Impacts of
Agricultural Production
and Specialty Crops
on Arizona's Economy in 2007

Initial Report, April 2009

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Department of Agricultural and Resource Economics

The College of Agriculture and Life Sciences

The University of Arizona

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EXECUTIVE SUMMARY

Gross domestic product (GDP) in primary crop and livestock farming in the United States now accounts for about one percent of total GDP in all U.S. industries. This is also the share in Arizona and in many other Western states such as California, Texas, and Colorado. In some Midwestern states with relatively large farm sectors—Iowa and Nebraska, for example—farming's share is just over five percent of total GDP.

Using only a small fraction of total labor and capital resources, highly efficient farmers in the United States and Arizona produce sufficient output to meet domestic demand for food and fiber while exporting the remainder to food-deficit countries throughout the world.
Since World War II, real disposable personal income per capita ("real" means adjusted for inflation) has more than tripled, resulting in shifting consumer preferences. While food consumption has grown markedly, the proportion of an average family's budget spent on food and beverages has declined appreciably: in 1950 about one quarter of disposable personal income was spent on food whereas in 2009 the share of food expenditures was only twelve percent. The falling share of consumer expenditures on food has allowed U.S. consumers to spend proportionally more of their income on essentials like health care and education as well as on financial services.

Growth in real disposable incomes hinges on increases in productivity in sectors throughout the economy, among them production agriculture. Innovations allow firms to combine purchased inputs, labor, management, and capital resources more efficiently. Increased productivity, by definition, means using fewer scarce resources to produce the same amount of output. More efficient use of scarce resources translates into lower costs of production with final consumers ultimately benefiting as some portion of cost savings is passed along. For most consumers, gains in productivity pass imperceptibly. Yet enhanced productivity is essential for augmenting consumers' purchasing power. And as real disposable incomes grow, consumers can afford to spend their growing incomes on a wider array of goods and services.

As agriculture registers higher rates of productivity, it enhances general economic welfare. Several government studies have concluded that agricultural productivity growth in the United States compares favorably not only to agriculture in other industrialized nations but also to productivity growth in other sectors of the U.S. economy. During the last two decades, farmers in Arizona have distinguished themselves by registering average annual productivity growth of three percent, well above the national average of two percent. Only Iowa has displayed a comparable growth rate in agricultural productivity.

In 2007, the impact of agribusiness activity on the Arizona economy reached $4.0 billion of value-added, up from $2.7 billion in 1990 and $3.0 billion in 2000. The total economic impact in terms of output also displayed similar increases rising from $6.6 billion in 2000 to $10.3 billion in 2007. The value of output overstates the contribution of a sector like agriculture to state GDP because it is only a gross measure. Value added, which nets out any double counting as raw products are transformed, processed and shipped, reflects more accurately the true contribution of a sector to a state's disposable income.

Under one-third or $2.94 billion of the estimated $10.3 billion value-added impact for all agricultural production has its origin in specialty crop productions - vegetables, melons, fruit, berries, tree nuts, greenhouse, nursery and floricultural products. By contrast, over one-third or $1.48 billion of the estimated $4.02 billion value-added impact for all agricultural production has its origin in specialty productions.

In order to calculate the total value added impact of agribusiness activity in Arizona, it is essential to use an input-output model which carefully nets out contributions along the value chain so that double counting does not inflate the estimated contribution to state GDP. This study employed the IMPLAN input-output model [9] to perform the relevant calculations.

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INTRODUCTION

The economic impact of activity in agriculture on other parts of Arizona's economy was analyzed in an earlier report titled, *Impacts from Agricultural Production and from Specialty Crops on the Arizona Economy*, published April 2009. This addendum to the 2009 Report surveys how agriculture's contribution to the state's total economy has developed from 1990 to 2007 based on the 2009 study and two earlier reported impact projects in the Department of Agricultural and Resource Economics (AREC). Several sub-sectors of agriculture—specialty crops and dairy—were the focus of two special earlier studies performed by AREC at the University of Arizona.

In the first section of this addendum, value-added and other indicators spanning the last couple of decades compare primary farming with other industries in Arizona and in other states. Included are data and a brief discussion relating increases in farm productivity to economic growth. With economic growth comes increased purchasing power and changes in consumer preferences, which, in turn, shape market opportunities for agricultural producers.

