University of Wisconsin-Madison
Department of Agricultural & Applied Economics

Staff Paper No. 541 August 2009

The Contribution of Agriculture to the Wisconsin Economy

By

Steven C. Deller and David Williams

AGRICULTURAL &

APPLIED ECONOMICS

STAFF PAPER SERIES

July 10, 2009

The Contribution of Agriculture to the Wisconsin Economy

Steven C. Deller
Professor and Community Development Specialist
Department of Agricultural and Applied Economics
515 Taylor Hall – 427 Lorch St.
University of Wisconsin-Madison/Extension
Madison, WI 53706

and

David Williams
Associate Professor and Assistant Program Leader
Agriculture and Natural Resources
633 Extension Building -- 432 N Lake St
University of Wisconsin-Extension
Madison, WI 53706

The University of Wisconsin Cooperative Extension program areas of Agriculture and Natural Resources and Community, Natural Resource and Economic Development provided support for this work. Ed Jesse, Ken Barnett, John Shutske and Jim Resick offered invaluable comments. All errors are the responsibility of the authors.

The Contribution of Agriculture to the Wisconsin Economy

Steven C. Deller and David Williams

Executive Summary

This study assesses the contribution of agriculture to Wisconsin's economy. Building on the analysis of Deller (2004), we use data from 2007 in this study. By using 2007 as the year of analysis, we are able to build on the current Census of Agriculture, which provides detailed data for 2007. We also explore changes in aggregate measures of agriculture from 1990 to 2007, and more detailed assessment of the strengths and weaknesses of on-farm production and food processing, from 2001 to 2007.

- Historical data from the United States Bureau of Economic Analysis shows that from 1990 to 2002, farm employment declined but more recently, from 2003 to 2007, stabilized. From 1990 to 2000, food processing experienced employment growth, but from 2001 to 2007, food-processing employment dropped slightly (Figure 1). This is somewhat contradictory to the input-output economic impact analysis included in this study which shows on-farm employment declining from 2000 to 2007 and food processing employment increasing slightly over the same period.

- Farm earnings saw little growth between 1990 and 2007, and the instability of farm earnings reflects the nature of the industry. Earnings from food processing grew annually from 1990, but the rate of growth slowed from about 2002 (Figure 2). Earnings from farm employment tend to be significantly below average Wisconsin earnings, but average per-job earnings in food processing were consistently above Wisconsin's economy-wide average earnings (Figure 3).

- Comparing employment levels to the national average, Wisconsin retains a growing strength in dairy farming, cattle ranching, production of animals for fur and, increasingly, dry, condensed and evaporated dairy, breweries, frozen specialty food processing, fruit and vegetable canning and drying, as well as the broad category of dairy product processing. Traditionally strong agricultural sectors that appear to be weakening include potato production and frozen fruit and vegetable processing.

- In 2007 agriculture contributed $59.16 billion to Wisconsin's industrial output (i.e. industry sales), or about 12.5% of the Wisconsin total. Dairy, including on farm-level production/sales and processing, accounted for about $26.5 billion of total industrial output. Dairy processing (such as cheese), accounted for the majority of industrial sales. This represents a 14.9% increase over the 2000 estimated impact of agriculture, which was $51.5 billion.

- In 2007 agriculture contributed 353,991 jobs to the Wisconsin economy, or 10% of total employment. On-farm production contributed 132,000 jobs. Agricultural processing accounts for 251,800 jobs, horticulture contributes about 16,700 jobs, and forestry and logging 7,600 jobs. This represents a 15.7% decline from the 2000 estimated impact of agriculture on Wisconsin employment, which was 420,000 jobs.

- In 2007 agriculture contributed $20.2 billion to total income, about 9.0% of Wisconsin's total income. The majority of this comes from the agricultural processing sectors. This is a 20.2% increase over the 2000 estimated contribution of agriculture to total income, or about $16.8 billion.

The Contribution of Agriculture to the Wisconsin Economy

Steven C. Deller and David Williams

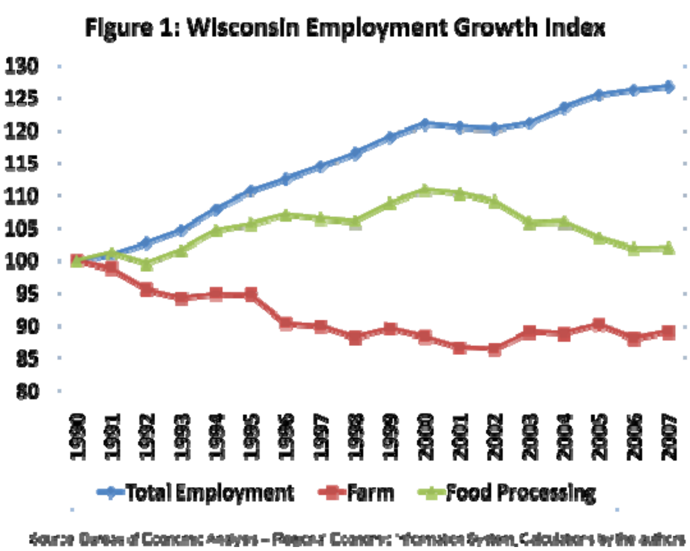
Introduction

This study is an update and expansion of the 2004 study by Deller that examined the economic contributions of agriculture, both on-farm production and agricultural processing, on Wisconsin's economy, using data for 2000.[1] In that study Deller documented that agriculture contributed $51.5 billion in industrial sales, 420,000 jobs and $16.8 billion in total income to Wisconsin's economy. The 2004 study also documented that agricultural processing, including cheese production and vegetable processing among others, is a strength of the Wisconsin economy. This study replicates the 2004 study by examining the contribution of on-farm production, agricultural processing and horticulture, and adds new information by looking at forestry's contribution to the Wisconsin economy.

This study contains three parts. The first section examines trends in earnings and employment from 1990 to 2007. We compare Wisconsin to the United States and the Great Lakes states. The second section introduces new analysis by looking at the strengths and weaknesses of detailed sectors of farming and agricultural processing. Building on the concept of "clusters," we look at changes in an indicator of strength, called location quotients, in 2007 compared to 2001. The third section reports our findings of the economic contributions of agriculture to Wisconsin's economy using economic multipliers derived from an input-output model of the Wisconsin economy.

Historical Trends[2]

In 2007 there were 78,463 farms in Wisconsin, a 2% increase over 2002, according to the U.S. Census of Agriculture. Total land in farms fell from just over 15.7 million acres in 2002 to about 15.2 million acres in 2007, a drop of about 3%. Average farm size declined from 204 acres in 2002 to 194 acres in 2007, but average value of production rose 57%, from $72,906 in 2002 to $114,288 in 2007. A key reason for the increase in average value of production was the unusually high price of milk in 2007 compared to 2002. In 2002 the average Wisconsin all-milk price was $12.19 per hundredweight compared to $19.27 in 2007. The average all-milk price from 1990 to 2007 was $13.98, indicating that 2007 was a particularly strong year for dairy.



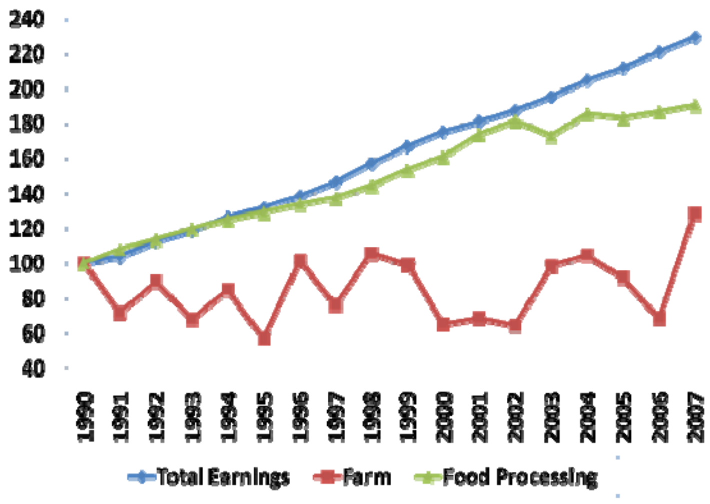
[1] Deller, Steven C. 2004. "Wisconsin and the Agricultural Economy." Department of Agricultural and Applied Economics Staff Paper Series No. 471, University of Wisconsin-Madison/Extension. (March). http://www.aae.wisc.edu/pubs/sps/pdf/stpap471.pdf

[2] The data for the historical analysis in this section is from the Bureau of Economic Analysis, Regional Economic Information System: http://www.bea.gov/regional/reis/. It is important to note that there is significant overlap between the data used for the economic impact assessment and the historical trend analysis. There are, however, subtle but important differences between the two data sources. As will become clear, at face value, the analysis changes in the agricultural processing levels lead to two polar conclusions. Upon reflection, the conclusion is reasonable.

If we examine Wisconsin employment growth from 1990 to 2007 across total (all industries) farm and food-processing employment, three patterns become apparent (Figure 1). First, from 1990 to about 2002, farm employment declined steadily, but between 2002 and 2007, farm employment stabilized and increased modestly. Second, employment in food processing tended to increase between 1990 and 2000 but has been declining between 2001 and 2007. Third, other than stagnation in total employment growth during the modest recession of the early 2000s, total employment in Wisconsin has grown at an average annual rate of about 1.6%. The result is that farming and food processing, as a share of total Wisconsin employment, has been declining.

When we examine changes in earnings (wages, salaries, proprietor income, employer contributions for employee pension and insurance funds, and of employer contributions for government social insurance) for Wisconsin from 1990 to 2007, a few observations warrant discussion (Figure 2). First, earnings growth from food processing tracks closely with total earnings up until 2003 when earnings growth from food processing slows. Second, earnings from farming are relatively flat and unstable from 1990 to 2007, revealing the volatility of farm prices. Also, as mentioned, high commodity prices in 2007 are reflected in the jump in farm earnings from 2006 to 2007.

