order cities: Washington, DC, Baltimore and New York City[65]. Pittsburgh retail prices are compared to those in three other cities located in the Mideast Marketing Area, Detroit, Cleveland and Cincinnati. For context, some comparison data for additional cities (Hartford, CT, Syracuse, NY and Boston, MA, Detroit, MI, Louisville, KY) are also reported.

Based on the Class I differential zones in the region (Figure 2), differences in the gallon-equivalent Class I differential for the Philadelphia comparison cities are less than $0.01/gallon (Table 2) and generally so for Pittsburgh comparison cities also[66]. These differences assume that fluid milk was first received at a processing plant in the same price zone as the city in which the milk was received (which is likely unrealistic), but suggest that any differences in retail prices due to class I differentials are likely to be small in the key comparisons.

[65] The reported price series for New York City uses data for Fort Lee, NJ (in the New York City metropolitan area) rather than within the actual city boundaries, presumably to control for the specific nature of food retailing (smaller, higher-cost stores) within the boroughs of New York.
[66] Detroit is the exception, because its $1.80/cwt Class I differential results in a gallon-equivalent difference of $0.026/gallon from Pittsburgh.

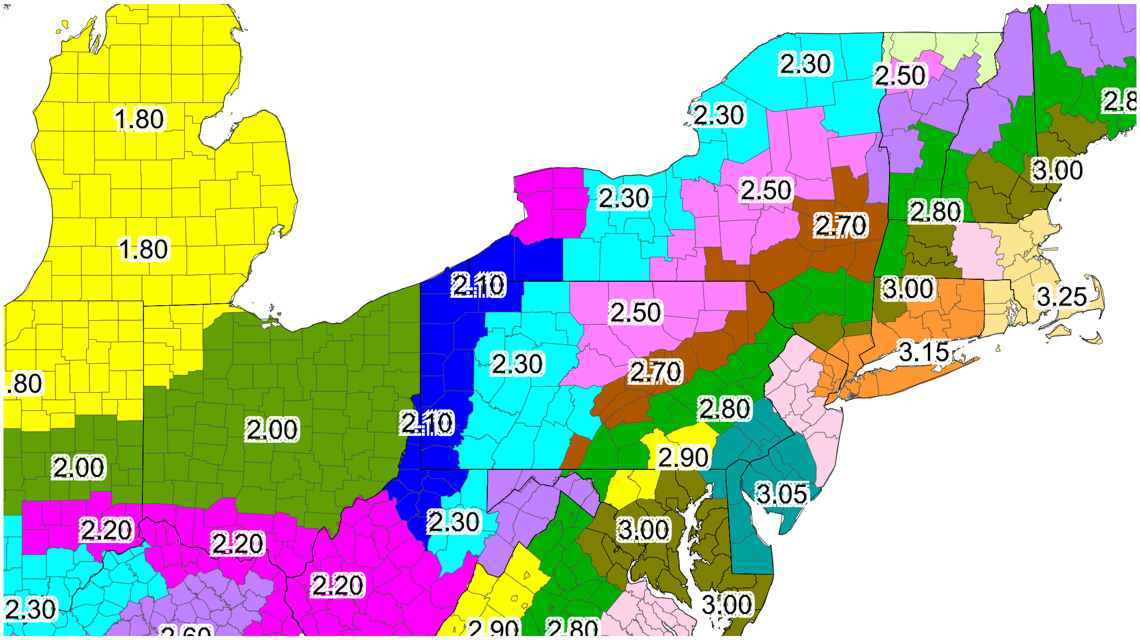

Figure 8.2. Federal Milk Marketing Order Class I Differential Zone Map for the Analyzed Region of the Northeast

Table 8.1. Class I Zone Differentials in Cities Analyzed and their Gallon-equivalent Values

Class I Differential in Zone, $/cwt	Cities Analyzed in Zone	Gallon-equivalent Class I Differential Value, $/gallon	Difference from Philadelphia Zone, $/gal	Difference from Pittsburgh Zone, $/gal
1.80	**Detroit**	**0.155**	**-0.108**	**-0.026**
2.00	**Cleveland**	**0.172**	**-0.090**	**-0.009**
2.10	Pittsburgh	0.181	-0.082	--
2.20	**Cincinnati**	**0.189**	**-0.073**	**0.009**
2.30	Louisville	0.198	-0.065	0.017
2.50	Syracuse	0.215	-0.047	0.034
2.70		0.232	-0.030	0.052
2.80		0.241	-0.022	0.060
2.90		0.250	-0.013	0.069
3.00	**Baltimore, Washington, DC**	**0.258**	**-0.004**	**0.077**
3.05	Philadelphia	0.262	--	0.082
3.10		0.267	0.004	0.086
3.15	**New York City, Hartford**	**0.271**	**0.009**	**0.090**
3.25	Boston	0.280	0.017	0.099

The difference in retail fluid milk prices between Philadelphia and comparison cities for both whole and reduced fat milk has varied over time (Figures 3 and 4). From 2007 to 2010, retail fluid milk prices in Philadelphia were generally below those in the three comparison cities. From

2010 to 2015, Philadelphia prices were generally higher than those in the comparison cities (sometimes by more than $0.75/gallon), but for the last two observed years, Philadelphia prices were in general below those in comparison cities. At a minimum, these changes over time suggest that there is not a fixed relationship between retail fluid milk prices in Philadelphia and comparison cities, which in and of itself suggests that price regulation may not be the most important driver of price differences. In addition, prices in Philadelphia are not consistently higher than those in comparison cities, as might be expected if there were substantive price enhancement due to minimum price regulation. Finally, differences in average prices over time indicate different patterns for different products. On average during the 2007 to 2017 period, whole milk prices in Philadelphia were $0.08 to $0.10/gallon *higher* than those in the three comparison cities (Table 2), but Philadelphia prices for reduced-fat milk averaged $0.05 to $0.09/gallon *lower* than those in comparison cities (Table 2).

We can use these average price differences to compare with the expected wholesale price difference at demand locations based on analysis with the USDSS spatial economic model for March and September 2016 that accounts for transportation and processing costs. The observed price differences are modified by the expected cost difference to determine the difference in prices due to "other factors". As noted above, this is not the same as the impact of PMMB price regulation, but it provides a context for assessment of the likely magnitude of impacts.

The differences in retail prices due to other factors between Philadelphia and Washington, DC, Baltimore and New York are generally small, with a maximum value of $0.06/gallon for Philadelphia (that is, Philadelphia had a higher price) compared to New York City. On a percentage basis, the difference due to other factors between Philadelphia and the other three cities are generally small, and ranged from -0.3% to 1.6% of the prices in the three comparison cities.