The second part of the addendum briefly reviews the role of output in input-output modeling, which depends on information about purchases and sales to and from the individual sectors in the economy. Output is also discussed in the context of choice of conceptual basis for impact quantifications.

As in earlier projects, the Minnesota IMPLAN Group Inc. is the source of the software and economic data employed in the input-output model calculations. The research was conducted by Jorgen Mortensen, who is responsible for any errors in the use of model software or interpretation of statistics.

1. Arizona Farm Activity and its Impact on the State Economy, 1990-2007

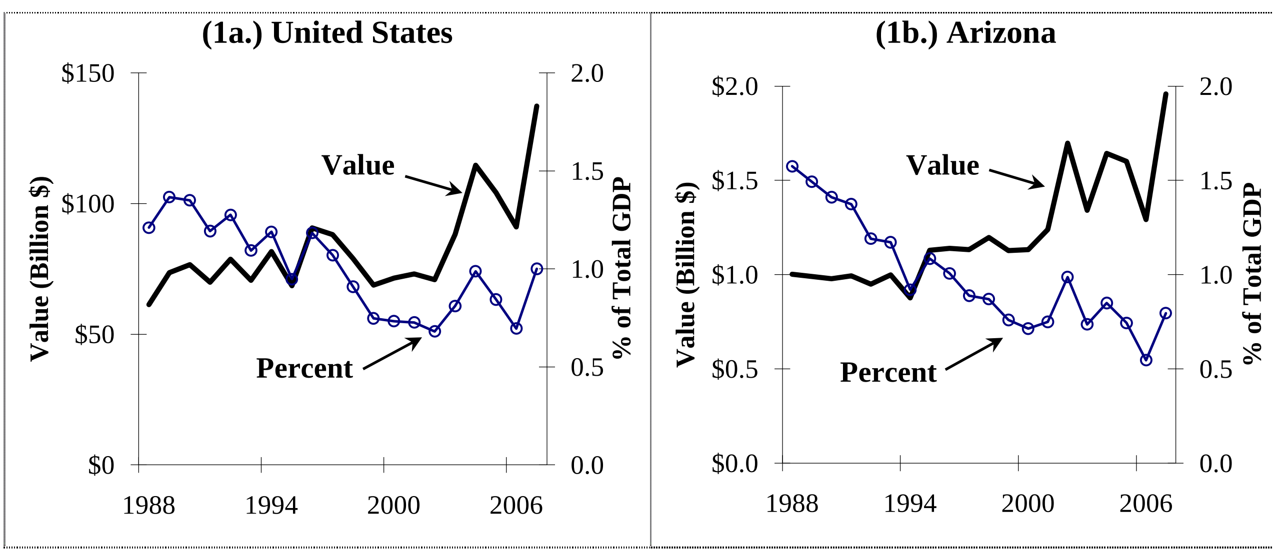
The state-wide value-added impact from crop and livestock production rose from $2.7 billion in 1990 to $4.0 billion in 2007 according to the impact research undertaken by the Department of Agricultural and Resource Economics at the University of Arizona [1, 2, 3]. Over the same period, total economic impact of output rose from $6.3 billion to $10.3 billion.

1.1. Agriculture's Share of Total Industry Activity

GDP is the value of production minus the value of intermediate products and services used as inputs in the production process. GDP is a net measure of economic activity by industry [4]. Time series showing GDP by industry and state are calculated regularly by the Bureau of Economic Analysis (BEA) in its National Income and Product Accounts (NIPA) [5].

In 2007, annual farm GDP in the United States approached $140 billion per year (see Figures 1a.). Agriculture's share of total GDP has declined moderately during the last two decades and is now on the order of one percent. Farm GDP in Arizona is of the same relative magnitude, having declined from 1.5 percent in 1990 to just less than 1 percent in 2007 (see Figure 1b.).

Figure 1. GDP from Crop and Livestock Production in the U.S. and Arizona, 1988-2007



Source: Based on Bureau of Economic Analysis [5].

