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How a Potential Tennessee Milk Plant Might Grow the State Economy

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How a New Tennessee Milk Plant Could Grow the State Economy

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Authors:

David W. Hughes
Professor and Greever Endowed Chair in Agribusiness Development
Department of Agricultural & Resource Economics

Andrew Griffith
Assistant Professor
Department of Agricultural & Resource Economics

David Mendez
Graduate Student Associate

Rob Holland
Extension Specialist and Director
Center for Profitable Agriculture

Kevin Ferguson
Farm Management Area Specialist
Department of Agricultural & Resource Economics

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Executive Summary

Food processors are increasingly trying to source locally or regionally in response to the local foods movement and concerns about transportation costs and the carbon footprint effect of transportation. As a result, milk-based value-added product processors currently in Tennessee (for example ice cream or yogurt producers) could source from a possible, new, in-state dried and condensed milk plant. To draw inferences concerning possible economic impacts of a new milk plant on the state economy, an IMPLAN-based, hybrid input-output (I-O) model is constructed with a focus on Tennessee milk production and processing. The model is based on farmer survey data, dairy cost of production data for Tennessee as reported by the U.S. Department of Agriculture, and discussions with industry experts. Different assumptions regarding the increase in milk from 724 to 2,253 in terms of jobs, $89.7 million to $145.3 million in gross state product, and $288.2 million to $452.5 million in economic activity or gross output. Even assuming no effect on Tennessee milk production, economic impacts are sufficiently large to warrant further investigation regarding the economic feasibility of a milk plant in Tennessee.

Introduction

Economic development leaders at the regional level are increasingly interested in using agribusiness as a means of raising productivity and per capita income, generating employment opportunities and increasing the size of the local tax base. Agribusiness leaders are also emphasizing the importance of value-added processing of regionally produced agricultural commodities as a way to create markets for farmers, increase farm incomes, and grow the regional agribusiness sector (Hughes et al., 2013, Hughes et al., 2012, Hughes et al., 2011, Carpio et al., 2008, Barkley and Wilson, 1995). Furthermore, because of the local foods movement and concerns about carbon footprint and shipping costs, many food processors are looking to source locally or regionally (Hughes and Boys, 2015). Taken together, all of these elements suggest a growing interest in how eliminating gaps in the food supply chain could pay dividends in terms of economic development.

Milk-based, value-added product processors currently in Tennessee (for example, yogurt, ice cream, cheese and fluid milk producers) would likely consider sourcing from a potential new, in-state milk plant. While Tennessee is a milk deficit state where demand outstrips supply by a wide margin, the state has several value-added dairy producers (Moss et al., 2012) who might find a local supply of processed milk a useful ingredient in furthering their value-added efforts. The economic impact of such an operation would provide useful information to policymakers considering supporting such an effort. Accordingly, discussed here are the results of a study examining the possible economic impact of a dried and condensed milk plant on the Tennessee economy.[1]

Major concepts in using input-output analysis for work of the type conducted in this study are initially examined, followed by a review of the literature regarding the economic impact of the dairy industry conducted for other areas. Adjustments made to the original model of the Tennessee economy are then described, followed by a discussion of the possible economic impact under four different scenarios regarding plant sourcing of milk supply. Summary conclusions regarding the study are then drawn.

[1] A dried and condensed milk plant would take in fluid milk as the primary input and produce dried milk, condensed milk and, in our case, cream as outputs. Producers of milk-based products, such as ice cream and yogurt producers, would then use the output of the condensing plant as inputs in their production. Several condensing plants apparently operate in Tennessee, but this plant would meet a demand that is currently provided by out-of-state sources.

Tennessee is currently a milk deficit state, where demand exceeds supply.