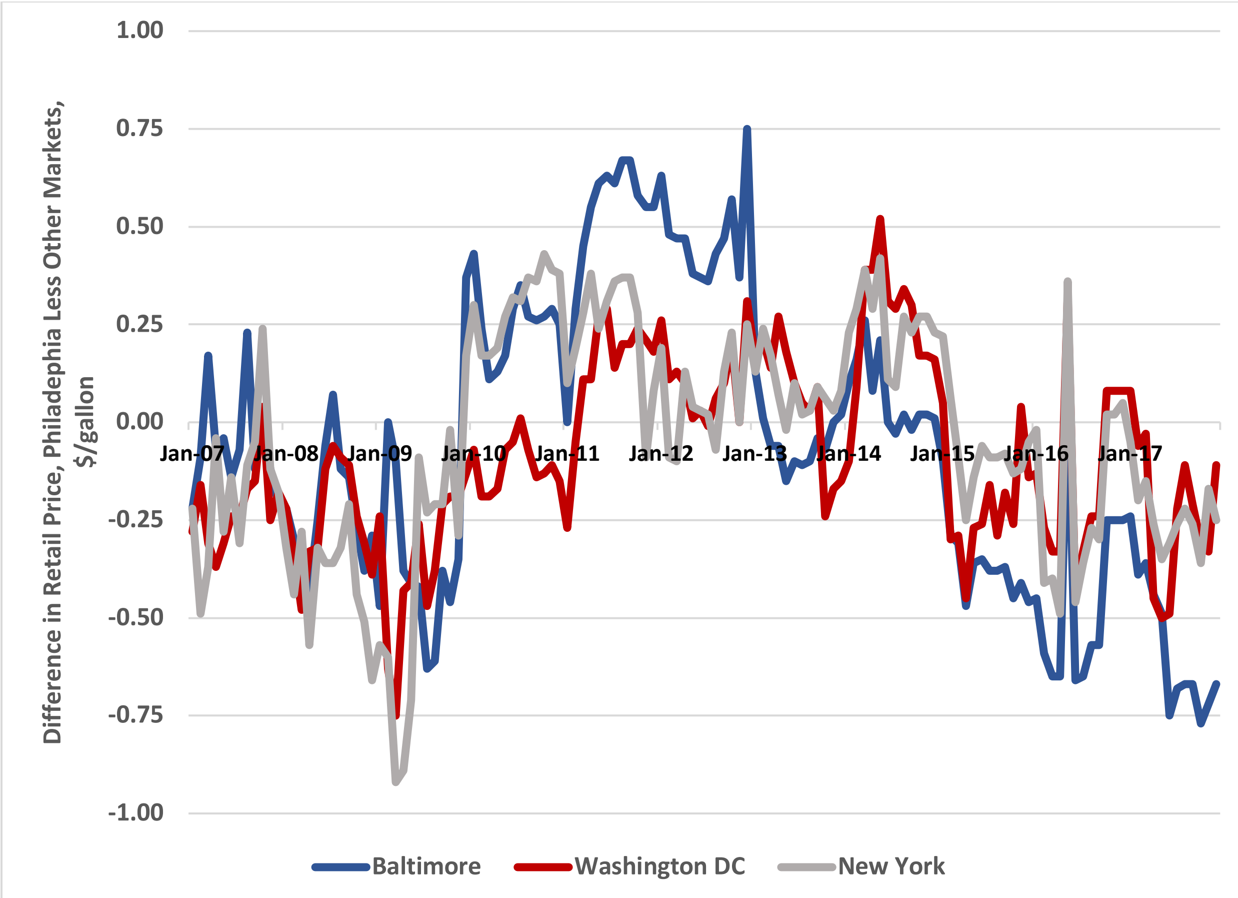

Figure 8.3. Difference in Reduced Fat Retail Fluid Milk Price Between Philadelphia and Three Other Northeast US Cities, 2007-2017

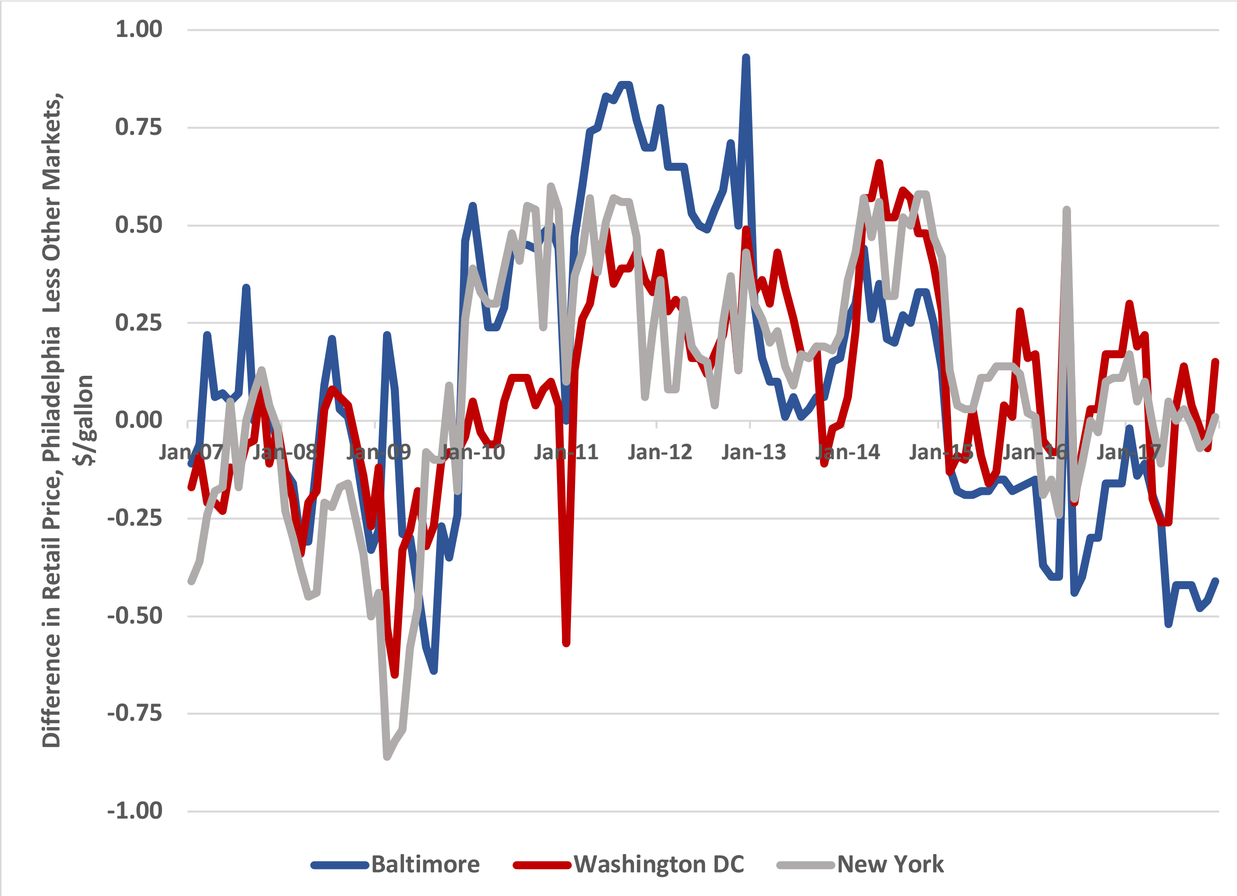

Figure 8.4. Difference in Whole Milk Retail Price Between Philadelphia and Three Other Northeast US Cities, 2007-2017

Overall, the evidence indicates that fluid milk retail price differences are relatively small between Philadelphia and comparison cities and roughly consistent differences expected based on selected supply chain costs. Although this could suggest limited retail price enhancement relative to other markets, this observation is potentially consistent with three explanations. The first is that PMMB price regulation does not markedly enhance average Philadelphia retail fluid milk prices relative to those in other cities. An alternative explanation is that average retail fluid milk prices are enhanced over a broader geographical area, but in such a way that differences among comparison cities are minimized[67]. A third possibility is that the PMMB enhances retail prices, but these (coincidentally) rather closely match the magnitude of the difference in other factors affecting in retail prices in the three comparison markets. Although it is not possible to determine definitively which of these explanations (or their combination) is most appropriate, the third explanation (relying as it does on the coincidence of PMMB price enhancement in Philadelphia closely matching the different in other factors influencing retail prices in other markets) is less likely.