1.1.A. COMPARISON OF ARIZONA WITH SELECTED STATES

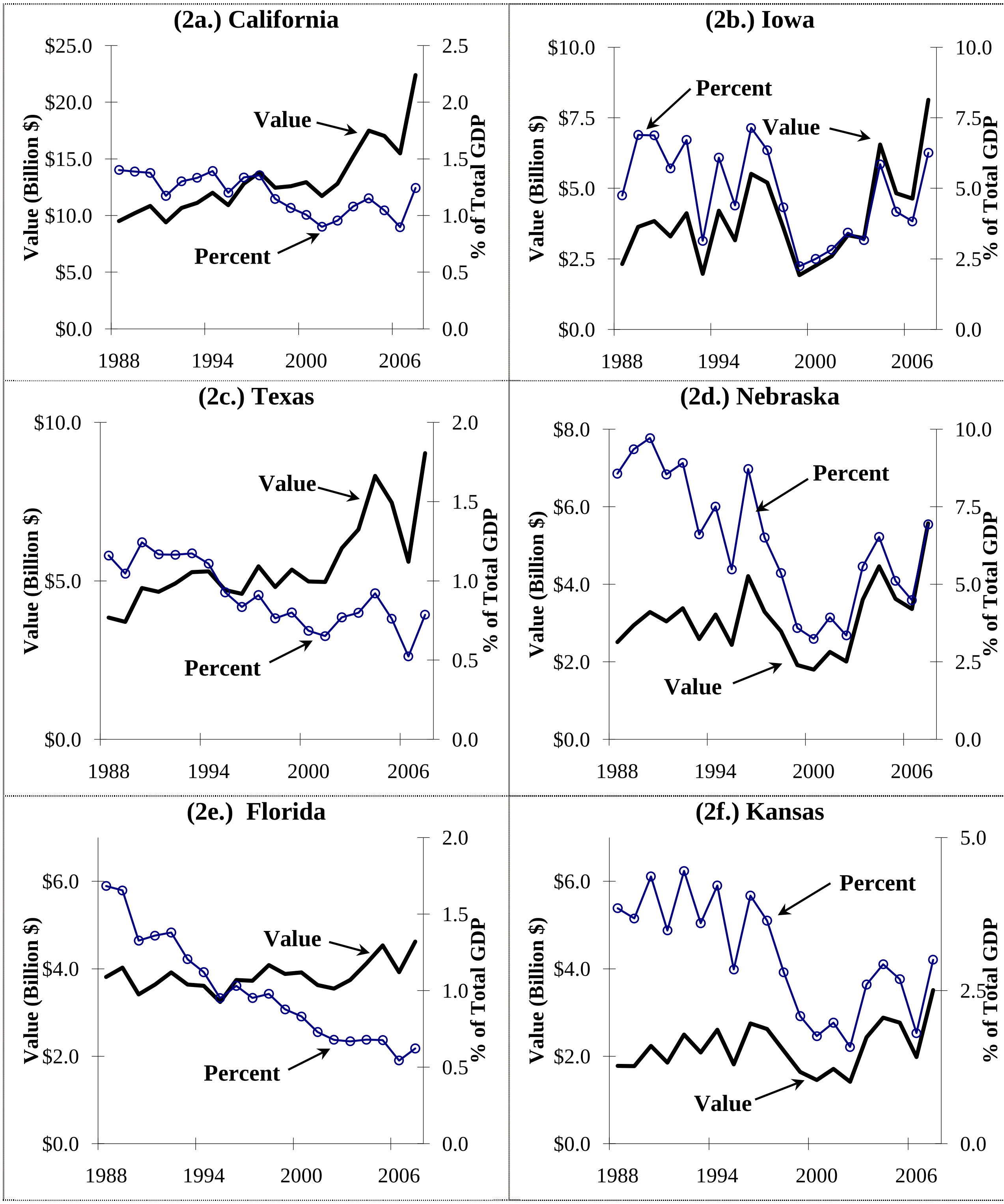
The importance of farm GDP in the past two decades in selected states is illustrated in Figure 2. Three of the selected states—California, Texas and Florida—have relatively large state GDP and their respective agricultural GDP's are also quite large. Nonetheless, over the past two decades farm as a percentage of total GDP has shrunk to around 1 percent (see left column of Figure 2—2a., 2c., 2e.). California possesses the largest agricultural GDP in the United States of $16.5 billion yet farm GDP represented only 1.24 percent of state GDP in 2007.