Hybrid Input-Output Model

The IMPLAN (Impact Planning) modeling system (Minnesota IMPLAN Group, Inc., 2000) is the most popular tool for computing regional I-O models (Hughes, 2003). IMPLAN is a ready-made modeling system, which relies on secondary data, such as employment, and the assumption that the regional economy is similar in structure to the national economy. Because this assumption may be tenuous, it is well established that ready-made I-O models should be evaluated and altered in light of other data sources and knowledge concerning the local economy (Jensen, 1987). Data from a variety of sources can be used to confirm, and in many cases modify, values found in original I-O models. This resulted in a hybrid model (a ready-made model that has been modified by more accurate external data or information). Hybrid I-O or SAM (Social Accounting Matrix) models are the result of efforts on the part of users to validate the model for a specific locale or use.[2] Many different procedures are employed in the validation process, ranging from the use of secondary and primary data sources to statistical procedures. The significance of these validation processes is particularly sensitive to the level of sector aggregation employed in the model and the economic structure of the economy being modeled. These factors are particularly important to those concerned with substate or rural economies.

A key to improving accuracy of this type of I-O model is to modify coefficients that accurately reflect the behavior of the economic sector directly evaluated. Financial information obtained by surveys, from published data such as publicly available firm-level financial records and information obtained from

[2] While IMPLAN terms its models as SAMs, our judgment is that such models are actually input-output (I-O) models. For more details see Hughes and Isengildina-Massa, 2015.

industry experts can be used as a guide for modifying input-output relationships between sectors. These sources also can be used in changing estimates of industry purchases, sales, employment and payments to factors of production (labor and capital).

Another change involves altering the general pattern of in-region versus out-of-region purchases by all industrial sectors in the model. In IMPLAN, the level of in-region versus out-of-region purchases for a given commodity is estimated through the use of Regional Purchase Coefficients (RPCs) (Minnesota IMPLAN Group Inc., 2000). RPCs (and hence model estimates) can be adjusted based on location theory, other studies, and general knowledge about regional economies.

Theory provides some guidance regarding which coefficients may be important to the accuracy of a study. In particular, the fundamental economic structure (FES) indicates the need to alter coefficients in input-output models. The FES states that more natural resource-oriented sectors tend to vary between regional economies in a given country while other sectors such as services often show little change in the nature of production between regions (West, 2001). That is, the underlying technical relationships in production can vary across regions, and the technical relationships of production in some sectors may be markedly different from the nation as a whole or from region to region. Accordingly, if natural resource-oriented sectors such as agriculture or food processing are the industry of interest for a particular study, then model users should be particularly concerned about the accuracy of important coefficients. Given that our effort is on milk processing and dairy farms as producers of milk, it is appropriate that we consider altering coefficients in the appropriate sectors of our input-output model.

The projected economic impact on the Tennessee economy under the "No Increase in Tennessee Milk Production Impact Scenario" was an increase in employment of 724 jobs, $288.2 million in output, $50.7 million in labor income, and $89.7 million in gross state product.

Review of Prior Studies

Several studies have examined the economic contribution of the dairy industry, usually at the state level, including associated value-added processing. Cabrera et al., (2008) estimated that dairy production and processing, directly and indirectly, contributed to $1.98 billion in output and 14,313 full-time equivalent jobs to the New Mexico economy in 2005. Neibergs and Brady (2013) estimated the total impact of dairy production and processing on the Washington state economy at 18,066 jobs, $0.7 billion in labor income and $5.2 billion in output in 2011. Horner and Milhollin (2013) estimated the contribution of dairy production and processing to the Missouri economy to be $7.7 billion in output, 23,297 jobs, $1.2 billion in labor income and $2.0 billion in gross state product in 2011. Rephann (2015) estimated the impact of dairy farming and processing on the Virginia economy to be 13,819 jobs, $3.2 billion in output and $452.4 million in labor income for 2014. Sumner et al., (2015) estimated the total economic impact of dairy production and processing on the California economy at 189,000 jobs and $65.0 billion in output for 2014. Impacts were especially pronounced in California because the sector in that state is well developed.