In contrast to the price relationships between Philadelphia and comparison cities, retail fluid milk prices in Pittsburgh tend to be more consistently higher for both whole and reduced-fat milk than prices in comparison cities (Figures 5 and 6). Prices observed in the Cleveland market were above those in Pittsburgh during much of 2015 and 2016, but retail fluid milk prices were often as much as $0.50/gallon more in Pittsburgh during 2007 to 2017. These observed patterns are likely due at least in part to the low-cost pricing strategy adopted by the Kroger chain for stores in Cincinnati and Detroit, and the sharp increase in the difference between Cincinnati and Pittsburgh in mid-2017 is due to an ongoing “price war” between Kroger and its competitors in that market[68]. Because Kroger does not operate stores in the Cleveland area, that market serves as the better comparison to Pittsburgh prices, although supermarket fluid milk pricing strategies in that market may also be influenced by Kroger’s low-cost pricing approach. Average whole milk prices were $0.40/gallon higher in Pittsburgh than in Cleveland during the 11-year period analyzed, and reduced-fat prices averaged $0.26/gallon higher in Pittsburgh than Cleveland during that period (Table 3). Accounting for selected costs differences using the USDSS, the difference due to other factors between average Pittsburgh retail fluid milk prices and those in Cleveland were $0.35/gallon. This difference is about 10% of the price in Cleveland. As for Philadelphia, a number of explanations could be consistent with the observed differences. The first is that there is no price enhancement due to the PMMB, but other factors (i.e., costs not analyzed by the USDSS and supermarket pricing strategy) explain the difference in observed prices. A second is that there is some price enhancement for retail fluid milk prices in western Pennsylvania relative to comparison markets that may be due to PMMB. It is also possible that some combination of the two effects explains the observed differences. The magnitude of the difference does suggest, however, that the evidence in support of the hypothesis that price enhancement occurred relative to comparison cities is somewhat stronger for the Pittsburgh market than for the Philadelphia market.

[67] This is consistent with the observation in the qualitative discussion piece that the PMMB provides a pricing benchmark for a wider geographic area in the Northeast, in addition to Pennsylvania.
[68] See for example, the news article https://www.wcpo.com/money/consumer/dont-waste-your-money/price-war-cincinnati-grocers-slash-milk-prices

Table 8.2. Differences Between Philadelphia Retail Fluid Milk Prices and Comparison Cities, 2007 to 2017 and USDSS Estimated Difference for 2016

Philadelphia Less Price in:	Average Difference in Whole Milk Price, 2007-2017, \$/gal[a]	Average Difference in Reduced Fat Milk Price, 2007-2017, \$/gal[a]	Difference in USDSS (2016)[b]	Difference Attributed to Other Factors[c]
Baltimore	**0.10**	**-0.07**	**0.00**	**0.02**
Boston	0.39	0.26	0.03	0.29
Cincinnati	1.19	1.02	0.03	1.08
Cleveland	0.51	0.38	0.03	0.42
Detroit	0.92	0.79	0.05	0.80
Hartford	0.20	0.05	-0.01	0.13
Louisville	0.80	0.66	0.05	0.69
New York	**0.10**	**-0.05**	**-0.03**	**0.06**
Syracuse	0.71	0.70	0.09	0.61
Washington DC	**0.08**	**-0.09**	**0.00**	**-0.01**

[a] Simple average of difference between Philadelphia reported monthly price and that reported in city listed in the first column.

[b] Difference in marginal value of a gallon of fluid milk (wholesale-equivalent value) between Philadelphia and the specified city location. This suggests the expected difference in per gallon values based on transportation and processing costs. Note that the USDSS aggregates fluid milk categories so does not allow direct assessment of marginal values of whole and reduced-fat milk products.

[c] Calculated as the difference between the simple average of average differences in whole milk and reduced fat milk less the (expected) wholesale cost difference based on transportation and processing cost differences. This thus represents the difference in retail prices that is due to “other factors” rather than the subset of assessed direct cost factors.

Note: Negative value means that the Philadelphia price is less than the price reported in comparison city. Positive value means that the Philadelphia price is more than the price reported in comparison city.

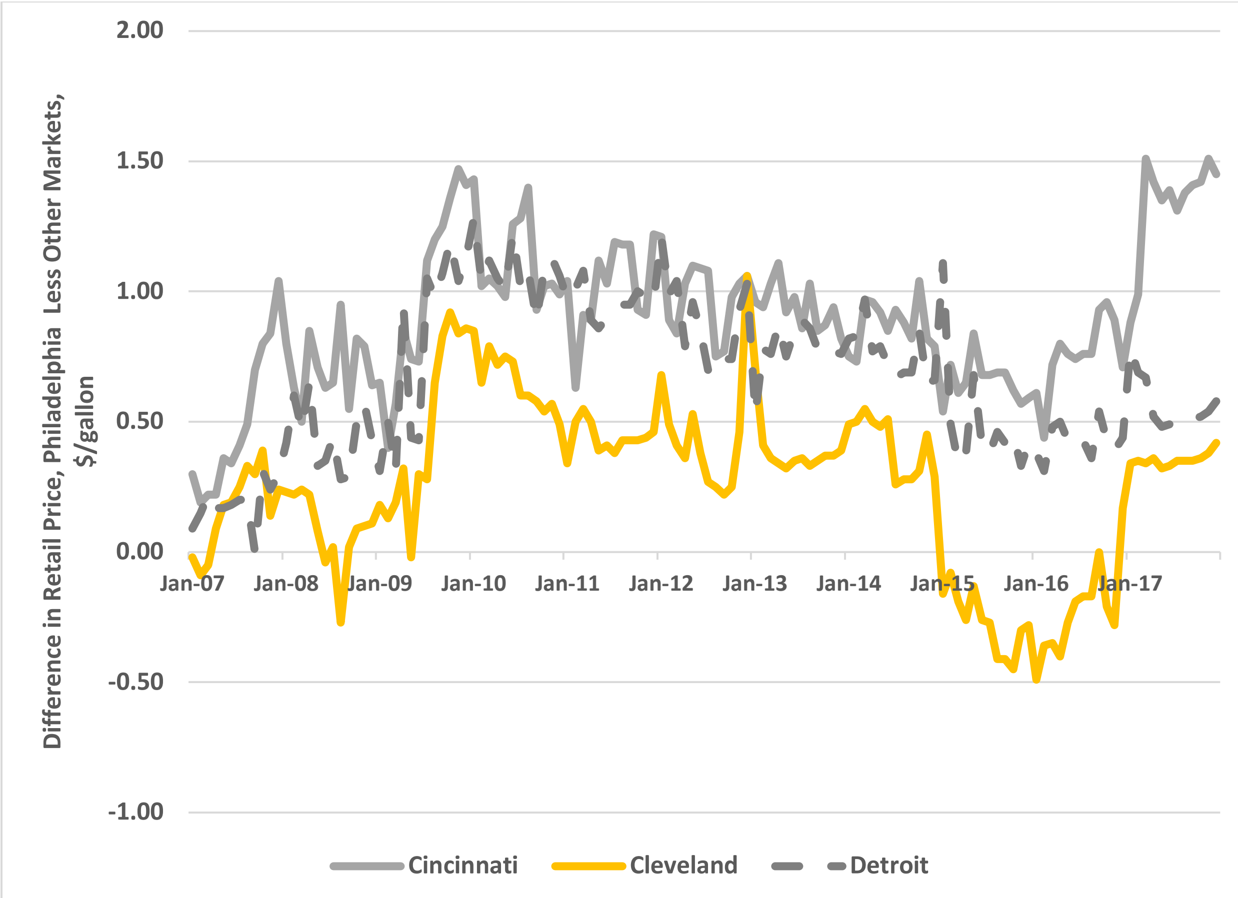

Figure 8.5. Difference in Reduced Fat Retail Fluid Milk Price Between Pittsburgh and Three Comparison Cities, 2007-2017