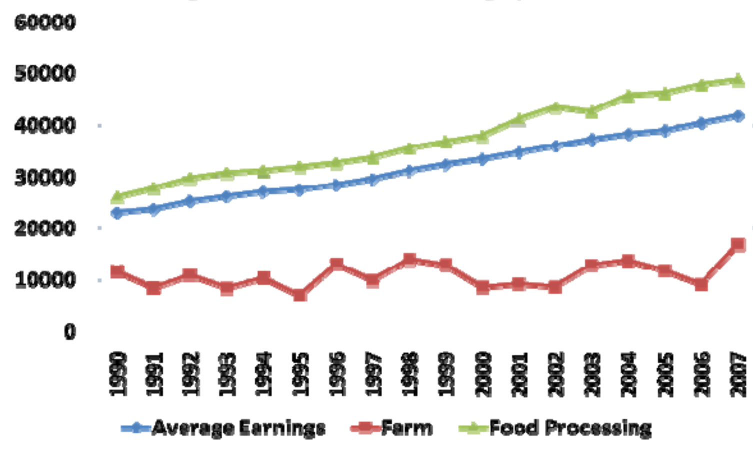
Figure 2: Wisconsin Earnings Growth Index



Source: Bureau of Economic Analysis – Regional Economic Information System, Calculations by the authors

Earnings per job (Figure 3) for the typical Wisconsin job increased from $23,000 in 1990 to about $42,000 in 2007, an increase of about 83% in nominal terms. Earnings per job for those employed on farms, however, stayed relatively flat from 1990 to 2007, at about $10,000 per year. The influence of high commodity prices in 2007 is evident in a strong upward tick in per-job farm earnings in 2007. Per-job earnings in food processing, however, are consistently above the statewide average, and grew from about $26,000 in 1990 to almost $49,000 in 2007, an increase of 88.5%. Hence, despite the slowdown, or more correctly, reverting back to trend after two years of abnormal growth in food-processing earnings, after 2002 the decline in food-processing jobs resulted in a net growth in per-job earnings. In other words, fewer jobs exist in Wisconsin's food-processing sector, but the remaining jobs tend to pay higher wages and salaries.

Figure 3: Wisconsin Earnings per Job

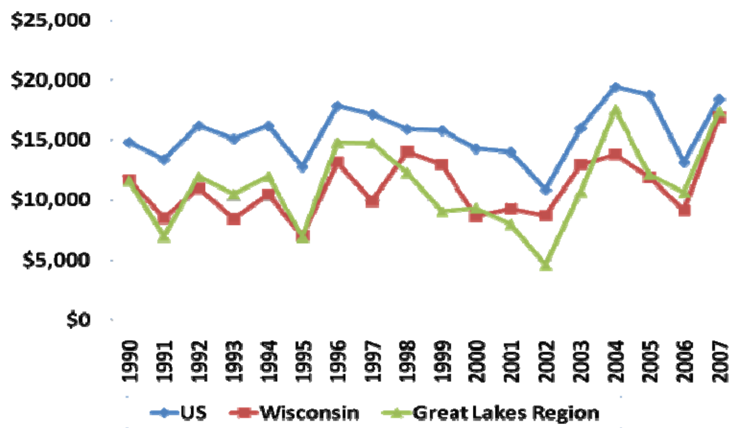


Source: Bureau of Economic Analysis – Regional Economic Information System, Calculations by the authors

The broad industry categories of farming and food processing contain wide variation in earnings across occupations. For example, in 2007 agricultural and food-science technicians in Wisconsin earned an average of $33,320. Agricultural engineers had an average annual salary of $68,570. Wisconsin farm managers earned an average of $56,800 in 2007, and animal breeders had an average salary of $38,290. Agricultural equipment operators earned an average $29,260, and farm workers earned $22,420. Keep in mind that 2007 was a unique year when average annual earnings and salaries were uniquely high. In 2000 Wisconsin farm managers earned an average of $37,240, while a typical farm worker earned only $17,860. Average earnings of about $10,000 for a typical job in farming, as reported in Figure 3, may appear to contradict the occupational data. Keep in mind, however, that employment counts include many part-time farm workers. Two part-time farm workers may earn only a fraction of what a full-time worker earns, dragging the average down.

How does Wisconsin compare to the nation or the Midwest? Looking at Wisconsin in isolation can lead to misperceptions about how agriculture and food-processing industries are growing within the state. Several observations warrant discussion as we look at farm employment earnings per job for Wisconsin, the United States and the states composing the Great Lakes region: Minnesota, Wisconsin, Michigan, Illinois, Indiana and Ohio (Figure 4). First, somewhat as expected from the analysis presented in Figures 2 and 3, farm employment earnings per job tend to be highly unstable from one year to the next. Second, from 1990 to 2007, Wisconsin's per-job farm employment earnings fell consistently below the national average. It is not clear from this simple analysis why Wisconsin consistently lags behind the United States. The diversity of Wisconsin agriculture might suggest the state would be in a better position to capture returns to higher-value products. Finally, although per-job farm earnings are highly unstable, Wisconsin appears slightly more stable than the Great Lakes region. Indeed, the standard deviation from 1990 to 2007 for per-job farm earnings in Wisconsin was 2,574 but 3,466 for the Great Lakes region. This difference is likely due to a drop in 2002 and a spike in 2004 for the Great Lakes region; other than these two years, Wisconsin tracks fairly close to the Great Lakes states.

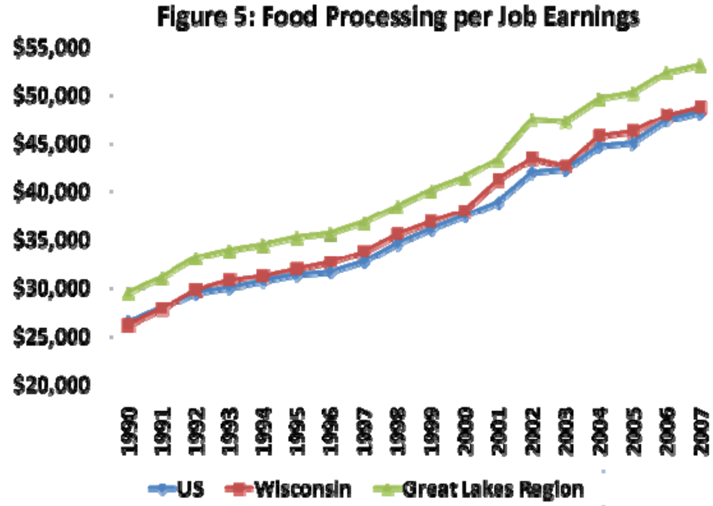
Figure 4: Farm Employment Earnings per Job



Source: Bureau of Economic Analysis – Regional Economic Information System, Calculators by the authors.

Earnings per job in food processing are more stable than farm earnings (Figure 5). Other than a minor downtick in 2004, the typical food-processing job has seen steady and stable earnings growth, with an average annual growth of about 5.3% for Wisconsin in nominal terms. Wisconsin's per-job earnings in the food-processing industry closely track the national average but are consistently below the average for the Great Lakes region. In 2007 the typical food-processing worker earned about $48,260 across the United States, and slightly more, $48,781, in Wisconsin. The Great Lakes region's average, however, was $53,921.

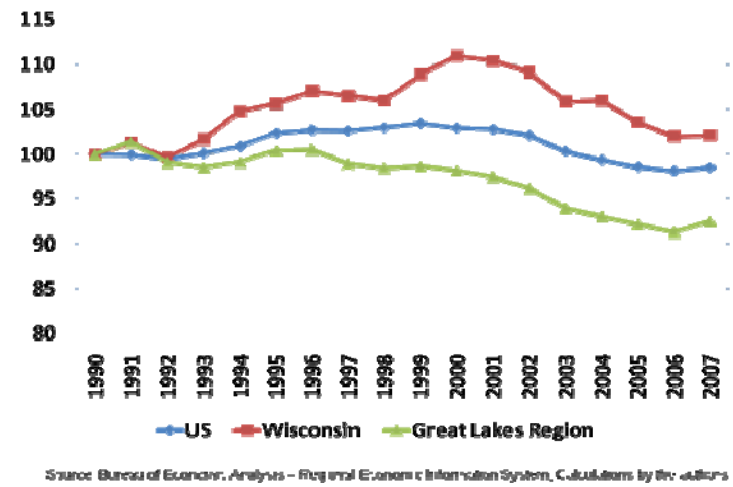
Figure 5: Food Processing per Job Earnings



Source: Bureau of Economic Analysis – Personal Economic Information System, Calculations by the authors

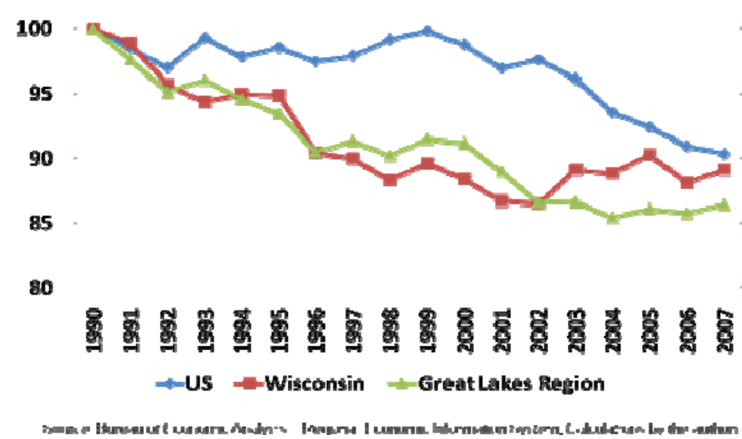
The food-processing industry has not been a source of employment growth from 2000 to 2007 (Figure 6). From 1990 to about 2000, employment growth in food processing was modest for the United States and slightly stronger for Wisconsin. Since 2000, however, there has been a modest decline in employment opportunities for both the United States and Wisconsin. The Great Lakes region has seen declining employment in food processing since 1996. A modest uptick in employment, however, occurred across all three regions from 2006 to 2007. From the perspective of economic growth, the food-processing industry provides a range of relatively well-paying jobs, but stagnating employment opportunities create some cause for concern. A policy question facing Wisconsin is how to reverse the downward employment trend for the processing sector. If this trend is simply a matter of consolidation and technical innovation (leading to greater efficiencies), the policy question hinges on promoting a more competitive industry that employs fewer people. Economic growth and development need not focus solely on growth in the absolute number of jobs. We will explore the strengths and weaknesses of the food-processing industry in more detail and hopefully shed some light on policy options.[3]

Figure 6: Food Processing Employment Growth Index



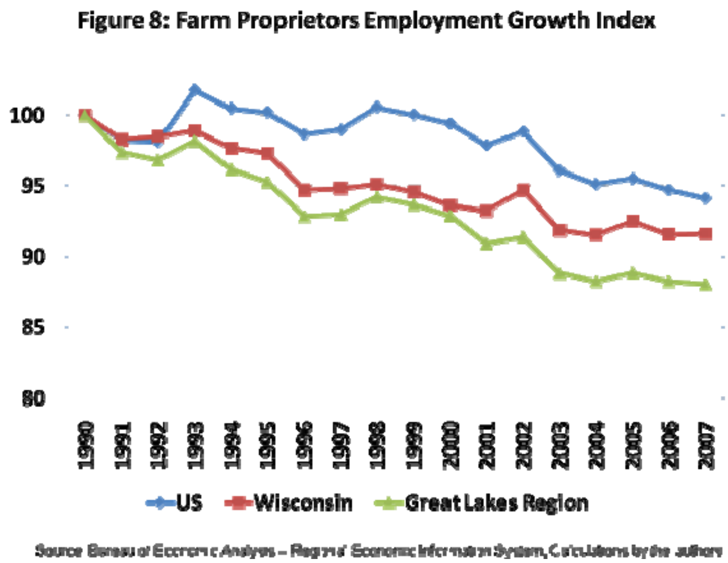
When we compare farm employment growth for Wisconsin to the United States and the Great Lakes region, a few patterns warrant discussion (Figure 7). It is clear that farming as a source of employment growth appears modest. For Wisconsin and the Great Lakes region, farm employment fell steadily from1990 to 2002, but stabilized and even ticked upward in Wisconsin, from 2002 to 2007. In contrast, U.S. farm employment was stable from 1990 to 2002 then began a steady decline until 2007. Wisconsin's upward tick happened in part because of an increase in hired labor on expanding Wisconsin dairy farms. One issue centers on the nature of the labor force that is supporting increased employment in dairy farming. Many new hires are Hispanic workers who send a portion of their wages to families in their home countries. This study does not address this outflow of those wages, which modestly leads to an underestimate of the impact assessments discussed in section 3.