In a study most similar to this analysis, Casey (2013), estimated the economic impact of a new dry milk facility on the Nevada economy. The plant produces a high-quality whole milk powder for the export market based on technology imported from New Zealand. The author estimated an economic impact output of $242.0 million in state output. The author saw the plant as a means of developing the Nevada dairy industry.

Construction of Hybrid Input-Output Model for Tennessee

An IMPLAN ready-made model of the state economy was constructed for 2013 based on the most recent available IMPLAN data. Model coefficients were then adjusted for two key industries in the study, dairy cattle and milk production (IMPLAN Sector 12) and dry, condensed and evaporated dairy product manufacturing (IMPLAN Sector 87).[3]

Data taken from the U.S. Department of Agriculture Economic Research Service (ERS) for 2014 for Tennessee dairy farms were used to adjust input coefficient for the dairy cattle and milk production sector. The ERS provides detailed input costs and net returns for major milk-producing states based on the farm-level Agricultural Resource Management Survey and other data sources. The authors' knowledge of dairy production practices and input-models were used to assign cost values to appropriate economic sectors. The processing of margining is used when appropriate, in that some values required the applications of marketing margins (such as purchased feeds), while others (such as grazed feed) did not.[4] Opportunity costs in the data were treated as part of the return to owner-operators. Some ERS survey values were adjusted based on knowledge of dairy farms in Tennessee; in particular, capital recovery costs of machinery and equipment were adjusted downward (i.e., returns to other property income were reduced in this IMPLAN sector). The result was a dairy cattle and milk production sector that more closely reflected practices and economic reality for Tennessee dairy farms than originally provided in the model.

Data taken from the Economic Census for Manufacturing for dry, condensed and evaporated dairy product manufacturing (U.S. Census Bureau, 2015); Casey's study of the Nevada milk plant; and most importantly, unpublished industry sources, were employed as guides in estimating size of operation and key model coefficients (especially with regard to the consumption of fluid milk) for the dry, condensed and evaporated dairy product manufacturing (87) sector in the hybrid IMPLAN model. An important element is the level of shipments of fluid milk from local dairy farms to such an operation.

Model Results

Four different economic impact scenarios were examined in the model based on assumptions regarding fluid milk supplied to the plant. Tennessee is currently a milk deficit state, where demand exceeds supply. Given our assumption of at least primary and perhaps exclusive supply of in-state fluid milk for the plant, the plant could still result in no net increase in sales by dairies in the state. For example, dairies in the state could supply the plant and outside milk could flow into Tennessee to meet that diversion of Tennessee-supplied milk (the "No Increase in Tennessee Milk Production Impact Scenario"). Alternatively, all of the milk supplied to the plant could come from increased milk production in the state (the "100 Percent of Plant Supply from Increased Tennessee Milk Production Impact Scenario"). The regional production coefficient (RPC) measures how much of regional supply goes to meet regional demand for a given commodity. The pattern of consumption could follow that currently estimated for Tennessee by the RPC for dairies as found in the state IMPLAN model (19.2 percent) (the "RPC Based Increase in Tennessee Milk Production Impact Scenario"). That is, milk production in Tennessee could increase by a level equal to 19.2 percent of the milk supplied to the plant.[5] Finally, we examine an arbitrary middle-of-the-road impact scenario, where we assume that half of the milk supplied to the plant comes from an increase in Tennessee milk production (the "50 Percent of Plant Supply from Increased Tennessee Milk Production Impact Scenario"). Under the "RPC Impact Scenario" and the "50 Percent of Plant Supply from Increased Tennessee Milk Production Impact Scenario," both the amount of

[3] IMPLAN Sector 12 covers the North American Industrial Classification Sector (NAICS) 11212 and IMPLAN sector 87 covers NAICS 311514.