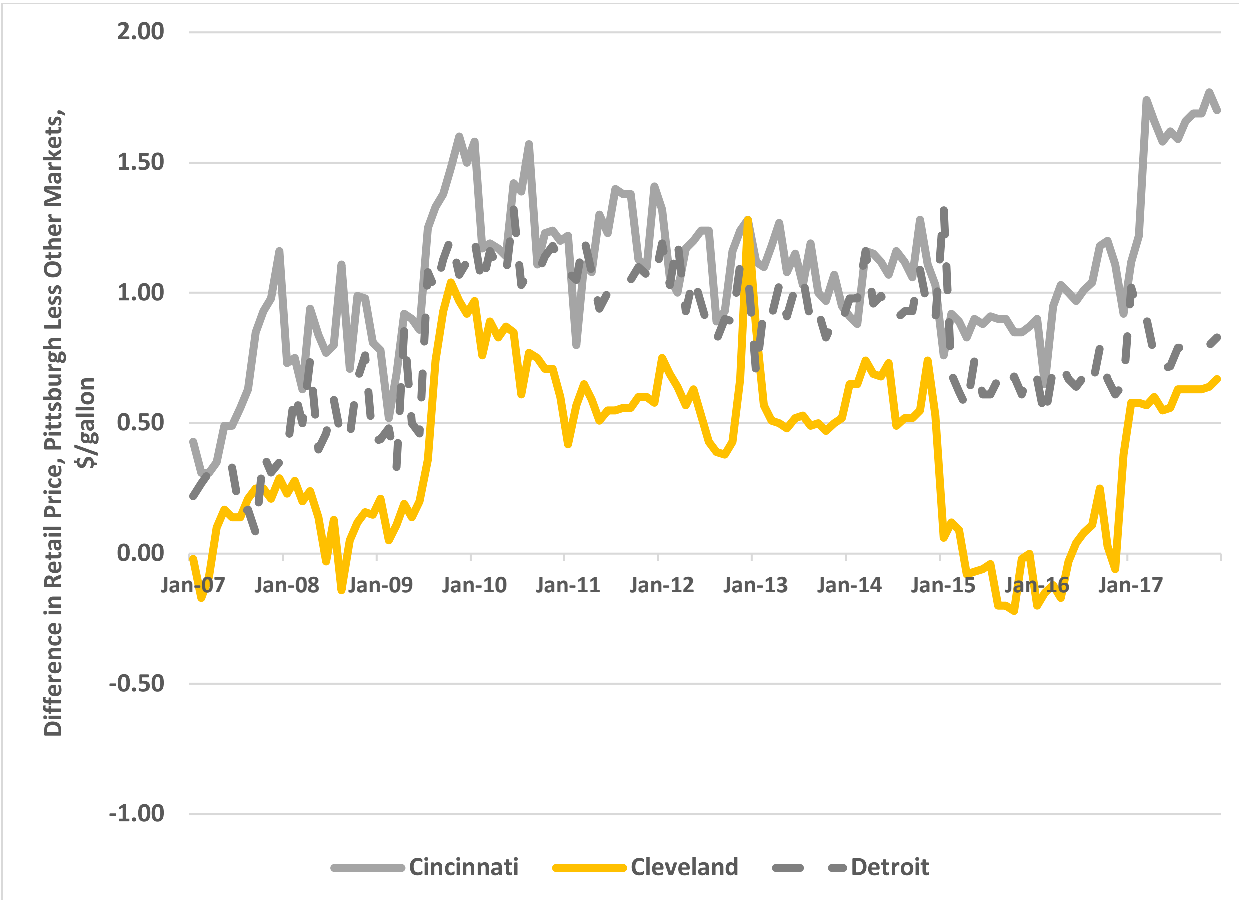

Figure 8.6. Difference in Whole Milk Retail Price Between Pittsburgh and Three Other Comparison Cities, 2007-2017

Table 8.3. Differences Between Pittsburgh Retail Fluid Milk Prices and Comparison Cities, 2007 to 2017 and USDSS Estimated Difference for 2016

Pittsburgh Less Price in:	Average Difference in Whole Milk Price, 2007-2017, $/gal[a]	Average Difference in Reduced Fat Milk Price, 2007-2017, $/gal[a]	Difference in USDSS (2016)[b]	Difference Attributed to Other Factors[c]
Baltimore	-0.01	-0.19	-0.05	-0.05
Boston	0.28	0.14	-0.02	0.22
Cincinnati	1.08	0.90	-0.02	1.01
Cleveland	**0.40**	**0.26**	**-0.02**	**0.35**
Detroit	0.81	0.67	0.00	0.74
Hartford	0.09	-0.07	-0.06	0.06
Louisville	0.69	0.54	0.00	0.62
New York	-0.01	-0.17	-0.08	-0.01
Syracuse	0.60	0.58	0.04	0.55
Washington DC	-0.03	-0.21	-0.05	-0.07

[a] Simple average of difference between Pittsburgh reported monthly price and that reported in city listed in the first column.

[b] Difference in marginal value of a gallon of fluid milk (wholesale-equivalent value) between Pittsburgh and the specified city location. This suggests the expected difference in per gallon values based on transportation and processing costs. Note that the USDSS aggregates fluid milk categories so does not allow direct assessment of marginal values of whole and reduced-fat milk products.

[c] Calculated as the difference between the simple average of average differences in whole milk and reduced fat milk less the (expected) wholesale cost difference based on transportation and processing cost differences. This thus represents the difference in retail prices that is due to "other factors" rather than the subset of assessed direct cost factors.

Note: Negative value means that the Pittsburgh price is less than the price reported in comparison city. Positive value means that the Pittsburgh price is more than the price reported in comparison city.

Example of Impact of Price Enhancement on Fluid Milk Sales

Although it is not possible to definitively assess the impact of PMMB on fluid milk sales because we cannot determine precisely the impact of PMMB on prices, we can undertake an example calculation that suggests relevant information about the likely magnitude of impact. To do so, we *assume* that the impact of the PMMB on whole milk and fluid prices is equal to the value of the impact of "other factors" for one comparison city (New York for Philadelphia and Cleveland for Pittsburgh) for the whole and reduced-fat milk retail prices. This assumes that all differences are due to price regulation, which is likely to overestimate the impact of PMMB retail pricing regulation. To capture the potential effect of low-cost pricing strategies for fluid milk in the Cleveland market and assess what would be the likely maximum possible impact of PMMB price regulation on fluid milk sales, we assume that half of the price difference between Cleveland and Pittsburgh is attributable to supermarket pricing strategies. We then use previously-reported fluid milk demand elasticities[69] to assess the impact on fluid milk sales of this magnitude of retail price difference. The basic calculation is undertaken in percentage terms (the definition of a price elasticity is the percentage change in sales for a percentage change in price), and is given as:

% Change in Sales =

(Reported Own-Price Elasticity)(% Change in Price)

+ (Reported Cross-Price Elasticity[70])(% Change in Other Product Price)

These calculations suggest that IF price enhancement by the PMMB is as assumed based on comparisons to average values in other cities, the impacts on fluid milk sales would differ by Pennsylvania city and product. In Philadelphia, price enhancement of $0.10/gallon would result in an example reduction in whole milk sales of 3.5%. However, the impact on reduced-fat milk sales would be positive, due to both lower reduced-fat retail milk prices and cross-price effects (the higher price of whole milk). The average effect (assuming equal sales volumes for whole and reduced-fat milk) would be a reduction in sales of less than 1%. To put this into context, combined sales for fluid milk products in both the Northeast and Mideast Milk Marketing Orders declined by about 15% during 2007 to 2017. To the extent that this decrease is representative of demand changes in Pennsylvania, the estimate of price enhancement would thus need to be more than fifteen times higher on a value and percentage basis (about $0.90/gallon at the average difference due to other factors value of $0.06/gallon) to explain the full reduction in fluid milk sales based on the reported elasticity values. This seems unlikely based on the evidence from the retail price comparisons, and so suggests that minimum price regulation under the PMMB is not the principal cause of reductions in fluid milk sales in the eastern part of the Pennsylvania.