Figure 7: Farm Employment Growth Index

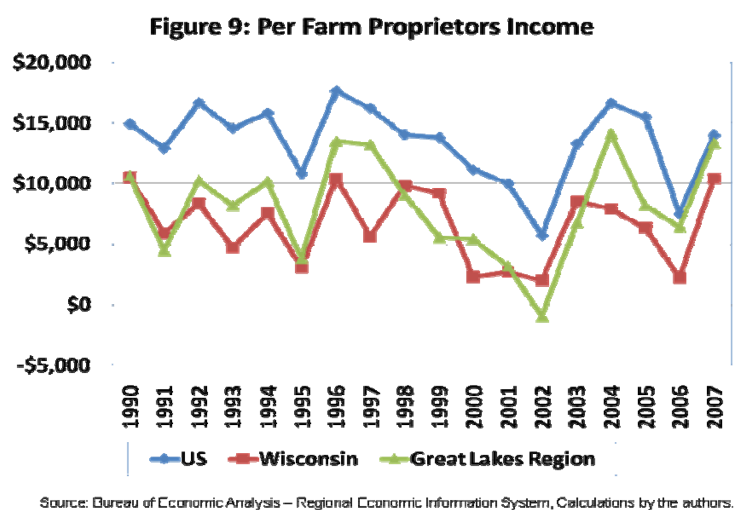


[3] It is important to note that the observations on food-processing employment trends outlined here contradict the results of the direct contribution discussed later. This is due largely to subtle but important differences in the definitions of the industries that make up agricultural processing. When the two distinct and separate data sets are considered together, the conclusion is that employment in Wisconsin's food-processing sector is stable, not growing but not declining either.

Farm employment, as discussed so far, is defined as the number of workers engaged in direct production of agricultural commodities, either livestock or crops, as a sole proprietor, partner or hired laborer. In Wisconsin the vast majority of farms are structured as sole proprietorships. Farm employment statistics may not adequately reflect changing patterns of the farm component of the agricultural economy. Based on the 2007 Census of Agriculture, 86.9% of Wisconsin farms are owned by families or individuals as proprietors, and 4.3% are owned by corporations. Given Wisconsin law, these corporations are family owned. The balance of ownership structure is primarily in the form of legal partnerships. In the data used, farm proprietor employment is the number of farms operated by sole proprietors plus the number of partners operating farm partnerships. The growth index of farm proprietor employment (Figure 8) tends to map closely with farm employment (Figure 7). The pattern of decline from 1990 to 2001, followed by a stabilization from 2003 to 2007, is evident.



Like farm employment earnings, per-farm proprietor income is highly unstable, and from 1990 to 2007, averaged only $6,275, $4,505 below average farm employment earnings (Figures 9 and 4).[4] This implies that farm workers may earn more income than farm proprietors. Farm proprietors, however, may be considering factors other than earnings in their decision to keep farming. Farm employees, on the other hand, may have more opportunities and not be tied to the farm to the same extent as the farm owner. It is important to note that how individual farmers pay themselves will influence how data is reported. If farmers pay themselves a salary, income will show up as earnings. If they report their income for tax purposes as self-employment income, it will be reported as proprietor income.



[4] Farm proprietors' income consists of income that is received by sole proprietorships and partnerships operating farms. It excludes income that is received by corporate farms.

Strengths and Weaknesses of Wisconsin Agriculture

In 2003 the Wisconsin Office of the Governor embraced the notion of cluster development as the foundation of economic development policies. Forward Wisconsin defines clusters as:

> . . .geographic concentrations of interconnected companies, specialized suppliers, service providers and associated institutions in a particular field. Clusters develop because they increase the productivity with which companies can compete in an increasingly more competitive global market, and they are the source of jobs, income and export growth. The philosophy behind clusters is that large and small companies in a similar industry achieve more by working together than they would individually. Clusters give businesses an advantage by providing access to more suppliers and customized support services, skilled and experienced labor pools, and knowledge transfer through informal social exchanges. In other words, clusters enhance competitiveness.

The state initially identified 10 existing and potential clusters, including dairy and food processing. Other clusters include paper and wood products, biotechnology, plastics, medical devices, information technology and wind energy. Methods of identifying clusters vary widely, but an approach suggested by Harvard business economist Michael Porter is growing in popularity. The approach is built on the notion of location quotients: current values of the location quotient, changes in the location quotient over time, and relative size of the industry coupled with other industry characteristics. The location quotient (LQ) is an indicator of self-sufficiency, or relative strength, of a particular industry. The LQ is computed as:

$$LQ_s^i = \frac{\text{Percent of local economic activity in sector i}}{\text{Percent of national economic activity in sector i}}$$

The proportion of national economic activity in sector i located in the region (state or community) measures the region's production of product i, assuming equal labor productivity. The proportion of national economic activity in the region proxies local consumption, assuming equal consumption per worker. The difference between local production and consumption is an estimate of production for export (i.e. production > consumption).

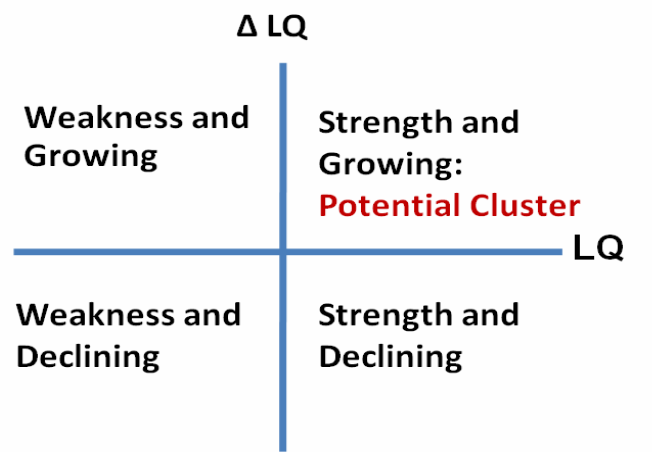
The key assumptions to operationalize the location quotient approach are that the regional production technology is identical to national production technology (i.e. equal labor productivity) and that local tastes and preferences are identical to national tastes and preferences (i.e. equal consumption per worker). Assuming the national economy is self-sufficient, the comparison between the community and the national benchmark gives an indication of specialization or self-sufficiency.

Three important location quotient values derive from the self-sufficiency interpretation of location quotients. A location quotient of 1 means the region has the same proportion of economic activity in sector i as the nation. The region just meets local consumption requirements through local production of the specified good or service. If the location quotient is less than 1, the region is not producing enough to meet local needs. If the location quotient is greater than 1, the region has a larger proportion of its economy in sector i than does the nation.

The Porter notion of clusters evaluates levels and changes of the location quotient coupled with the absolute size of the industry and other characteristics that may make the industry desirable as a source of employment opportunities. Consider the simple mapping of the level and change of the LQ as outlined in Figure 10. There are four potential combinations.

First, if the industry has a LQ less than 1 and is declining, this industry is considered a "weakness and declining" industry and generally should not be considered a potential cluster. Second, if the LQ is less than 1 but increasing, the industry can be considered a "weakness and growing" industry and may be a possible industry of focus for economic development. Third, if the LQ is greater than 1 but is declining over time, it is considered "strength and declining." Industries in this category might be considered at risk and deserving of special consideration to understand why a strong industry (i.e. LQ>1) is weakening (i.e. ΔLQ<0). In particular, does the decline of these industries present a potential risk to the regional economy? Fourth, if the LQ is greater than 1 and growing over time, it is considered "strength and growing." Porter suggests that industries in this category might be considered potential clusters for economic growth and development. These industries have self-identified the region as having a comparative advantage over other regions and may have further growth potential.

Figure 10: Porter's Identification of Clusters



There are several ways to measure economic activity, including employment, sales and income. We elected to use employment for this analysis for several reasons. First, the U.S. Economic Development Administration has embraced Porter's approach to identifying clusters and has provided numerous tools, all of which are based on employment. Second, employment data is generally more readily available in a timely manner than sales or income data. Third, employment data is available not only at the national and state level but at the county level. This allows for future work looking at the notion of agricultural clusters across different Wisconsin regions. But as we will see, the employment metric may show weakening of some agricultural sectors -- even though we know the sector is growing in terms of sales. This raises the question of what are the best metrics of economic growth and development? The answer to this question can drive economic policy.

<u>Strengths and Weaknesses of Broad Agricultural Categories</u>

To begin the discussion, consider the performance of Wisconsin's agricultural sectors as broadly defined in Table 1. Here and in all subsequent analysis in this section, Wisconsin is compared to the nation.

Table 1: Strengths and Weakness of Agriculture Broadly Defined

Industry	Share of Employment 2007	LQ 2007	LQ 2001	Change LQ 2001- 2007
Crop production	0.27%	0.57	0.55	0.02
Animal production	0.42%	2.15	1.63	0.52
Forestry and logging	0.03%	0.59	0.7	-0.11
Fishing, hunting and trapping	0.00%	0.45	0.51	-0.06
Agriculture and forestry support activities	0.10%	0.35	0.29	0.06
Food manufacturing	2.47%	1.91	1.94	-0.03
Beverage and tobacco product manufacturing	0.12%	0.68	0.61	0.07

Based on the LQ for 2007, two broad agricultural sectors stand out: animal production, which in Wisconsin includes on-farm dairy production, and food manufacturing or food processing. If we consider the change in LQ from 2001 to 2007, the LQ for animal production (e.g. dairy) rose from 1.63 to 2.15, placing it in the "strength and growing" or potential cluster quadrant of Figure 10. This is consistent with Wisconsin's identification of dairy as a cluster. From our comparison of farm proprietor and employment analysis (Figures 7 and 8), we can note that the U.S. share of total farm employment has dropped, yet in Wisconsin it has stabilized. In other words, the denominator of the LQ has gone down, while the numerator has stayed relatively constant.