Three Midwestern states—Iowa, Kansas, and Nebraska—are selected for purposes of comparison because in these states farm GDP as a percentage of total is well above the national average (see right column of Figure 2—2b., 2d., 2f.). Of these three Midwestern states, only Iowa has maintained a farm share of total GDP in the neighborhood of 5 percent during the last two decades despite pronounced year-to-year volatility. Kansas and Nebraska both registered significant decreases in the share of farm to total GDP. The state with the largest share of farm to total state GDP is North Dakota with 7.4 percent. Yet North Dakota's state GDP ranks 49th among all states (see Appendix A for an exhaustive list of farm and state GDP).

Recent rankings of states by farm and total GDP are displayed in Table 1. Arizona and Colorado are quite similar in terms of farm and state GDP. Both states rank around the middle in terms of state and farm GDP, and their share of farm to total GDP is just under 1 percent in recent years.

Though farming's share of state GDP appears rather small, many industries in Arziona account for small portions of state income. Mining, for example, is a prominent industry yet it accounts for just 1.6 percent of state GDP. The industry with the largest share of state GDP in

Figure 2. GDP from Crop and Livestock Production, Selected States



Source: Based on Bureau of Economic Analysis [5].

Table 1. Ranking of Selected States by All Industrial and Farm GDP (2005-07 Avg.)

State	Share of Total GDP in the United States				Farming, % of All Industry GDP in State
	All Industries		Crop and Livestock Farms		
	% of the U.S.	Rank	% of the U.S.	Rank	
California	13.2	1	16.5	1	0.8
Texas	8.2	2	6.7	2	0.7
Florida	5.5	4	3.9	4	0.5
Arizona	1.8	19	1.5	28	0.7
Colorado	1.7	20	1.7	25	0.9
Iowa	0.9	30	5.3	3	4.8
Nebraska	0.8	32	3.8	11	5.5
Kansas	0.6	36	2.5	6	2.5

Source: Based on BEA statistics [5].

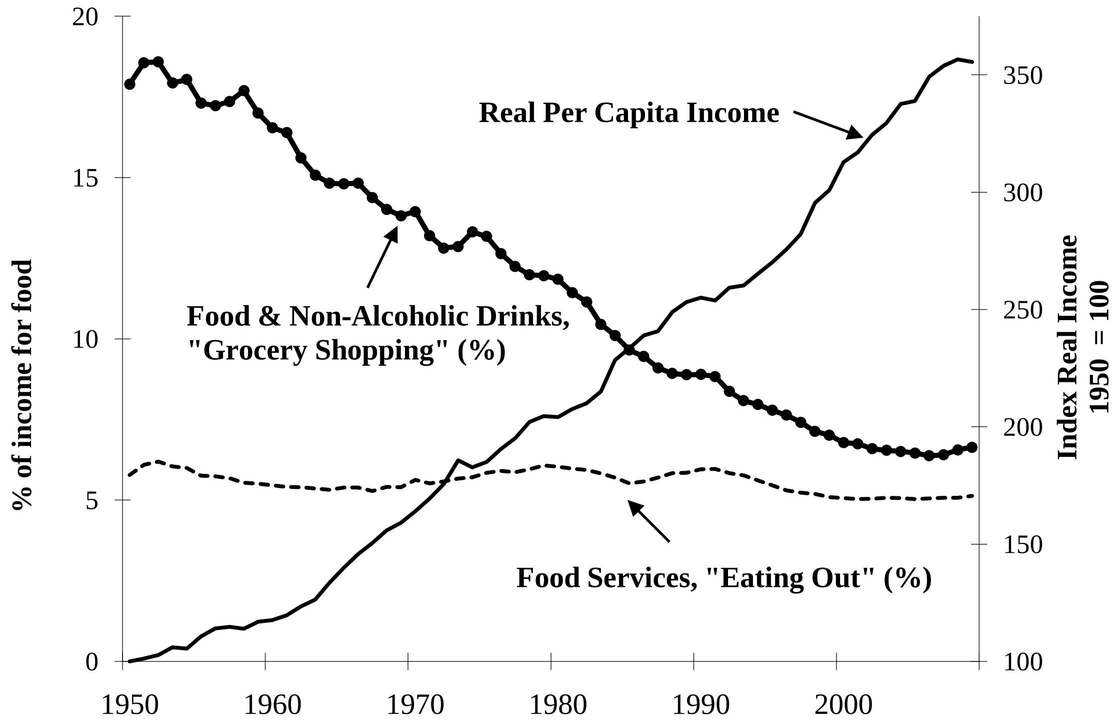
Arizona is real estate with 13.7 percent (see Appendix B for an exhaustive list of the shares of state GDP by industry category).