The assumed average price enhancement during 2007 to 2017 in Pittsburgh is somewhat larger than for Philadelphia, and thus would have a larger impact on sales for both whole and reduced-fat milk, an average of 4.7% for whole and low-fat milk. These effects would account for less than a third of the observed decline in fluid milk sales. Thus, although a negative impact of

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[69] There are many such studies reporting a wide range of values, but for the purposes of this example, we use "US Fluid Milk Demand: A Disaggregated Approach", authored by Davis et al., and published in 2012 (*International Food and Agribusiness Management Review*, 15:25-50.)

[70] A "cross-price" elasticity accounts for the fact that a change in the price of another product may affect the demand for a product under consideration. In this case, an increase in price of whole fat milk will affect both the sales of whole fat milk (a decrease) but also the sales of reduced-fat milk (typically, an increase).

price enhancement due to PMMB on fluid milk sales is possible in the western part of Pennsylvania, but it does not appear to be major factor driving the decline.

If the Philadelphia and Pittsburgh markets are considered representative of effects elsewhere in Pennsylvania and the effects weighted according to the relative size of the two markets, the overall effect of the PMMB on fluid milk sales in the state would be approximated as -2.6%. This is less than one-fifth of the observed decline in fluid milk sales and thus rather strongly suggests that the retail pricing regulation under the PMMB is not the major driver of declines in fluid milk sales.

Table 8.4. Example Calculations of the Impact of Price Enhancement on Fluid Milk Sales

Fluid Milk Product, Impact	Philadelphia[a]	Pittsburgh[b]
Whole Milk Sales Analysis		
% Change in Whole Milk Sales	-3.5%	-6.2%
Difference in Own-Price	0.10	0.20
% Change in Own-Price	2.6%	5.3%
Own-Price Elasticity Value	-1.28	-1.28
Change in Cross-Price	-0.05	0.13
% Change in Cross-Price	-1.3%	3.6%
Cross-Price Elasticity Value	0.14	0.14
Reduced-fat Milk Sales Analysis		
% Change in Reduced Fat Milk Sales	1.6%	-3.3%
Change in Own-Price	-0.05	0.13
% Change in Own-Price	-1.2%	3.6%
Own-Price Elasticity Value	-1.00	-1.00
Change in Cross-Price	0.10	0.42
% Change in Cross-Price	2.6%	2.6%
Cross-Price Elasticity Value	0.14	0.14
Average Effect	-0.9%	-4.7%

[a] Philadelphia uses New York City as the comparison market.
[b] Pittsburgh uses Cleveland as the comparison market, assuming that half of the price difference is attributable to retail pricing strategies.

Estimated Impacts on Fluid Milk Processing in Pennsylvania of the PMMB

Another issue that has been mentioned frequently in discussions concerning the PMMB is that the structure of the pricing regulation could provide incentives for fluid milk processing to be shifted to other states, even when the intended market for the milk is within Pennsylvania. As with the assessment of retail pricing, many factors will determine where farm milk is sourced for fluid processing, where fluid milk is processed and distribution routings from plants to customers. From a supply chain perspective, many factors influence the location and capacity utilization of a processing facility, including but not limited to the cost of major inputs (farm milk for fluid processing), transportation costs to the facility, operations costs (including labor, utilities, taxes, etc.) distribution costs, and institutional factors such as relationships with supply chain partners. Because fluid milk processing capacity is an expensive investment, construction of new facilities tends to be infrequent in any one region.

The available information is insufficient to assess each of these factors for the current locations of fluid milk processing and therefore the potential role of PMMB price regulation in plant location and utilization decisions. Thus, we again adopt a simpler approach that draws upon the USDSS spatial economic model[71]. Because the USDSS determines the combination of farm milk assembly, processing locations and distribution routes for all dairy products in the continental US (i.e., including but not limited to fluid milk products) that minimizes overall supply chain costs, we can use the results of the model as a competitive benchmark for comparison with available data, that is, as what might be expected to occur in the absence of any price regulation. This approach identifies a set of outcomes consistent with spatial economic factors and differences would be suggestive of the impact of other factors, including PMMB regulation.

For the purposes of this component of the analysis, we used results for March and September 2016, the latest update of the detailed USDSS datasets. We analyze the detailed results of farm milk assembly shipments, fluid milk processing volumes at specific locations, and distribution routes from fluid milk processing plants to locations for final demand. This allows us to assess the extent to which fluid milk consumed in Pennsylvania has spatial economic incentives to be produced and processed within the state—thus meeting the general conditions to be eligible for farm milk price regulation under the PMMB. We also compare selected results for the states of Pennsylvania, New York and Ohio.

The spatial economic incentives represented by the USDSS suggest a number of outcomes that might be considered counterintuitive. First, a high proportion—but not all—of the farm milk used at fluid processing plants in Pennsylvania would be expected to come from farm supply locations within the state (Table 5). About 8% of farm milk used in processing would come from outside the state, with the most notable shipments to fluid processing indicated for the northwestern part of Pennsylvania. Second, there are economic incentives for shipments of packaged milk from fluid milk processing plants in other states (primarily New York and New Jersey) to Pennsylvania cities. About 18% of packaged fluid milk consumed in Pennsylvania cities would make economic sense to source from outside the state. Together, these results suggest that Pennsylvania should not inevitably be "self-sufficient" in the sense that all

[71] A detailed description of the USDSS model is available in the companion report "Analysis of Economic Incentives for Additional Dairy Processing Capacity in Pennsylvania."

shipments of farm milk to fluid and all fluid processing for consumption in Pennsylvania should occur within state boundaries.

The basic results about “self-sufficiency” in fluid milk processing also apply to New York and Ohio (Table 5). About 20% of farm milk processed in New York fluid plants comes from out of state (much of this amount comes from Pennsylvania), and the proportion of fluid milk consumed in New York that is processed in plants in the state is only two-thirds of the total in March—and less than the proportion in Pennsylvania in both March and September. In Ohio, all the farm milk used in fluid processing in the state originated within the state, but only somewhat more than half of fluid milk consumed in Ohio is processed at a fluid plant in the state. Overall, these results suggest that for these Northeast states, “self-sufficiency” in fluid milk should not be considered the normal or expected outcome based on spatial economic considerations alone.

Another relevant outcome predicted by the spatial economic incentives represented in the USDSS is that a large proportion of Pennsylvania farm milk will be used in fluid processing in both March and September. However, a larger volume of this milk sent to fluid processing is shipped out of state than is processed at fluid plants in Pennsylvania (Table 5). In addition, about one-third of packaged fluid milk processed in Pennsylvania would be expected to be shipped out of state to demand locations (Table 5) in New Jersey, New York, Maryland, Delaware, West Virginia, Ohio, North Carolina, South Carolina. There are also spatial economic incentives for shipments of Pennsylvania farm milk to other states for processing and then back to Pennsylvania for consumption as packaged milk: about 6% of packaged fluid milk consumption in Pennsylvania has this characteristic in March and September. Taken together, these results suggest that farm milk assembly and fluid milk distribution routes that cross state boundaries in the Northeast (and into the mid-Atlantic) have an underlying spatial economic logic. As a result, the existence of these flows across state borders does not constitute strong evidence that they arise from price regulation under the PMMB.