Perhaps more important is the food-processing sector, which is a strength for Wisconsin as indicated by the LQ greater than 1. But from 2001 to 2007, the food-processing LQ declined slightly, placing it in the "strength and declining" quadrant of Figure 10. Because of the relative importance of food processing as a source of employment and well-paying jobs in Wisconsin, the modest decline in the LQ may be cause for concern, particularly given downward trends in industry employment (Figure 6).

One of the difficulties with the analysis presented in Table 1, and the more detailed analysis presented below, is a lack of guidance on what constitutes a "significant" difference from 1 or change from one year to another. For example, one might reasonably conclude that the growth in the LQ for animal production (dominated by dairy) from 1.63 to 2.15, a change of 0.52, is a significant increase. But is the decrease in food processing from 1.94 to 1.91 significant enough to warrant specific attention? Unfortunately, the theory of clusters as an economic development policy does not lend any insight into what constitutes significant levels or changes.

Crop production, though important to Wisconsin's livestock and dairy industry, is not a strength of Wisconsin's economy, given Porter's notion of clusters. Despite the diversity of Wisconsin's crop production, the topography is such that other states, primarily the Corn Belt, dominate aggregate crop production in this country. One limitation to this observation about crops is that much of Wisconsin's crop production is undertaken by dairy farmers and, as such, is reported in animal production. These industry breakouts do not adjust for multiple-product firms, such as a dairy farm, that has significant crop production.

Forestry and logging is also a relatively weak sector for Wisconsin, with the LQ less than 1, and declining from 2001 to 2007. In certain parts of Wisconsin, forestry and logging is an important sector and a potential cluster, but from a statewide perspective, the forestry and logging sector does not rise to the level of a potential cluster. As previously noted, wood products have been identified by the Wisconsin Department of Commerce and Forward Wisconsin as a cluster, so how do we reconcile the conclusions based on the analysis in Table 1? Two important points help explain this. First, the forestry and logging sector is associated with the growth and harvesting of wood, not processing wood into consumer products. Second, from a statewide perspective, forestry and logging may not be important as defined by cluster analysis, but in many parts of the state, forestry and logging can be a viable industry and potential cluster. The policy question is whether this vast resource should be used in a traditional extractive activity such as logging or a non-extractive activity such as tourism and recreation. Ideally, new forest-management methods may allow for both activities to occur at the same time.

One limitation of the simple analysis in Table 1 is the aggregate nature of the industries; the sectors are simply too large to provide any strong insights into industry strengths and weaknesses. For example, food processing lumps cheese production with bakeries. To gain additional insight, we decompose the two broad categories of farming and food processing into detailed industries.

Sector Trends for Farming

Farming Sectors That Show "Strength and Growing" Consider first the farm sectors deemed "strength and growing" (Table 2A). Both dairy and cattle ranching are strong and have been growing relative to the nation over the 2001-2007 time period. Animal production not associated with cattle, such as sheep and goats along with horses, is another farm sector that falls in "strength and growing." Although crops as a broad category is not a strength for Wisconsin's economy, corn farming, particularly corn for silage, is a strength. Indeed, based on the 2007 Census of Agriculture, Wisconsin ranks first in the nation in the production of corn for silage, in terms of acreage planted, and second in milk and other dairy products from cows. Given the strengths of Wisconsin's animal-based agriculture, it should not be surprising that "support activities for animal production" is also a Wisconsin strength.

Table 2A: Farming -- Strength and Growing				
Industry	**Share of Employment 2007**	**LQ 2007**	**LQ 2001**	**Change LQ 2001- 2007**
Fur-bearing animal and rabbit production	0.01%	13.53	11.53	2.00
Dairy cattle and milk production	0.35%	4.80	3.97	0.83
Cattle ranching and farming	0.36%	3.21	2.46	0.75
Animal production	0.42%	2.15	1.63	0.52
Hunting and trapping	0.00%	1.20	0.85	0.35
Oilseed and grain farming	0.03%	1.05	0.85	0.20
Floriculture production	0.05%	1.09	0.90	0.19
Corn farming	0.02%	2.24	2.08	0.16
Support activities for animal production	0.06%	2.35	2.32	0.03

Two sectors that are somewhat surprising, however, are floriculture (i.e. horticulture) production along with fur-bearing animal and rabbit production. The LQ for floriculture is weakly above 1, but appears to be a potential growth sector for Wisconsin. It is important to note that the definition of floriculture used here is very narrow and does not necessarily include the landscaping-services industry, which is a major component of the horticulture industry used in the economic impact analysis below. The LQ for the production of fur-bearing animals is high and growing, suggesting this is a true strength of Wisconsin agriculture. However, the relatively small size of the industry, accounting for only .01% of total state employment, may be too small to fit Porter's notion of a cluster.

<u>Farming Sectors That Show "Strength and Declining"</u> Consider farming sectors that are strengths for Wisconsin but appear to be declining, shown in the lower right corner of Figure 10 (Table 2B). These include two generic categories called "other" animal production, which do not fit in the more specific animal production sectors in Table 2A. Two that are perhaps more meaningful are berry (except strawberry), production and potato production. These are concerns given Wisconsin's dominant position in cranberry and historical strengths as a potato producing state. Based on the LQ in 2007, cranberry and potato farming are strengths, but relative strength is declining over time. One must keep in mind that this analysis is based on employment and not sales. It may be that due to economies of scale and innovations, output (sales) can increase with fewer associated employees. This simple analysis is not sufficiently reflective to assess the level of that threat or even if there is sufficient threat to worry about.

Table 2B: Farming -- Strength and Declining				
Industry	**Share of Employment 2007**	**LQ 2007**	**LQ 2001**	**Change LQ 2001- 2007**
Other animal production	0.03%	1.75	1.85	-0.10
Berry, except strawberry, farming	0.04%	3.06	3.36	-0.30
All other animal production	0.01%	1.75	2.46	-0.71
Potato farming	0.05%	4.09	5.17	-1.08

<u>Farming Sectors That Show "Weak but Growing"</u> Now let's examine farming sectors not considered strengths based on their LQs in 2007 but that appear to be gaining strength from 2001 to 2007. This would include sectors that fall into the upper left quadrant of Figure 10, reported in Table 2C. From a practical perspective, most of the farm sectors classified as "weakness and growing" are relatively stable in terms of LQs from 2001 to 2007. Some sectors that appear to be experiencing growth include grain farming that does not include corn or oilseed grains, such as sorghum, milo, oat or barley among others, and soil preparation, planting and cultivating services. The latter reflects the growth in specialized services that more farmers are turning to in their production decisions.

Table 2C: Farming -- Weakness and Growing

Industry	Share of Employment 2007	LQ 2007	LQ 2001	Change LQ 2001- 2007
All other grain farming	0.00%	0.78	0.24	0.54
Soil preparation, planting, and cultivating	0.02%	0.81	0.44	0.37
Other grain farming	0.01%	0.53	0.16	0.37
Oilseed and grain combination farming	0.00%	0.42	0.11	0.31
Agriculture, forestry, fishing and hunting	0.83%	0.81	0.68	0.13
Beef cattle ranching, farming, and feedlots	0.02%	0.37	0.28	0.09
Poultry and egg production	0.02%	0.50	0.42	0.08
Agriculture and forestry support activities	0.10%	0.35	0.29	0.06
Support activities for crop production	0.04%	0.16	0.11	0.05
Mushroom production	0.00%	0.22	0.17	0.05
Natural Resources and Mining	0.94%	0.59	0.54	0.05
Hog and pig farming	0.01%	0.36	0.32	0.04
Support activities for forestry	0.00%	0.29	0.25	0.04
Apple orchards	0.01%	0.38	0.35	0.03
Fruit and tree nut farming	0.05%	0.33	0.30	0.03
Food crops grown under cover	0.00%	0.24	0.21	0.03
Noncitrus fruit and tree nut farming	0.05%	0.35	0.32	0.03
Crop production	0.27%	0.57	0.55	0.02
Aquaculture	0.00%	0.32	0.32	0.00

Farming Sectors That Show "Weak and Declining" The final category in Figure 10 is "weakness and declining," with the farming sectors in this category shown in Table 2D. Sectors that appear weak and declining include forestry and logging, nursery tree production, and greenhouse and nursery production. One could argue that declines in these sectors are relatively modest and may not reflect regional changes. Rather than view the analysis in Table 2D as a threat to parts of Wisconsin's agricultural economy, the analysis can prompt more fundamental questions as to why these trends are present in the data. Keep in mind that all LQs are reported in terms of employment, not industry sales or income earned in the industry.

Table 2D: Farming -- Weakness and Declining

Industry	Share of Employment 2007	LQ 2007	LQ 2001	Change LQ 2001- 2007
Other crop farming	0.01%	0.17	0.19	-0.02
Other postharvest crop activities	0.01%	0.18	0.20	-0.02
Vegetable and melon farming	0.08%	0.96	0.99	-0.03
Greenhouse and nursery production	0.10%	0.65	0.69	-0.04
Nursery and floriculture production	0.10%	0.71	0.75	-0.04
Other vegetable and melon farming	0.03%	0.38	0.43	-0.05
Chicken egg production	0.01%	0.79	0.85	-0.06
Fishing, hunting and trapping	0.00%	0.45	0.51	-0.06
Other food crops grown under cover	0.00%	0.28	0.37	-0.09
Forestry and logging	0.03%	0.59	0.70	-0.11
Fishing	0.00%	0.23	0.35	-0.12
Logging	0.03%	0.63	0.75	-0.12
Nursery and tree production	0.05%	0.52	0.67	-0.15
Finfish fishing	0.00%	0.43	0.67	-0.24

Sector Trends for Food Processing

Processing Sectors That Show "Strength and Growing"   Despite the modest decline in food-processing employment outlined in Figure 6, numerous industries in the food-processing sector could be classified as "strength and growing" by Porter's industry clusters (Table 3A). The industry of dry, condensed and evaporated dairy products is a strength for Wisconsin (LQ in 2007 is 4.92) and growing. Our analysis is based on employment, not quantity produced. The amount produced in Wisconsin pales in comparison to other dairy products based on employment numbers with only .06% of workers as compared to 0.67% for dairy manufacturing and 0.51% for cheese manufacturing. This analysis, however, suggests that this product line may be an area of potential focus. One explanation for this growth is an expanding foreign export market for whey products. Other large and growing food-processing sectors include breweries, including a growing number of smaller specialty breweries, along with frozen foods such as specialty foods, ice cream and dessert foods, fruit and vegetable processing, and even animal food production. The largest food-processing sector, dairy product manufacturing, remains a dominant sector. In terms of growth in the LQ between 2001 and 2007, however, the sector remains unchanged.