1.2. Long-Run Changes in Consumer Expenditures

The size of an industry such as agriculture is determined largely by the size of the population, consumer purchasing power, and the proportion of income spent on food and fiber. Agricultural producers can do little to influence the size of the market for their products because throughout the world as real incomes grow, consumers in the aggregate spend a smaller share of their income on food and fiber. Consequently, agricultural markets in industrialized countries are expanding very slowly.

Real disposable per capita income in the United States has more than tripled since the end of World War II (see the solid line in Figure 3) [6]. State income figures are not available but the national figure indicates the general trend for most states. Increases in real per capita income permit U.S. consumers to buy more and potentially save more. Despite some annual

Figure 3. Real Per Capita Income and Share Spent on Food



fluctuations, the long-term trend in real income growth has been sustained for over half a century.

A universally observed economic phenomenon known as Engel's Law indicates that when real incomes increase, consumers spend a diminishing share of their disposable income on food. This phenomenon is depicted in Figure 3 for the United States since World War II. Summing the expenditures shares for grocery shopping and eating out, the proportion of real income spent on food and beverages fell from just under one quarter to less than 12 percent (see scale on the left-hand vertical axis). A falling share of income spent on food does not mean total U.S. consumer spending on food has declined. Current U.S. population is now almost twice what it was in 1950 and consumers have more income to spend. But the falling share of income spent on food does mean U.S. consumers have larger proportions of their budgets to spend on other goods and services.

Long-term shifts in consumer expenditures across broad classes of goods and services are illustrated in Table 2. The proportion of real income spent on necessities like food and non-alcoholic drinks, clothing, and household maintenance have all declined substantially. The declining share spent on those necessities has permitted U.S. consumers to invest a larger proportion of their budgets in education, health, and financial services. Over this period, the shifts in spending have allowed U.S. consumers to enjoy the fruits of enhanced education and earnings, better health care, and until recently enhanced financial security.

These changes in the long-term pattern of consumption necessarily mean some sectors of the economy shrink in relative terms while other sectors grow. Shrinking size of an industry or sector does not imply, however, that the industry or sector is not productive, profitable, or essential. Firms producing in any sector, whether shrinking or growing, must compete with one

Table 2. Consumer Expenditure Shares by Category (Percent)

Category	**1950**	**1970**	**1990**	**2009**	**% Change, 1950-09**
Food & Non-Alcoholic Drinks, Shopping	17.9	13.9	8.9	6.6	-63%
Food Services, Eating Out	6.3	6	6.1	5.3	-16%
Clothing, Footwear, & Related Services	11.1	7.7	5.4	3.4	-69%
Housing, Utilities, & Fuel	14.8	17.6	18.5	19	28%
Household Furnishing & Maintenance	9.7	7.2	5.2	4.2	-57%
Health Care	4.4	8.8	15.2	19.7	348%
Transportation	12.8	11.8	11.5	8.9	-30%
Recreation	6.1	7.2	8.2	9	48%
Education	0.8	1.5	1.7	2.3	188%
Financial Services & Insurance	2.9	4.8	6.6	8.1	179%
Other Goods & Services	13.1	13.5	12.6	13.4	2%

Source: Based on BEA statistics [5].

another, adopting new techniques and strategies, producing newly differentiated products while constantly innovating. It is precisely because innovative and productive firms can produce more using the same resources that economic growth occurs and consumers enjoy the benefits of growing real incomes.