We also further examined the specific sets of farm milk assembly and packaged fluid milk distribution flows to assess what spatial economic incentives suggest about the amount of farm milk that would be expected to qualify for minimum pricing regulation under the PMMB, based only on the criteria that the packaged fluid milk consumed at demand locations in Pennsylvania was also processed and sourced from farms within the state (Table 6). Although about 75% of total packaged milk consumption in Pennsylvania would be from farm milk expected to qualify for minimum farm milk price regulation under the PMMB, it is important to note that about 25% of packaged milk sales would not, based spatial economic incentives, although retail minimum pricing would still apply. Moreover, less than about 20% of Pennsylvania farm milk would be expected to be priced according to PMMB minimum pricing regulations. These results serve as a relevant basis for comparison to observed outcomes, to be discussed subsequently. In practical terms, these results suggest that observations that a relatively small proportion of the state’s farm milk is supported by PMMB pricing, in and of itself, is not strong evidence that the program is not achieving its intended purposes or is providing substantive incentives to avoid price regulation through plant location and processing capacity utilization decisions.

Table 8.5. Summary of Farm Milk Assembly at Fluid Plants and Distribution of Packaged Milk from Fluid Plants from USDSS Model for Pennsylvania, New York and Ohio, March and September 2016

State, Variable	Farm Milk to Fluid Plants			Shipments of Packaged Fluid Milk from Plants to Demand Locations	
	March	September		March	September
Pennsylvania	*(mil lbs/mo)*	*(mil lbs/mo)*		*(mil lbs/mo)*	*(mil lbs/mo)*
PA to PA	228	222		156	150
Other State to PA	19	21		30	34
PA to Other State	341	327		81	84
Total	588	570		267	268
PA to PA	38.8%	38.9%		58.3%	56.1%
Other State to PA	3.3%	3.8%		11.3%	12.7%
PA to Other State	58.0%	57.3%		30.4%	31.3%
% of PA Fluid from PA	92.2%	91.2%		83.8%	81.6%
New York					
NY to NY	196	231		177	213
Other State to NY	59	56		90	51
NY to Other State	29	65		50	63
Total	284	352		317	327
NY to NY	62.8%	65.7%		48.3%	65.2%
Other State to NY	18.9%	15.8%		24.6%	15.6%
NY to Other State	9.1%	18.6%		13.5%	19.2%
% of NY Fluid from NY	76.9%	80.6%		66.3%	80.7%
Ohio					
OH to OH	144	148		116	117
Other State to OH	0	0		89	92
OH to Other State	134	156		22	26
Total	278	304		227	234
OH to OH	51.8%	48.7%		51.0%	49.8%
Other State to OH	0.0%	0.0%		39.4%	39.1%
OH to Other State	48.2%	51.3%		9.6%	11.1%
% of OH Fluid from OH	100.0%	100.0%		56.4%	56.0%

Table 8.6. Summary of Expected Volumes of Packaged Milk and Farm Milk Meeting Basic Criteria for PMMB Minimum Farm Milk Price Regulation Based on Spatial Economic Incentives, March and September 2016

Model-Predicted Outcome	March	September
Packaged Milk That Meets PMMB Criteria, mil lbs/mo	144	146
Total Fluid Consumption, mil lbs/mo	194	200
% of Packaged Milk that Meets PMMB Criteria	74.3%	73.2%

Farm Milk Meeting PMMB Criteria, mil lbs/mo	159	152
Farm Milk Production, mil lbs/mo	867	943
% of Farm Milk that Meets PMMB Criteria	18.3%	16.1%

Note: For the purposes of the above, "meets PMMB criteria" implies that packaged fluid milk consumed in Pennsylvania locations was processed at a fluid milk plant in Pennsylvania and the farm milk supplying that plant was also sourced in Pennsylvania. Thus, production, processing and consumption all occurred within the boundaries of the state of Pennsylvania, which makes the milk eligible for minimum farm-level pricing.

Volume of Milk Priced Under the PMMB

The foregoing assessment of outcomes under a perfectly competitive spatial market can be complemented by an assessment of the actual volumes of farm milk priced by the PMMB, and their comparison in percentage terms. From 2007 to 2016, the amount of farm milk priced by the PMMB declined from an average of 133 million lbs per month to 107 million lbs per month (Figure 7) and from 15% of the total Pennsylvania milk production to about 12%[72]. However, this reduction in milk priced is most appropriately considered in reference to the patterns of overall fluid milk product sales in the main Federal Milk Marketing Orders to which Pennsylvania farms ship, the Northeast and Mideast orders. Overall fluid milk sales declined in the Northeast and Mideast orders in a pattern very similar to the decline in milk priced under the PMMB (Figure 8), although the trend for the PMMB is somewhat more negative. The declines in the milk price by PMMB and the Northeast order are highly correlated (0.92) and also align with the overall decline in annual US fluid milk sales, which occurred at a somewhat slower rate than the declines in the Northeast. Thus, although the amount of farm milk priced under the PMMB has declined, much of this decrease appears due to general patterns of demand and not to the specific regulatory policies in place under the PMMB.

The percentage of farm milk actually priced under the PMMB during 2007 to 2016 ranges from 10.3 to 17.1%, which is roughly similar to the proportion predicted by the spatial economic incentives analyzed with the USDSS model. In the specific months analyzed, the actual milk priced under the PMMB was lower than that predicted by the USDSS, 13% compared to 18% for March 2016 and 12% compared to 16% for September 2016. This suggests that price regulation under the PMMB may have some impact on fluid milk processed in Pennsylvania, but it is important to note that the USDSS does not account for all factors that will influence the location and volume of fluid milk processed—mentioned above—and thus price regulation is only one component that might explain the differences between model-predicted and actual outcomes.

Taken together, these comparisons suggest that the price regulation under the PMMB may have an impact on fluid milk sales and volumes processed, but the impact is probably not large relative to the impact of other factors influencing the observed patterns over the past 10 years.

[72] Data for these analyses were provided by the PMMB from their accounting records, and the authors gratefully acknowledge their cooperation in doing so.