Table 3A: Food Processing -- Strength and Growing

Industry	Share of Employment 2007	LQ 2007	LQ 2001	Change LQ 2001- 2007
Dry, condensed, and evaporated dairy products	0.06%	4.92	3.66	1.26
Breweries	0.07%	2.87	2.02	0.85
Frozen specialty food manufacturing	0.15%	2.94	2.16	0.78
Spice and extract manufacturing	0.05%	3.03	2.35	0.68
Seasoning and dressing manufacturing	0.08%	2.91	2.43	0.48
Other animal food manufacturing	0.06%	2.31	1.85	0.46
Mixes and dough made from purchased flour	0.03%	2.07	1.64	0.43
Sugar and confectionery product manufacturing	0.10%	1.51	1.17	0.34
Animal food manufacturing	0.08%	1.85	1.62	0.23
Confectionery mfg. from purchased chocolate	0.04%	1.41	1.19	0.22
Mayonnaise, dressing, and sauce manufacturing	0.03%	2.74	2.54	0.20
Animal, except poultry, slaughtering	0.17%	1.34	1.20	0.14
Ice cream and frozen dessert manufacturing	0.02%	1.21	1.09	0.12
Fruit and vegetable canning	0.19%	3.20	3.11	0.09
Fruit and vegetable canning and drying	0.22%	2.78	2.76	0.02
Dairy product manufacturing	0.67%	5.89	5.88	0.01

Processing Sectors That Show "Strength and Declining"   While the analysis in Table 3A suggests some of the strength sectors in Wisconsin's food-processing industry, a few sectors are cause for modest concern (Table 3B). Although dairy product manufacturing appears stable in terms of the LQ across 2001 and 2007, cheese manufacturing and creamery butter manufacturing appear to be weakening. Although the LQ for cheese production was a very strong 15.14 in 2007, it was higher in 2001 at 16.37. This is largely due to the increase in cheese production in other parts of the United States. The decline in frozen fruit and vegetable processing, however, is more severe, with the LQ falling from 3.82 in 2001 to 1.46 in 2007, a drop of almost 62%. In comparison, nearly all other Wisconsin food-processing sectors classified as "strength and declining" in Table 3B have declined modestly. For example, meat processing, reflected in animal slaughtering and processing, fell from 1.68 in 2001 to 1.67 in 2007.

Table 3B: Food Processing -- Strength and Declining				
Industry	**Share of Employment 2007**	**LQ 2007**	**LQ 2001**	**Change LQ 2001- 2007**
Frozen fruit and vegetable manufacturing	**0.04%**	**1.46**	**3.82**	**-2.36**
Malt manufacturing	**0.01%**	**15.98**	**17.74**	**-1.76**
Cheese manufacturing	**0.51%**	**15.14**	**16.37**	**-1.23**
Creamery butter manufacturing	**0.03%**	**16.84**	**17.57**	**-0.73**
Frozen food manufacturing	**0.19%**	**2.42**	**2.89**	**-0.47**
Flour milling and malt manufacturing	**0.02%**	**1.21**	**1.53**	**-0.32**
Meat processed from carcasses	**0.43%**	**4.40**	**4.69**	**-0.29**
Fruit and vegetable preserving and specialty	**0.40%**	**2.60**	**2.82**	**-0.22**
Snack food manufacturing	**0.05%**	**1.20**	**1.37**	**-0.17**
Dog and cat food manufacturing	**0.02%**	**1.09**	**1.22**	**-0.13**
Dairy product, except frozen, manufacturing	**0.65%**	**6.73**	**6.84**	**-0.11**
Bread and bakery product manufacturing	**0.19%**	**1.03**	**1.12**	**-0.09**
Animal slaughtering and processing	**0.74%**	**1.67**	**1.68**	**-0.01**
Rendering and meat byproduct processing	**0.01%**	**1.37**	**1.38**	**-0.01**

<u>Processing Sectors That Show "Weak but Growing"</u> In terms of food-processing sectors that are not necessarily considered strengths for Wisconsin but have experienced some growth in terms of the LQ, two warrant discussion (Table 3C). Ice manufacturing has seen a tripling of the LQ from 2001 (0.24) to 2007 (0.73), but the level of employment is sufficiently small to question whether this particular food-processing sector has the potential to have a large impact on Wisconsin's economy. Beverage and tobacco product manufacturing has a much larger share of Wisconsin employment when compared to other food-processing sectors, and a modest but positive growth rate in the LQ over the time examined. Unfortunately, the data are not sufficiently detailed to provide further insights to this trend.

Table 3C: Food Processing -- Weakness and Growing				
Industry	**Share of Employment 2007**	**LQ 2007**	**LQ 2001**	**Change LQ 2001- 2007**
Ice manufacturing	**0.01%**	**0.73**	**0.24**	**0.49**
Beverage and tobacco product manufacturing	**0.12%**	**0.68**	**0.61**	**0.07**
Starch and vegetable oil manufacturing	**0.00%**	**0.08**	**0.01**	**0.07**
Seafood product preparation and packaging	**0.00%**	**0.11**	**0.05**	**0.06**
Bottled water manufacturing	**0.01%**	**0.78**	**0.73**	**0.05**
Wineries	**0.01%**	**0.28**	**0.28**	**0.00**

<u>Processing Sectors That Show "Weak and Declining"</u> The final set of analysis in this section examines food-processing sectors deemed weak, as measured by the LQ, and declining from 2001 to 2007 (Table 3D). Four food-processing sectors that were deemed strengths (i.e.,LQ>1) in 2001 are now considered weaknesses (i.e., LQ<1). These include bakeries and tortilla manufacturing, as well as commercial bakeries, fluid milk production, and perishable prepared food manufacturing. The decline in fluid milk production may be surprising given the strength of Wisconsin's dairy industry. But when one looks within the fluid milk industry, this finding is not so surprising. The growth of the fluid milk industry in neighboring states, such as Swiss Valley Farms in Iowa, Land O'Lakes in Minnesota and Dean Foods, which distributes fluid milk in Wisconsin that is processed in Illinois, have contributed to the decline in Wisconsin's fluid milk industry. Smaller producers, such as Oberweis from northern Illinois, have also contributed to the decline in Wisconsin. Foremost is the only major fluid milk processor in Wisconsin, and this company recently sold its fluid milk facilities and brands to Dean. On a positive note, the decline of Wisconsin's fluid milk industry also reflects a shift to other dairy processing sectors that bring additional value-added resources to the state as dairy products get converted to higher valued products such as cheese.

Table 3D: Food Processing -- Weakness and Declining				
Industry	**Share of Employment 2007**	**LQ 2007**	**LQ 2001**	**Change LQ 2001- 2007**
Flour milling	**0.01%**	**0.68**	**0.71**	**-0.03**
Poultry processing	**0.13%**	**0.62**	**0.65**	**-0.03**
Bakeries and tortilla manufacturing	**0.24%**	**0.96**	**1.04**	**-0.08**
Grain and oilseed milling	**0.02%**	**0.39**	**0.51**	**-0.12**
Fluid milk manufacturing	**0.05%**	**0.93**	**1.08**	**-0.15**
Commercial bakeries	**0.10%**	**0.88**	**1.04**	**-0.16**
Cookie and cracker manufacturing	**0.02%**	**0.77**	**0.93**	**-0.16**
Soft drink manufacturing	**0.03%**	**0.38**	**0.54**	**-0.16**
Perishable prepared food manufacturing	**0.02%**	**0.76**	**1.39**	**-0.63**

Summary The analysis of location quotients for the years 2001 and 2007 provide unique insights into the strengths and weaknesses of Wisconsin agriculture. We have documented that Wisconsin has a very strong presence in malt, cheese and butter manufacturing as well as dairy, berry and potato farming. While there are several bright spots for Wisconsin agriculture, such as frozen specialty food processing, other sectors appear to be retreating in terms of strength, such as commercial bakeries and frozen fruit and vegetable processing.

While this cluster analysis provides additional insights into the changing nature of Wisconsin's agricultural industry, one must think of this analysis as a broad overview. Looking at two distinct years is likely to produce anomalies unique to those years. For example, U.S. whey exports spiked in 2007 due to unusual world market conditions and, generally, overall dairy prices were remarkably high in 2007. Since 2001, large labor-efficient cheddar cheese plants were built in Idaho, New Mexico and Texas, altering the market for cheddar cheese, a major Wisconsin commodity. At the same time, markets for specialty cheeses have grown more rapidly than commodity cheeses, and Wisconsin has been well positioned to benefit from that growth. This analysis provides an indicator of overall changes and points to specific directions for more focused analysis.

This analysis also brings to the front of the discussion what metric(s) should be used to guide economic development and growth initiatives. During the current crisis in the larger economy, with Wisconsin's unemployment rate approaching 9%, the focus has been on job creation. A few years ago when unemployment was low, discussions focused on job quality, including wages and benefits. As we will discuss in the economic impact assessment, different pictures of the contribution of agriculture to Wisconsin's economy appear depending on the economic metric examined.

Methods of Impact Assessment

This study uses input-output analysis to assess how the value of agriculture and agricultural processing ripples throughout the state's economy. Input-output (IO) is at its roots an accounting method to describe a specific regional economy. One can think of IO as a "spreadsheet" of the economy where the columns represent buyers (demand) and the rows capture sellers (supply). Any cell where a column and row intersect represents the dollar flow between the buyer and seller of a particular good or service. The sum of any row is the total supply (output or total sales) of that particular industry, and the sum of any column is total demand of the industry. Given the laws of supply and demand in competitive markets, total demand must equal total supply.

The power of IO is not the data accounting framework it provides, but the ability to use this tool to track small changes in one part of the economy through the entire economy. For example, in the case of milk production, the operation of dairy farms introduces new, or additional, levels of spending in the economy. This new injection of money into the economy causes a ripple, or multiplier, effect throughout the economy. Using IO, we can track and measure economic impact.

There are several means to measure the size of the economy, including industry sales (output), income and employment. Because IO modeling is based on the flow of dollars, or sales, measured impacts are related to industry output or sales. While this information is of considerable value in and of itself, policy-makers and concerned citizens often find it difficult to relate to and understand the nature of industry sales and output. Hence, methods have been developed and widely employed to convert sales to income and employment.

Because the structure of IO is "linear," the relationship between industry output, employment and income is in fixed proportions. Given these fixed proportions, we can compute changes in output in terms of changes in employment and income. As was done in the 2004 analysis, for this report we look at the impact of all on-farm agricultural production, all agricultural processing production and all agricultural on-farm and processing production combined. We also look more closely at some parts of Wisconsin agriculture, including the impact of all on-farm dairy production, all dairy processing, and all on-farm dairy and dairy processing combined, and horticulture. For this report we also examine the contribution of forestry and logging to Wisconsin's economy.