[4] Margining is the process of applying margins that are the values of wholesale, transportation and retail trade services provided in delivering commodities from producers' establishments to purchasers. The total margin is calculated as sales receipts less the cost of goods sold at the retail level and is distributed to the wholesale sector and appropriate retail and transportation sectors (Miller and Blair, 2009). So, for example, assume the value for purchased feeds as $1 million and the retail margin was 40 percent, then assuming all in-region purchases the direct shock would be $600,000 for the feed producing sector and $400,000 for the retail sector.

[5] We are not saying that Tennessee milk production would increase by 19.2 percent; rather that 19.2 percent of what was supplied to the plant would come from increased Tennessee milk production. Similar statements apply to the other two scenarios (i.e., the "50 Percent of Plant Supply from Increased Tennessee Milk Production Impact Scenario" and the "100 Percent of Plant Supply from Increased Tennessee Milk Production Impact Scenario") where Tennessee milk production is assumed to increase.

Table 1. Estimated Economic Impact of New Milk Plant on the Tennessee Economy, No Increase in Tennessee Milk Production Scenario.

Sector	Employment	Labor Income	Gross State Product	Output
		(2013 $)	(2013 $)	(2013 $)
Total	724	50,693,036	89,707,703	288,164,098
Agriculture	4	30,478	98,634	256,563
Mining	1	18,150	30,312	93,580
Construction	8	521,070	455,642	1,386,489
Manufacturing	173	22,257,656	43,706,737	208,519,494
TIPU*	80	4,628,611	6,612,374	14,835,760
Trade	143	7,825,430	14,717,108	22,970,967
Service	300	14,219,177	22,315,201	35,565,038
Government	14	1,192,465	1,771,694	4,536,207
% of Total Change				
Agriculture	0.6%	0.1%	0.1%	0.1%
Mining	0.1%	0.0%	0.0%	0.0%
Construction	1.2%	1.0%	0.5%	0.5%
Manufacturing	23.9%	43.9%	48.7%	72.4%
TIPU	11.1%	9.1%	7.4%	5.1%
Trade	19.8%	15.4%	16.4%	8.0%
Service	41.4%	28.0%	24.9%	12.3%
Government	2.0%	2.4%	2.0%	1.6%

*TIPU is Transportation, Information and Public Utilities.

milk produced in Tennessee and the amount of milk imported into the state from elsewhere would increase. Because of concerns regarding divulging sensitive information, model results are only reported at aggregate (one-digit NAICS) levels.

The projected economic impact on the Tennessee economy under the "No Increase in Tennessee Milk Production Impact Scenario" was an increase in employment of 724 jobs, $288.2 million in output, $50.7 million in labor income, and $89.7 million in gross state product (Table 1). Because milk production was assumed not to increase, the change in agriculture was slight, while increases in manufacturing output at $208.5 million (or 72.4 percent of total output), gross state product ($43.7 million or 48.7 percent) and labor income ($22.3 million or 43.9 percent) were pronounced. The service sector had the largest employment impact at 300 jobs (41.4 percent of the total increase in employment) followed by manufacturing at 173 jobs and trade at 143 jobs.

The projected economic impact on the Tennessee economy under the "RPC Based Increase in Tennessee Milk Production Impact Scenario" was an increase in employment of 1,017 jobs, $319.6 million in output, $55.6 million in labor income and $100.4 million in gross state product (Table 2). With the increase in Tennessee milk production (supplying around 19 percent of plant needs) agriculture had the second largest projected increase in employment at 223 jobs (22 percent of total scenario employment), which was less than services (345 jobs or 33.9 percent) but greater than manufacturing (174 jobs or 17.1 percent) or trade (157 jobs or 15.4 percent). Manufacturing had the largest projected increase in output at $211.5 million (or 66.2 percent of total output), gross state product ($44.0 million or 43.9 percent), and labor income ($22.4 million or 39.5 percent).