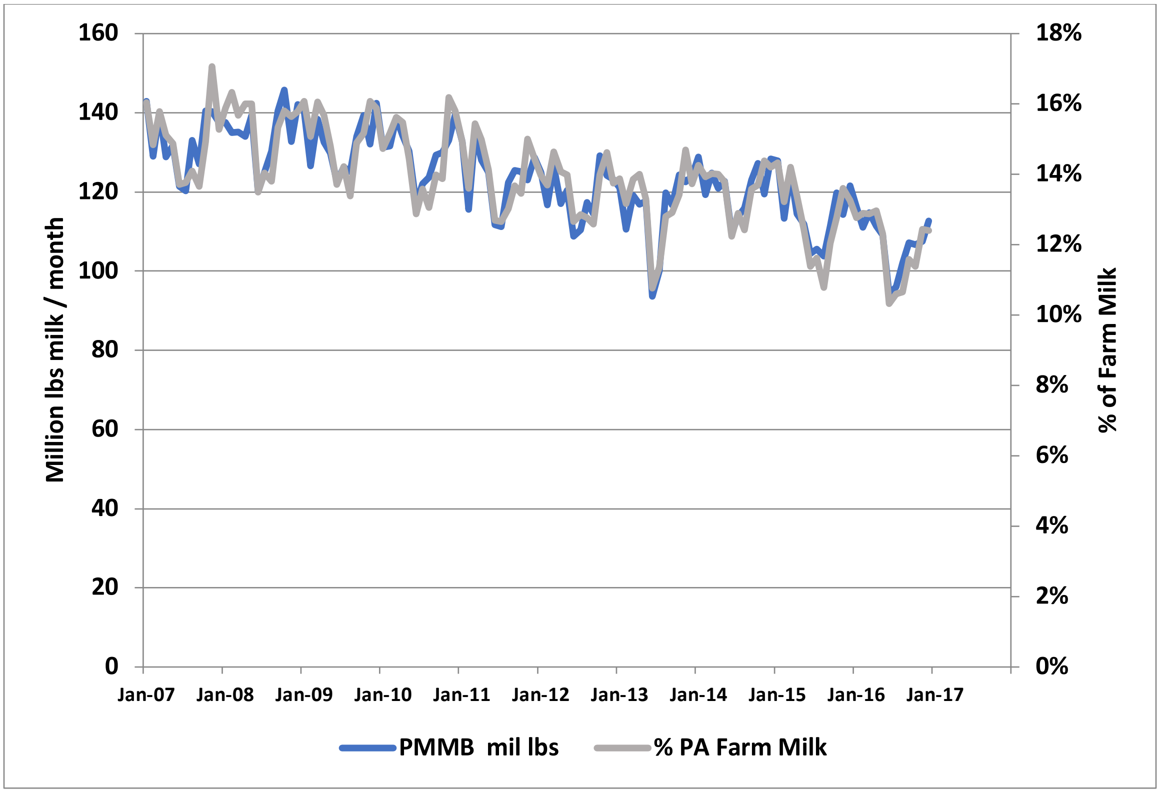

Figure 8.7. Farm Milk Priced by PMMB and Percentage of Pennsylvania Milk Production, 2007-2016

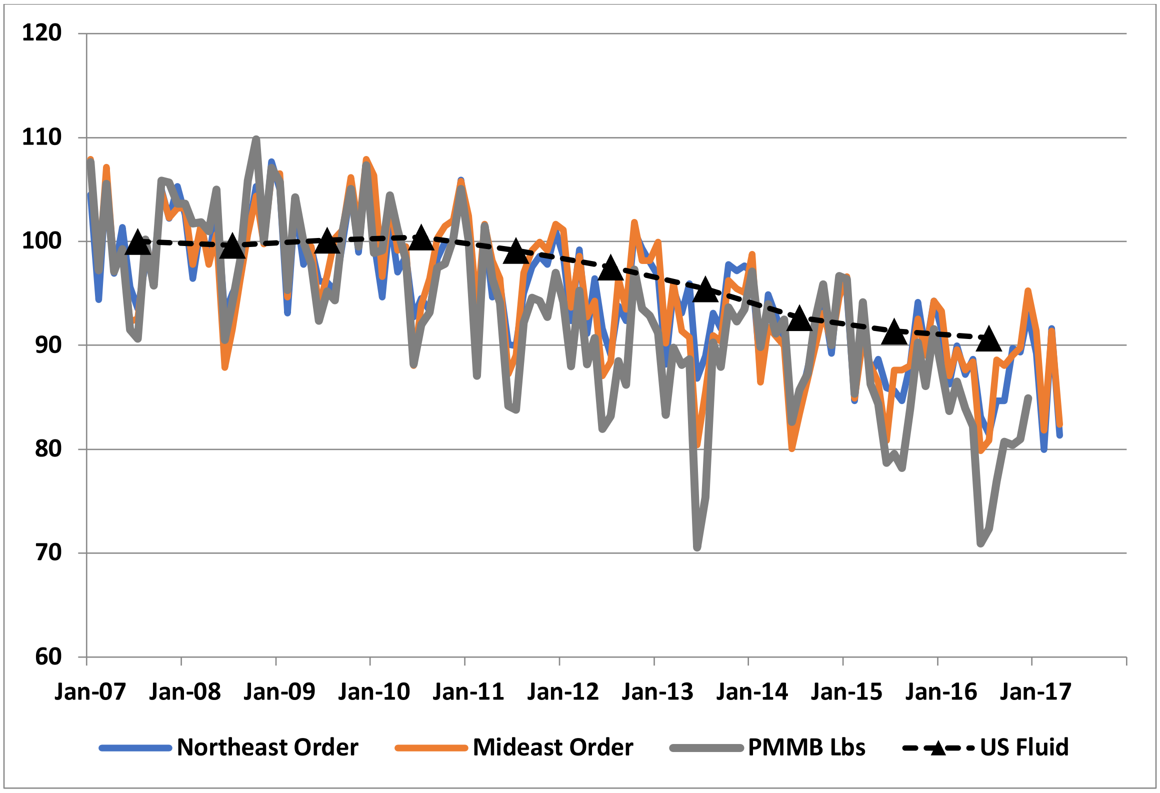

Figure 8.8. Index Values[73] for Farm Milk Priced by PMMB, Fluid Milk Sales in the Northeast and Mideast Federal Milk Marketing Orders, and Total Annual US Fluid Milk Sales, 2007-2017

[73] Index is defined as Average Monthly Value for 2007 = 100 for the three monthly series and 2007 Annual Value = 100 for US fluid milk sales.

Chapter 9: Study to Support Growth and Competitiveness of the Pennsylvania Dairy Industry: Key Points and Recommendations

Chuck Nicholson, Mark Stephenson and Andrew Novakovic[74]

This study has covered a large number of elements, including farm-level and processing-level performance, the economic incentives for investments in processing capacity, economic impacts of the state's dairy industry, the capacity of *PhilaPort* to support export market development and impacts of the PMMB. Summaries have been provided for each of these individual study elements, so we focus here instead on drawing upon those studies to assess potential constraints to growth and competitiveness and recommended actions to address them.

What Constrains Growth of Pennsylvania's Dairy Industry?

As noted in the Phase I report, growth in milk production has been limited for the past 15 years and milk per cow growth has been slower than in comparison states. Available data also suggest that growth in the volumes processed of many dairy products have also not grown as rapidly as those in comparison states. Although the available information does not allow a definitive determination of why growth has been slower than in other states with similar agronomic resources, we believe that a number of factors are NOT major constraints to growth. It is relevant to consider both factors related to supply and demand of milk and dairy products. On the supply side, these include the basic nature of agronomic resources (including soils and climate), the availability of inputs (including agricultural credit and hired labor), supportive—if potentially improvable—educational and advising programs (such as PSU extension programs and the Center for Dairy Excellence) and regulation (both environmental and pricing regulation under the PMMB[75]). Our view of the impact of processing capacity on growth is somewhat more nuanced, in part because major investments in processing in recent years typically are made through collaboration between processors and milk suppliers, with a view to developing a dedicated milk supply. Capacity has clearly been a constraint in the past few years and is likely to be more important going forward absent additional investment. On the demand side, the proximity of Pennsylvania milk production to growing major Northeast markets and the potential for milk shipments to deficit regions to the south both suggest that growth in demand that could be served by Pennsylvania has also not been a substantive constraint to growth. However, the decline in fluid milk sales suggests that the markets to be served have evolved and will likely continue to do so. As a reflection of demand, supply and transportation costs, Pennsylvania all-milk prices have been higher on average than for the US as a whole, by $1.57/cwt from 2000 to 2017 although reduced somewhat to $1.29/cwt during the five years ending December 2017.

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[74] The authors are, respectively, former Clinical Associate Professor of Supply Chain Management, Penn State University (now Adjunct Associate Professor, Cornell University), Director of Dairy Policy Analysis, University of Wisconsin, Madison, and E. V. Baker Professor of Agricultural Economics, Cornell University.

[75] Although permitting for farm expansions was frequently mentioned by stakeholders as a factor that should be changed and we did not examine the farm-level costs of alternative permitting arrangements, it is our assessment that this has not been a major impediment to growth during the past 15 years, although tightened environmental standards in the Chesapeake Bay watershed may be more important in the future. The PMMB probably <u>supports farm-level growth</u> because it enhances returns to producers.