A better appreciation of the three metrics of economic size (output, employment and income) can be gained with the following example. Suppose a dairy farm has $1 million in annual sales and employs two people along with the farm's owner/operator. Suppose the farmer pays the workers $25,000 apiece and herself $50,000 a year. In this case, industry sales are $1 million, employment is three and income is $100,000. If we want to look at changes in the dairy industry using IO, we would look at changes in industry sales and then track through changes in employment and income.

The economic multipliers drawn from IO analysis are composed of three parts. First is the *direct,* or *initial,* effect, which captures the event that caused the initial change in the economy. Here, dairy farms contribute directly to the economy by employing people and paying wages and salaries. Given the structure of the IO model, we know that the operation of dairy farms will have a ripple effect across the entire economy. This ripple effect is captured by the second component of a multiplier, the *indirect* effect. The third component is called the *induced* effect.

In the framework of IO analysis, dairy farms have two types of expenditures (costs) that ripple through the economy. The first are business-to-business transactions, such as the purchase of feed from farmers or feed suppliers, fertilizer, seed and chemicals, veterinary services, trucking services to haul milk, electric services, insurance, farm and equipment repairs and maintenance, and many others. These business-to-business transactions are captured by *indirect* effects. For example, a grain farmer uses the proceeds from feed sales to dairy farmers to pay his or her own farm's operating purchases, make investments, buy new equipment, hire workers, etc. Suppose the farmer uses the proceeds to purchase a new truck from a local dealership. That purchase represents sales to the truck dealership which, in turn, uses part of that sale to pay its own operating expenses. This is an example of the ripple effect captured by the *indirect* component of the multiplier.

The second type of expenditure dairy farms introduce into the economy are wages and salaries paid to employees. Spending this income in the regional economy is captured by the *induced* effect. Dairy farmers and their employees spend income at local grocery stores, movie theaters, restaurants and many other retail outlets. They also pay mortgages or rent, buy vehicles, purchase property insurance, and incur medical, financial, legal and other expenses. The theater owner, for example, uses part of the money spent by dairy farmers to pay theater employees, and the cycle continues.

Indirect and induced effects are intertwined but can be separated within the structure of the IO model. Consider the crop farmer selling grain to dairy farmers. In the previous example, the farmer elected to use the additional revenue (sales) to make purchases from other businesses. Those business-to-business transactions are captured by the *indirect* effect. Instead of spending the money, the farmer could take some of the revenue as additional income, paying him or herself as an employee of the farm business. This would be captured in the *induced* component of the multiplier. In the example, in which dairy farm employees spend part of their income at the movie theater, the theater owner may elect to use part of the additional revenue to pay the theater's electric bill. This would be an example of an *indirect* effect.

One insight gained from looking at *indirect* and *induced* effects separately relates to the labor intensity or wage structure of the industry being examined. Farming, for example, tends to make much larger *indirect* than *induced* effects. This implies that farming is very capital intensive and/or may not pay the highest wages to employees. Financial-service industries, on the other hand, tend to have low *indirect,* but fairly high, *induced* effects. This seems to make intuitive sense in that, other than computers and basic office supplies, financial-services companies tend to be a low capital intensive industry but labor intensive and able to pay high wages.

Direct Impacts of Agriculture Before reporting the results of the complete impact analysis, it is useful to provide a simple "head-count" analysis of Wisconsin's economy (Table 4). This simple analysis is different from the analysis of location quotients in the previous analysis for three reasons. First, in the location quotient analysis, we compare the share of employment in a specific Wisconsin agricultural sector to the national average and show how that comparison changes over time. Second, the location quotient analysis considers only employment and not other aspects of the Wisconsin economy. Third, the industrial classifications used for the impact assessment do not coincide perfectly with the classification scheme used above. In the prior discussion, the traditional NAICS (North American Industry Classification Scheme) is used for data reporting and analysis.[5] In the impact analysis presented here, the IMPLAN (IMpact analysis for PLANing) classification scheme is used.[6] It should be noted that for this impact analysis, 2007 industrial sales figures for ethanol were not available. Therefore, impact assessment estimates may be underestimated.

As discussed above, the impact analysis considers three separate metrics of scale: industry sales (output), employment and total income. From an economic accounting framework, total income is akin to gross state product or gross domestic product. All data here represent a snapshot of the Wisconsin economy in 2007. Non-dairy, on-farm activity had $4.47 billion in sales in 2007, which accounts for 0.9% of total industrial sales across Wisconsin. There are also 57,400 jobs on non-dairy farm operations, or 1.6% of all Wisconsin employment, and $1.56 billion in total income, which is about 1.0% of total income in Wisconsin. Dairy farm production contributes $4.59 billion to industrial sales, or about 1.0% of Wisconsin's total, and 40,690 jobs, slightly more than 1% and $1.85 billion in total income, or 0.8%. Dairy processing, which is dominated by cheese production, contributes almost $11.8 billion to industrial sales before the multiplier effect, or about 2.5% of Wisconsin's total industrial sales. Dairy processing accounts for about 0.5% of all employment in Wisconsin, about 16,200 jobs and just over $1 billion in total income, which is also about 0.5% of Wisconsin's total income. The rest of agricultural or food processing contributes $16.4 billion to industrial sales, which is about 3.4% of the state's total, and 46,157 jobs, or 1.3%, and $3.15 billion to Wisconsin's total income, about 1.4%. Food-processing sectors that account for much of the scale of the non-dairy processing industry include fruit and vegetable processing ($3.3 billion in industrial sales) as well as meat processing ($4.1 billion in industrial sales).

[5] For a detailed discussion of the NAICS system see http://www.naics.com/info.htm.

[6] For a NAICS to IMPLAN classification bridge please see http://implan.com/ under general information in the download section.

The horticulture and forestry and logging sectors are relatively small compared to on-farm crop and livestock production and food processing. Horticulture had sales of about $758 million, which is 0.2% of total industrial sales for Wisconsin, about 12,900 jobs, or 0.4% of the state's total employment, and $395 million in total income, about 0.2% of total income.[7] The forestry and logging sector was not included in the 2004 study. In 2007 forestry and logging accounted for $794 million in industrial sales, which is about the same size as horticulture, but contributes only 5,366 direct jobs, which is 0.2% of total employment and $454 million in total income. One important aspect to the state analysis of horticulture and forestry and logging is the masking of important regional variations. It appears reasonable that horticulture will be more concentrated in the southern and eastern parts of Wisconsin, while forestry and logging will be more concentrated in northern and perhaps western Wisconsin. If such spatial concentration exists, then the direct relative contribution of these two agricultural sectors will vary significantly across the state.

Now consider the rest of the Wisconsin economy and how different industries directly contribute to industry sales, employment and income. In terms of industrial sales, Wisconsin remains highly dependent on manufacturing, which accounts for 30.2% (not including agricultural or food processing) of total sales. This compares to only 19.1% for the United States. Non-agricultural manufacturing accounts for 12.3% of employment and 18.8% of total income. The relatively large share of total income compared to total direct employment in non-agricultural manufacturing suggests that per-job income is relatively high compared to the statewide average. The state's dependency on manufacturing, coupled with relatively high levels of associated income, helps explain why promoting manufacturing remains a central part of Wisconsin's economic growth-and-development efforts, though policy makers are increasingly looking at the specific characteristics of those manufacturing jobs.

In terms of employment, in addition to non-agricultural manufacturing, other important sources of jobs are retail (11.2%), health and social services (10.6%), which is dominated by health care such as hospitals, and the public sector (12.1%), which includes schools, higher education, corrections and other government-related jobs. In terms of total income, retail accounts for only 7%, which is a reflection of the lower pay associated with retail jobs. Health and social services account for 8.7% of all income, while the public sector accounts for 10.8% of total income. Comparing employment to income for health and social services points to the wide range of occupations in this sector. Hospitals, for example, employ highly paid medical specialists along with food-service workers. Dentists earn an average of $169,000 per year, yet a medical secretary earns about $30,000 in Wisconsin. Pay scales in the public sector tend to be slightly below the state average. Bailiffs, for example, earn about $25,500 per year, while detectives earn an average of $61,000.

<u>Economic Impact Results</u> As shown above and described in detail in an appendix, input-output analysis allows us to track through the linkages and, hence, estimate the impact of agriculture and its components on the total Wisconsin economy. The results of this analysis, using 2007 data, are discussed and reported in Table 5. Tax impact summaries are given in Table 6.

The economic impact of agriculture, as we have defined it, on total industrial sales is $59.16 billion, about 12.5% of Wisconsin's total sales. The vast majority of this impact comes from agricultural processing, almost $50 billion, of which dairy processing accounts for $23.1 billion. Using the industry sales multiplier, every dollar of agricultural activity yields an additional 52 cents of industrial sales elsewhere in

[7] It is important to note that almost all the agricultural sectors examined in this study are comparable to the 2004 study, which examined data for the year 2000. Unfortunately, changes in the industrial classifications used within IMPLAN caused differences in the definition of horticulture. In particular, parts of the landscaping industry, such as landscape architects, are merged into business services within the 2007 IMPLAN industrial scheme. Thus, direct comparisons between horticulture in the 2000 analysis and the analysis presented in this study are not possible.

Wisconsin's economy. If we decompose the multiplier effect into its two components, indirect and induced, we see that the bulk of the impact comes from business-to-business activity, or the indirect effect. The indirect multiplier is 0.35 and the induced multiplier is 0.17. The largest industry sales multiplier is for dairy processing (1.95). The smallest multiplier is for forestry and logging (1.25).[8]

Wisconsin agriculture supported about 354,000 jobs in 2007, about 10% of all Wisconsin employment, with a multiplier of 1.89. This implies that every job in agriculture supports an additional 0.89 jobs elsewhere in the Wisconsin economy. As with industrial sales, the majority of these jobs are generated by agricultural or food processing. On-farm dairy operations support 56,470 jobs. Dairy processing supports 115,500 jobs. And combined dairy supports 146,200 jobs. The employment multiplier for all dairy is 2.23, which suggests that every job in dairy supports an additional 1.23 jobs elsewhere in the Wisconsin economy. Horticulture supports 16,700 jobs, while the forestry and logging sector, as we have defined it, supports 7,600 jobs. As with industrial sales, the bulk of the multiplier impact comes in the form of indirect (0.54), or business-to-business, activity and a smaller amount from induced (0.35), or labor spending income in the state's economy. This pattern holds true for all agriculture sectors except horticulture where the induced effect is larger than the indirect effect.

Now consider total income, which includes wages, salaries, proprietor income and other property income (e.g. rent). All of agriculture supports about $20.2 billion of total income, which is 9% of total income in Wisconsin. The overall income multiplier for agriculture is 2.24, which indicates that every dollar of income in agriculture generates an additional 1.24 dollars of income elsewhere in the Wisconsin economy. As with industrial sales and employment, the bulk of the impact comes from agricultural processing. On-farm dairy generates $2.7 billion in total income, and dairy processing supports $7.2 billion in total income. The income multiplier for combined dairy is 2.54, which suggests that every dollar of dairy income generates an additional $1.54. Except for horticulture and forestry and logging, indirect, or business-to-business, activity dominates the induced or labor-spending income effect.