The service sector had the second largest projected increase in labor income ($16.2 million or 28.7 percent of the total labor income impact), gross state product ($25.2 million or 25.2 percent of the total impact) and output ($40.3 million or 12.6 percent of the total impact on output) followed by trade (a $8.6 million or 15.1 percent of the increase in labor income for example).

Table 2. Estimated Economic Impact of New Milk Plant on the Tennessee Economy, RPC-Based Increase in Tennessee Milk Production Scenario.

Sector	Employment	Labor Income	Gross State Product	Output
		(2013 $)	(2013 $)	(2013 $)
Total	1,017	56,564,345	100,353,840	319,641,618
Agriculture	223	2,231,141	4,939,924	19,095,113
Mining	1	20,564	35,078	106,172
Construction	9	561,253	490,556	1,494,306
Manufacturing	174	22,357,390	44,007,242	211,488,312
TIPU*	92	5,285,012	7,510,027	16,887,856
Trade	157	8,568,152	16,105,016	25,138,201
Service	345	16,208,615	25,277,884	40,337,644
Government	16	1,332,219	1,988,113	5,094,013
% of Total Change				
Agriculture	22.0%	3.9%	4.9%	6.0%
Mining	0.1%	0.0%	0.0%	0.0%
Construction	0.9%	1.0%	0.5%	0.5%
Manufacturing	17.1%	39.5%	43.9%	66.2%
TIPU	9.0%	9.3%	7.5%	5.3%
Trade	15.4%	15.1%	16.0%	7.9%
Service	33.9%	28.7%	25.2%	12.6%
Government	1.6%	2.4%	2.0%	1.6%

*TIPU is Transportation, Information and Public Utilities.

The projected economic impact on the Tennessee economy under the "50 Percent of Plant Supply from Increased Tennessee Milk Production Impact Scenario" was an increase in employment of 1,488 jobs, $370.3 million in output, $66.0 million in labor income and $117.5 million in gross state product (Table 3). With the increase in Tennessee milk production (supplying 50 percent of plant needs), agriculture had the largest projected increase in employment at 577 jobs (38.7 percent of total scenario employment) followed by services (418 jobs or 28.1 percent), trade (179 jobs or 12.0 percent) and manufacturing (176 jobs or 11.8 percent). Manufacturing had the largest impacts in terms of output ($216.3 million or 58.4 percent of the total projected increase in output), labor income ($22.5 million or 34.1 percent of the total increase in labor income) or gross state product ($44.5 million or 37.9 percent of the increase). Agriculture had the second largest increase in output among the major sectors of the Tennessee economy (at $49.4 million or 13.3 percent of the total projected increase) but had smaller increases in labor income ($5.8 million) and gross state product ($12.7 million) than the service and trade sectors.

The projected economic impact on the Tennessee economy under the "100 Percent of Plant Supply from Increased Tennessee Milk Production Impact Scenario" was an increase in employment of 2,253 jobs, $452.5 million in output, $81.3 million in labor income and $145.3 million in gross state product (Table 4). With the increase in Tennessee milk production (supplying all plant needs), agriculture had the largest projected increase in employment at 1,149 jobs (51.0 percent of total scenario employment) followed by services (536 jobs or 23.8 percent); trade (215 jobs or 9.5 percent) and manufacturing (179 jobs or 7.9 percent); and transportation, information and public utilities (139 jobs or 6.2 percent). Increases in agricultural employment were concentrated in the dairy cattle sector and in the other crop sector (where hay and pasture production reside). Manufacturing had slightly less than half of the increase in output ($224.0 million) and the largest projected increase in gross state product ($45.3 million or 31.1 percent of the total increase) followed by services. Services had the largest projected increase in labor income ($44.5 million or 30.2 percent of the total increase) followed by manufacturing and then trade. Agriculture had the second largest increase in output among the major sectors of the Tennessee economy (at $98.6 million or 21.8 percent of the total projected increase) and increases of $11.5 million in labor income and $25.4 million in gross state product ($12.7 million). Among the major sectors of the Tennessee economy, agriculture had the fourth largest increases in labor income (slightly less than trade) and the third largest increases in gross state product (behind manufacturing and services).