Our assessment is that one likely constraint to growth during the past 15 years has been farm structure—the size and number of farms—interacting with incentives to invest in new processing capacity. As noted in the Phase I report, the average size of farms in PA was considerably below that in comparison states. Unlike those states, the largest total number of cows was owned by farms with 50 to 99 cows rather than farms with more than 500 cows. Farm structure implies a number of potentially important characteristics that affect competitiveness and the potential for growth. Smaller average farm sizes tend to be associated with higher costs of production (there are economies of scale in production), lower profitability (observed to some extent in our comparative assessment of farm financial performance), access to inputs (including credit and specialized management advice), and higher costs of milk hauling (for the same distance). These characteristics can reduce both the interest in and ability for growth. However, we do NOT mean to imply that big farms in and of themselves are the main pathway to dairy industry growth. We firmly believe that "Bigger is not always better, but better *might* imply bigger". That is, better managed farms—of all sizes—can support farm growth if that is otherwise aligned with individual farm manager objectives.

Another potential constraint relates to the perspective of producers regarding the desirability of farm growth. In the Phase I report, we reported survey results from CDE indicating that a) many farms intend to exit in the next five years and b) increasing both milk per cow and farm size were not considered important to improvement of farm business performance during the next five years. A number of stakeholder comments indicated that greater focus on improving farm business management would be appropriate.

Together, smaller average farm sizes (and a limited number of large farms that serve as potential examples to others) and less interest in growth appear to be key factors that have resulted in slower growth in Pennsylvania milk production, given the absence of other major constraints. This also affects the desirability of making processing investments in Pennsylvania, given the emphasis on arranging a dedicated milk supply to support utilization of new capacity. Growth of milk production in Michigan has proceeded somewhat independently of capacity expansion, which is one reason that dairy cooperatives in that state are actively exploring investments in processing capacity (and shipping milk to the Northeast and Wisconsin). New York has seen new plant capacity, particularly for Greek yogurt. The coordination of milk production and capacity growth is thus an important element of a successful growth strategy.

What Can Be Done to Support Growth and Competitiveness of Pennsylvania's Dairy Industry?

Given the above, we see a number of potential actions that can support greater growth and competitiveness. These include a) increasing support for improved dairy farm management education, b) collection and dissemination of information relevant for decision making by farms, processors and supporting industries, c) increasing awareness and use of the resources to support improved management and expansion or diversification (such as economic development funds), d) evaluation of the effectiveness of existing demand-related programs such as PA Preferred and spending of dairy checkoff funds, e) further exploration of opportunities to expand value-added dairy processing (and branding) and f) continued efforts to highlight the benefits of processing investment and unique resources such as *PhilaPort*. These actions can be supported by the Pennsylvania Department of Agriculture (probably at minimal cost) but would benefit from coordinated actions by other key industry stakeholders—

cooperatives, dairy producer associations, dairy processor associations, agricultural input suppliers (including credit), consultants, and other state-related organizations (PSU, CDE). Expected improvements in farm-level profitability after 2018 will likely help to facilitate interest and implementation.

It is also relevant to discuss the absence of what might be called “direct support” programs to increase dairy farm revenues or farm milk prices in our recommendations. First, we believe in a global marketplace for dairy, the potential effectiveness of such state-level programs would be limited. The PMMB provides support for the state’s dairy farmers, but this support is probably not large enough to be a key factor in farm growth over time. Second, most programs in this vein would be costly to consumers, taxpayers or both, and thus appear to have limited political prospects. Finally, we believe that support for improved decision making by key dairy stakeholders is the key to sustained improvement and growth.

Increased Support for Improved Dairy Farm Management Education

Although a number of existing organizations support dairy farm management, we believe that additional support would be appropriate. This includes:

- Facilitating the participation of Pennsylvania dairy farms in the multi-state *FarmBench* program that would provide relevant management benchmarks to participants and aggregated performance summaries to industry stakeholders. This would in part address the lack of information on farm performance mentioned in Phase I and the study on farm financial performance, and can identify priority actions for improvement for individual farms and more generally;
- Formation of groups of participants in educational working groups (similar to the “Top Dairies” invitational program implemented early in the 2000s) to enhance professionalism of dairy managers and generate enthusiasm for improved management decision making. This can complement existing programs with similar objectives.
- Support for an additional farm business management professional to coordinate the *FarmBench* and *Top Dairies* efforts and undertake appropriate applied research and outreach. Preferably this position would be filled by an individual trained to the PhD level and specializing in farm management (although the position would not need to be located at an academic institution);
- Promote improved coordination in farm management educational efforts among key current organizations (CDE, PSU Dairy Team, and producer organizations such as PDMP), with a joint review of current educational programs and their target audiences;

Collection and Dissemination of Information

Lack of information on key performance metrics for the state’s dairy farms and processing facilities appears to be an impediment to more informed decision making. Thus, we recommend:

- Farm-level data collection via the *FarmBench* and *Top Dairies* educational programs and its analysis and dissemination on a regular basis to industry stakeholders;
- Processing sector data collection, through enhanced coordination with the state’s NASS organization and independent surveys (similar to that attempted for this study, for which responses from Pennsylvania plants was limited), perhaps including processing costs, processing volumes and expansion plans, also analyzed and disseminated (on an

aggregated basis, no individual firm data) in a timely way. It is possible to envision the formation of multi-state benchmarking groups;
- Review the currently available data from organizations collecting farm- and processor-level data, to promote improved data sharing and coordination in data analysis and dissemination;
- Organize a series of strategic planning sessions with key industry stakeholders to develop a set of joint goals and suggested actions. We are mindful that strategic planning must account for the independent nature of involved organizations (development of a plan *per se* does not obligate them to actions) but can be useful as a means of envisioning the actions required for enhanced growth and competitiveness and provide a framework for interpretation of available data;

Increasing Awareness and Use of Support Resources

The state already provides many supporting services that can enhance dairy growth and competitiveness but may benefit from enhanced information about the extent of use of these services and communication of their availability to industry stakeholders, as is undertaken in comparison states. This could include:

- Better promote available resources through centralized clearinghouse online and through social media;
- Further documentation of the uses and potential of the state's economic development programs to support investment in dairy farms and processing facilities;

Evaluation of Effectiveness of Existing Demand-Related Programs

Although not reviewed in detail by this project, it seems appropriate to undertake a review of the effectiveness of demand-related programs, including the *PA Preferred* program and the spending of dairy checkoff dollars. Such an assessment would either indicate that current programs are having the desired effect or may indicate opportunities for enhanced effectiveness. The use of dairy checkoff funds might be linked to development of smaller-scale value added (branded) dairy processing business, which we believe should be further explored (see the next point);

Further Exploration of Value-Added and Branding Opportunities

Given the characteristics of many Pennsylvania dairy farms, there may be opportunities to enhance marketing based on them, either generically or through development of specific branded products. One idea has been proposed at listening sessions is a generic marketing approach (likely more applicable in the southeastern part of the state) with something like the language "Simply good." Although value-added dairy processing can impose substantive additional management and marketing challenges, there may be opportunities to further develop this as a business strategy. We encourage additional study of the potential for value-added (and small-scale) dairy processing, with inputs from key industry stakeholders and perhaps led by PSU Food Science extension.

Continued Efforts to Highlight the Benefits of Processing Investments and Pennsylvania's Dairy-Related Resources

One component of this study identified incentives for investments in additional plant capacity in Pennsylvania, and this information has been incorporated in to the discussion process with potential dairy industry investors. This information should continue to be communicated, particularly to producer organizations, to whom many of the quantified economic benefits would accrue. It is worth noting that Michigan's milk production growth "forced the issue" to examine opportunities for additional processing capacity, so it is possible to conceive of a strategy that grows milk production in advance of capacity growth, although the marketing opportunities for farm milk and current capacity could limit the potential for this sort of approach.