The economic activity supported by agriculture also supports tax revenues used to fund public services. The total level of revenue generated is about $2.5 billion, most in the form of property and sales taxes. It is important to note that this analysis does not include property taxes collected by the K-12 public school system. Depending on where you live in Wisconsin, public schools can represent more than half of all property taxes collected. This suggests that tax revenue estimates presented here are highly conservative because we underestimate property tax impacts. Equally important is the fact that we do not consider the impact agriculture has on public services and the costs associated with those services. For example, although agriculture is a major user of the state highway system, this report does not consider the costs of providing highway services. What's more, most of the children of workers supported by agriculture attend public schools across Wisconsin. Those costs are also not considered.

[8] It is important to note that the sum for all agriculture is not the sum of the individual impacts because of the inter-linkages within agriculture itself. For example, dairy processing has a strong feedback on dairy farming. To add the two separate impacts together would double count those inter-linkages.

Summary

This study is an update of the 2004 study by Deller, which documented the contribution of agriculture to Wisconsin's economy using 2000 data. In addition to updating historical trends and impact analyses, we explore the strengths and weaknesses of agriculture within the framework of Michael Porter's notion of clusters.

We draw three conclusions from our analysis. First, agriculture remains an important part of the Wisconsin economy, supporting about 10% (depending on the metric of activity) of the state's economy. Second, Wisconsin's agricultural economy appears to have stabilized. Unlike the 1980s and 1990s, which experienced significant declines, particularly in on-farm activity, the recent decade has seen a stabilization of the industry. Finally, while growth opportunities exist for certain agriculture sectors, such as dried, condensed and evaporated milk, traditional strengths, including frozen fruit and vegetable processing, appear to be weakening.

This report not only provides an update of the 2004 Deller study, it creates an opportunity to think about the future of Wisconsin agriculture, and policies that can be implemented at state and local levels, to promote a stable and growing agricultural economy.

Table 4: Direct Economic Activity 2007

Industry	Industry Sales*	(%)	Employment	(%)	Total Income*	(%)
On Farm Non-Dairy	$ 4,474	0.9%	57,426	1.6%	$ 1,560	0.7%
On Farm Dairy	$ 4,588	1.0%	40,690	1.1%	$ 1,848	0.8%
Forestry and Logging	$ 794	0.2%	5,366	0.2%	$ 454	0.2%
Horticulture	$ 758	0.2%	12,896	0.4%	$ 395	0.2%
Food Processing Non-Dairy	$ 16,404	3.4%	46,157	1.3%	$ 3,156	1.4%
Dairy Processing	$ 11,814	2.5%	16,187	0.5%	$ 1,081	0.5%
Mining	$ 887	0.2%	3,780	0.1%	$ 469	0.2%
Utilities	$ 6,642	1.4%	11,182	0.3%	$ 4,410	2.0%
Construction	$ 27,882	5.8%	200,794	5.6%	$ 11,546	5.1%
Manufacturing	$ 144,866	30.2%	437,518	12.3%	$ 42,381	18.8%
Wholesale Trade	$ 21,118	4.4%	131,751	3.7%	$ 13,558	6.0%
Retail Trade	$ 22,657	4.7%	399,774	11.2%	$ 15,711	7.0%
Transportation & Warehousing	$ 14,865	3.1%	120,254	3.4%	$ 7,411	3.3%
Information Services	$ 13,711	2.9%	57,081	1.6%	$ 6,119	2.7%
Finance & Insurance	$ 32,874	6.9%	168,412	4.7%	$ 14,511	6.4%
Real Estate & Rental	$ 30,592	6.4%	106,215	3.0%	$ 21,225	9.4%
Professional- Scientific & Technical Services	$ 18,346	3.8%	166,353	4.7%	$ 11,229	5.0%
Management of Companies	$ 9,225	1.9%	43,009	1.2%	$ 5,159	2.3%
Administrative & Waste Services	$ 9,391	2.0%	166,405	4.7%	$ 5,239	2.3%
Educational Services	$ 3,330	0.7%	57,373	1.6%	$ 1,700	0.8%
Health & Social Services	$ 32,228	6.7%	379,538	10.6%	$ 19,537	8.7%
Arts- Entertainment & Recreation	$ 2,555	0.5%	63,508	1.8%	$ 1,420	0.6%
Accomodation & Food Services	$ 11,982	2.5%	245,391	6.9%	$ 5,298	2.4%
Other Services	$ 11,188	2.3%	197,132	5.5%	$ 5,633	2.5%
Government	$ 25,963	5.4%	430,767	12.1%	$ 24,260	10.8%
Totals	$ 479,134		3,564,959		$ 225,311	

*Millions of dollars

Table 5: Economic Impact of Agriculture on the Wisconsin Economy 2007

	Direct	Indirect	Induced	Total	Implicit Multiplier
Industry Sales/Output					
On Farm Dairy	4,588,322,816	1,300,929,213	420,918,539	6,310,170,562	1.38
All On Farm	9,062,162,407	2,465,880,989	1,064,302,744	12,592,346,144	1.39
Horticulture	758,038,672	180,157,464	229,522,016	1,167,718,146	1.54
Dairy Processing	11,813,690,144	8,664,467,649	2,578,904,666	23,057,062,330	1.95
Dairy Combined	16,402,012,960	7,069,030,244	2,989,734,005	26,460,777,205	1.61
All Agricultural Processing	28,218,173,820	16,343,879,900	5,437,569,847	49,999,623,702	1.77
Forestry and Logging	794,598,304	83,558,187	115,447,701	993,604,202	1.25
All Agriculture	38,822,572,876	13,634,692,629	6,701,860,966	59,159,126,641	1.52
Employment					
On Farm Dairy	40,690	11,726	4,055	56,473	1.39
All On Farm	98,116	23,710	10,258	132,085	1.35
Horticulture	12,896	1,643	2,200	16,707	1.30
Dairy Processing	24,880	65,565	25,039	115,486	4.64
Dairy Combined	65,570	51,612	29,034	146,216	2.23
All Agricultural Processing	71,038	127,004	53,723	251,765	3.54
Forestry and Logging	5,366	1,167	1,112	7,646	1.42
All Agriculture	187,416	100,626	65,949	353,991	1.89
Total Income					
On Farm Dairy	1,848,261,888	661,370,190	233,871,585	2,743,503,657	1.48
All On Farm	3,407,969,557	1,383,618,921	593,117,280	5,384,705,740	1.58
Horticulture	394,709,840	93,335,666	127,516,040	615,561,568	1.56
Dairy Processing	1,612,234,964	4,156,309,940	1,441,947,720	7,210,492,636	4.47
Dairy Combined	3,460,496,852	3,651,123,885	1,672,778,449	8,784,399,162	2.54
All Agricultural Processing	4,768,638,728	7,700,390,348	3,096,571,259	15,565,600,445	3.26
Forestry and Logging	453,846,904	49,206,722	64,103,499	567,157,141	1.25
All Agriculture	9,025,165,024	7,318,306,985	3,834,762,851	20,178,234,857	2.24

Table 6: Fiscal Impact of Agriculture on the Wisconsin Government 2007

	On Farm Dairy	All On Farm	Horticulture	Dairy Processing
Corporate Profits Tax	26,326,495	45,882,113	2,244,032	38,054,623
Dividends Tax	86,609,438	150,943,905	7,382,461	125,192,870
Income Tax	21,301,881	54,294,221	11,645,922	131,411,006
Sales Tax	56,746,378	143,609,838	12,142,217	184,438,013
Property Tax	71,653,054	181,334,629	15,331,850	232,887,936
Other	21,720,451	54,889,523	6,708,421	89,088,792
State and Local (Non-K12)	284,357,697	630,954,229	55,454,903	801,073,240

	Dairy Combine	All Agricultural Processing	Forestry and Logging	All Agriculture
Corporate Profits Tax	64,381,118	71,680,567	5,218,656	125,025,365
Dividends Tax	211,802,307	235,816,181	17,168,439	411,310,981
Income Tax	152,712,890	284,935,411	5,833,266	356,708,820
Sales Tax	241,184,393	441,599,514	9,800,614	607,152,178
Property Tax	304,540,991	557,603,054	12,375,132	766,644,657
Other	110,809,243	204,553,179	4,156,800	270,307,923
State and Local (Non-K12)	1,085,430,942	1,796,187,906	54,552,907	2,537,149,924

Appendix A

Basics of Input-Output Modeling

A simple non-technical discussion of the formulation of input-output (IO) modeling is presented in this section. Similar descriptive treatments are readily available, including Shaffer, Deller and Marcouiller (2004) while more advanced discussions of input-output include 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 a regional transactions table (Table 1). The transactions table shows the flows 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 1. Illustrative Transactions Table

	Purchasing Sectors (Demand)			Final Demand		
Processing Sectors (Sellers)	Agr	Mfg	Serv	HH	Exports	Output
Agr	10	6	2	20	12	50
Mfg	4	4	3	24	14	49
Serv	6	2	1	34	10	53
HH	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. Specifically, 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 2).

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 regardless of input prices or production levels.

Table 2. Illustrative Direct Requirements Table			
	Purchasing Sectors (Demand)		
Processing Sectors (Sellers)	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	0.32	0.51	0.72
Imports	0.28	0.24	0.17
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 in 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 3). 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 3. Illustrative Total Requirements Table

	Purchasing Sectors (Demand)		
Processing Sectors (Sellers)	Agr	Mfg	Serv
Agr	1.28	0.17	0.06
Mfg	0.12	1.11	0.07
Serv	0.16	0.07	1.03
Total	1.56	1.35	1.16

An additional, useful 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. By definition, as imports increase the values of the direct requirement coefficients will 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.

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 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.

But 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 perhaps 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 1. 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 spillover 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. A general discussion of the proper, and inappropriate, uses of multipliers is presented in the next appendix to this text.