Table 3. Estimated Economic Impact of New Milk Plant on the Tennessee Economy, 50 Percent of Plant Supply From Increased Tennessee Milk Production Scenario.

Sector	Employment	Labor Income	Gross State Product	Output
		(2013 $)	(2013 $)	(2013 $)
Total	1,488	66,014,883	117,490,003	370,308,255
Agriculture	577	5,773,357	12,732,529	49,417,893
Mining	1	24,449	42,750	126,440
Construction	10	625,933	546,755	1,667,851
Manufacturing	176	22,517,924	44,490,938	216,266,961
TIPU*	110	6,341,563	8,954,901	20,190,938
Trade	179	9,763,649	18,339,011	28,626,610
Service	418	19,410,840	30,046,658	48,019,696
Government	18	1,557,169	2,336,463	5,991,866
% of Total Change				
Agriculture	38.7%	8.7%	10.8%	13.3%
Mining	0.0%	0.0%	0.0%	0.0%
Construction	0.7%	0.9%	0.5%	0.5%
Manufacturing	11.8%	34.1%	37.9%	58.4%
TIPU	7.4%	9.6%	7.6%	5.5%
Trade	12.0%	14.8%	15.6%	7.7%
Service	28.1%	29.4%	25.6%	13.0%
Government	1.2%	2.4%	2.0%	1.6%

*TIPU is Transportation, Information and Public Utilities.

Table 4. Estimated Economic Impact of New Milk Plant on the Tennessee Economy, 100 Percent of Plant Supply from Increased Tennessee Milk Production Scenario.

Sector	Employment	Labor Income	Gross State Product	Output
		(2013 $)	(2013 $)	(2013 $)
Total	2,253	81,336,714	145,272,274	452,452,327
Agriculture	1,149	11,516,231	25,366,410	98,579,171
Mining	1	30,747	55,187	159,301
Construction	12	730,795	637,867	1,949,214
Manufacturing	179	22,778,192	45,275,138	224,014,418
TIPU*	139	8,054,512	11,297,425	25,546,111
Trade	215	11,701,866	21,960,911	34,282,247
Service	536	24,602,499	37,778,106	60,474,340
Government	23	1,921,872	2,901,231	7,447,524
% of Total Change				
Agriculture	51.0%	14.2%	17.5%	21.8%
Mining	0.0%	0.0%	0.0%	0.0%
Construction	0.5%	0.9%	0.4%	0.4%
Manufacturing	7.9%	28.0%	31.2%	49.5%
TIPU	6.2%	9.9%	7.8%	5.6%
Trade	9.5%	14.4%	15.1%	7.6%
Service	23.8%	30.2%	26.0%	13.4%
Government	1.0%	2.4%	2.0%	1.6%

*TIPU is Transportation, Information and Public Utilities.

Summary and Conclusions

Regional and local leaders are increasingly looking at agribusiness processing as an economic growth option, and processing firms are increasingly considering local sourcing of agricultural inputs. A hybrid, IMPLAN-based model of the Tennessee economy is used to examine the possible impact of a new milk processing plant on the state economy. Assumptions regarding how much milk production would increase in the state are important in driving model results. The projected increases in total impact on employment range from 724 jobs under the "No Increase in Tennessee Milk Production Impact Scenario" to 2,253 jobs under the "100 Percent of Plant Supply from Increased Tennessee Milk Production Impact Scenario." Increases under the former scenario in terms of output exceed those under the latter by 57.0 percent ($452.5 million versus $288.2 million), while percentage increases in labor income ($81.3 million versus $50.7 million) and gross state product ($145.3 million versus $89.7 million) are in a similar vein. Even under the scenario where the level of milk production does not increase, the economic impact is sufficiently large to warrant investigation by appropriate leaders regarding the economic feasibility of such a plant.

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