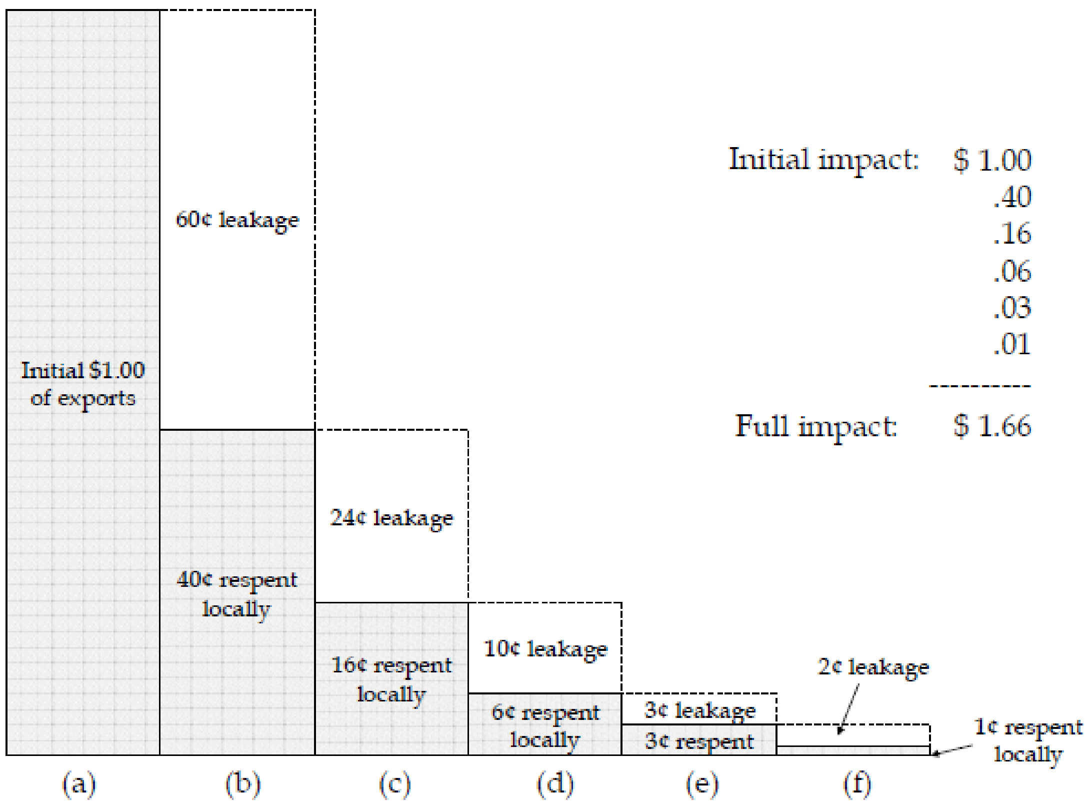


Figure 1. Multipliers and the round-by-round impacts estimated using input-output analysis

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 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 and also 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) and also 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 generating an additional round of impacts. This second round 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.

Appendix B:

Misuses and Evaluation of Economic Multipliers

Multipliers are often misused or misunderstood. Problems frequently encountered in applying multipliers to community change include: (1) using different multipliers interchangeably; (2) double counting; (3) pyramiding; and (4) confusing multipliers with other economic measurements, such as turnover and value added. Please note that if IMPLAN is used to generate the multipliers used in the analysis, many of the concerns outlined in this appendix are moot.

Misuse of Multipliers

(1) Interchanging Multipliers. As mentioned earlier, multipliers can be estimated for changes in business output, household income, and employment. These different multipliers are sometimes mistakenly used interchangeably. This should not be done, as the sizes of the multipliers are different—and they measure totally different types of activity.

(2) Double Counting. Unless otherwise specified, the direct effect or initial change is included in all multiplier calculations. Consider, for example, a mining business multiplier of 2.20. The 2.20 represents 1.00 for the direct effect, and 1.20 for the indirect effects. The direct effect is thus accounted for by the multiplier and should not be added into the computation (double counted). A $440,000 total impact resulting from an increase of $200,000 in outside income (using the above 2.20 multiplier) includes $200,000 direct spending, plus $240,000 for the indirect effects. The multiplier effect is sometimes thought to refer only to the indirect effect. In this case, the initial impact is added to the multiplier effect, and is thereby counted twice—yielding an inflated estimate of change.

(3) Pyramiding. A more complicated error in using multipliers is pyramiding. This occurs when a multiplier for a nonbasic sector is used, in addition to the appropriate basic sector multiplier.

For example, sugar beet processing has been a major contributor to exports in many western rural counties. Assume the local sugar beet processing plant were closed, and local officials wanted to determine the economic effect of the closing, as well as the subsequent effect upon local farmers. The multiplier for the sugar beet processing sector includes the effect upon farms raising sugar beets, because the sugar beet crop is sold to local processors and not exported. Therefore, the processing multiplier should be used to measure the impact of changes in the sugar industry on the total economy. The impact estimate would be pyramided if the multiplier for farms, whose effects had already been counted, were added to processing.

Double counting and pyramiding are particularly serious errors because they result in greatly inflated impact estimates. If inflated estimates are used in making decisions about such things as school rooms or other new facilities, the results can be very expensive, indeed.

(4) Turnover and Value Added. Economic measurements incorrectly used for multipliers also result in misleading analysis. Two such examples are turnover and value added. Turnover refers to the number of times money changes hands within the community. In Figure 1, for example, the initial dollar "turns over" five times; however, only part of the initial dollar is respent each time it changes hands. Someone confusing turnover with multiplier might say the multiplier is 5, when the multiplier is actually only 1.66.

Value added reflects the portion of a product's total value or price that was provided within the local community. The value added would consider the value of a local raw product—like wheat delivered to the mill—and subtract that from the total wholesale value of the flour, then figure the ratio between the two. With cleaning losses, labor, bagging, milling, etc., the wholesale value may represent several times the value of the raw product and may be a fairly large number.

Evaluating Multipliers

The determination of whether a multiplier is accurate can be a complicated procedure requiring time, extensive research, and the assistance of a trained economist. On the other hand, there are several questions that anyone who uses multipliers should ask. Essentially the test of accuracy for a multiple is: How closely does that multiplier estimate economic relationships in the community (or region) being considered?

(1) Is the multiplier based on local data, or is it an overlay? Often, multipliers are used that were not developed specifically from data for that area. These multipliers are overlaid onto the area on the assumption that they will adequately reflect relationships in the economy. An example would be using the mining multiplier from a county in northwestern Wyoming to estimate a mining impact in northeastern Nevada.

A multiplier is affected by the economy's geographic location in relation to major trade centers. Areas where the trade center is outside the local economy have smaller multipliers than similar areas containing trade centers. Geographic obstacles enroute to trade centers also affect a local economy. Multipliers for small plains towns are smaller than those for apparently comparable mountain towns, since plains residents usually do not face the same travel obstacles as mountain residents. More services will characteristically develop in the mountain area because of the difficulty in importing services; the larger services base will lead to a larger multiplier effect.

The size of the economy will influence multiplier size. A larger area generally has more businesses; thus, a given dollar is able to circulate more times before leaking than would be the case in a smaller area.

Two economies with similar population and geographic size may have quite different multipliers, depending on their respective economic structures. For example, if two areas have similar manufacturing plants, but one imports raw materials and the other buys materials locally, then the manufacturing multiplier for the two areas would be quite different.

The overlaying practice, when used appropriately, can save money and time—and produce very acceptable results. However, an area's dollar flow patterns may be so unique that overlaying will not work. Also, it is often difficult to find a similar area where impact studies have been completed so that multipliers can be borrowed readily. It is, however, worth checking.

(2) Is the multiplier based on primary or secondary data? Usually, there is more confidence in a multiplier estimated from data gathered in the community, as opposed to published or already-collected data.

Primary data collection is expensive and time consuming. Recent research has indicated that, in some cases, there is little difference between multipliers estimated by primary or secondary data. In fact, primary data multipliers are not necessarily better than secondary data multipliers. While the type of secondary data needed for estimating multipliers may be available from existing sources, the format and/or units of measurement may not permit some multipliers to be estimated. The resulting adjustments made to use the existing data may cause errors. If secondary data is used, it may be advisable to consult individuals familiar with the data regarding its use.

(3) Aggregate versus disaggregate multipliers. As mentioned earlier in this publication, disaggregate multipliers are much more specific and therefore generally more trustworthy than aggregate multipliers. The accuracy required, and the time and money available most likely will determine whether the model will be aggregate or disaggregate. In many cases, an aggregated rough estimate may be sufficient.

(4) If you are dealing with an employment multiplier, is it based on number of jobs or full-time equivalent (FTE)? Employment multipliers are often considered to be the most important multipliers used in impact analysis. This is because changes in employment can be transmitted to changes in population, which in turn affect social service needs and tax base requirements. Employment multipliers can be calculated on the basis of number of jobs or on FTE. One FTE equals one person working full-time for one year. When multipliers are calculated on a number-of-jobs basis, comparisons between industries are difficult because of different definitions of part-time workers. For example, part-time work in one industry might be four hours per day, while in another it might be ten hours per week. If calculations were based on number of jobs, a comparison of multipliers would be misleading. The conversion of jobs to FTE also helps adjust for seasonal employment in industries such as agriculture, recreation, and forestry.

(5) What is the base year on which the economic model was formulated? Inflation can affect multipliers in two ways: (1) through changes in the prices of industry inputs, and (2) through changes in the purchasing patterns produced by inflation. Each input-output multiplier assumes that price relationships between sectors remain constant over time (at least for the period under consideration). In other words, the studies estimating multipliers assume that costs change proportionally: utility prices change at nearly the same rate as the cost of food, steel, and other commodities. If some prices change drastically in relation to others, then purchasing patterns and multipliers will likely change.

Marketing patterns change slowly, however, and while they must be considered, they usually do not present a major problem unless the multiplier is several years old. The rate of growth in the local area will influence the period of use for the multipliers.

(6) What can a multiplier do? The multipliers discussed here are static in nature, as are most multipliers encountered by local decision makers. Static means that a multiplier can be used in "if/then" situations; they do not project the future. For example, if a new mine that employs 500 people comes into the country, then the total employment increase would be the employment multiplier times 500. A static model cannot be used to make projections about the time needed for an impact to run its course, or about the distribution of the impact over time. Static multipliers only indicate that if X happens, then Y will eventually occur.

(7) How large is the impact in relation to the size of the affected industry on which the multiplier is based? Dramatic changes in an industry's scale will usually alter markets, service requirements, and other components of an industry's spending patterns. Assume a mining sector employment multiplier of 2.0 had been developed in a rural economy having 132 FTE. If a mine were proposed several years later with an estimated 300 FTE, the multiplier of 2.0 would probably not accurately reflect the change in employment because of the scale of the project relative to the industry existing when the multiplier was developed. In essence, the new industry would probably change the existing economic structure in the local area.

(8) Who calculated the multiplier—and did the person or agency doing the calculation have a vested interest in the result? Multipliers are calculated by people using statistics, and as such, there is always the opportunity to adjust the size of the multiplier intentionally. Before accepting the results of a given multiplier, take time to assess the origin of the data. Studies conducted by individuals or firms having a vested interest in the study's results deserve careful examination.

(9) Is household income included as a sector similar to the business sectors in the local economic model? The decision to include household income in the model depends upon whether or not the household sector is expected to react similarly to other sectors when the economy changes, or whether personal income is largely produced by outside forces. Discussion of this issue is too lengthy for this publication, but the important point is that multipliers from models that include household sectors are likely to be larger than those from models without household sectors.