1.4. INCREASING FARM PRODUCTIVITY

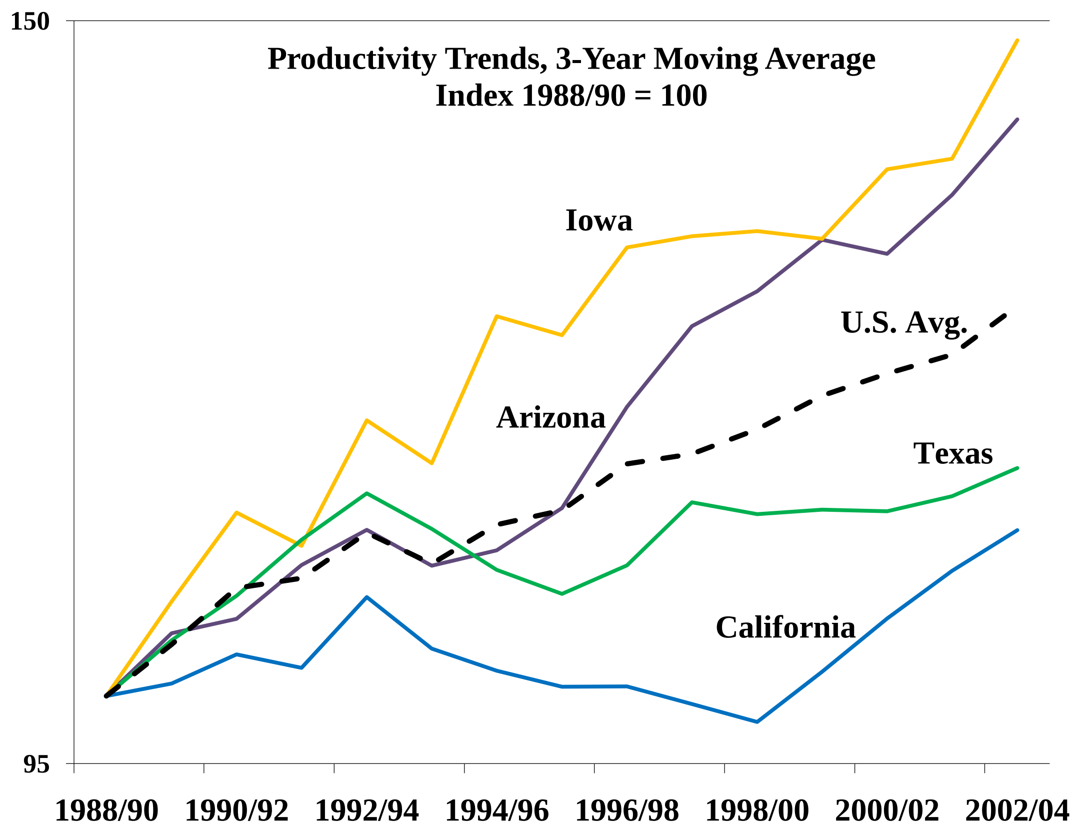
Economic growth occurs as firms and the sectors in which they produce become more efficient. Research and development, education, and receptivity to innovation are pivotal for introduction of new and better production methods. The advent of new techniques and products combined with knowledge and learning permit entrepreneurs and firms to innovate and become more efficient. The accumulated innovation of firms in an industry leads to a more productive industry and sector.

Increasing productivity can be interpreted in two complementary ways: the same level of output can be produced with fewer resources or the same level of resources can produce more output. By becoming more productive, firms can lower their costs of production and still remain profitable. These lower costs of production are passed along in some degree to final consumers in the form of lower product prices. In the long run, increasing productivity—what economists refer to as total factor productivity—results in cheaper goods and services for consumers. And as real incomes increase owing to this economic growth, consumption patterns change substantially over the long term.

High rates of productivity growth signify the industry is contributing significantly to lower prices and increased incomes. Studies conducted by the U.S. Department of Agriculture's Economic Research Service conclude productivity growth in U.S. agricultural compares favorably not only to that of agriculture in other industrialized countries but also to productivity growth in the U.S. economy [8]. Hence, another important measure of the importance of agriculture is its productivity.

Since the late 1980s, farmers in Arizona have contributed significantly to Arizona's economic growth and welfare through innovative and increased productivity. Growth in Arizona's farm total factor productivity averaged 3 percent annually, well above the national average of 2 percent. Over the same period, Arizona farming also performed well in compared with many other states (see Figure 4). Only Iowa farming displayed a comparable growth in total factor productivity.

Figure 4. Trends in Total Factor Productivity, Selected States and the United States



Source: Calculated and graphed on the basis of data from ERS, USDA [7].

1.5. ECONOMIC IMPACT OF FARM PRODUCTION ON ARIZONA'S ECONOMY

A complete accounting of farming's contribution to the Arizona economy requires careful measurement of agricultural activity beyond the farm gate. First, *direct* impacts need to be measured. These direct impacts go backward to account for inputs purchased for primary farm production and also include the value of farm products sold for subsequent processing. Farms together with directly linked processing and supply firms are referred to as *agribusiness* throughout the report. Input suppliers, in turn, purchase other inputs used to produce the agricultural inputs they sell to farmers and ranchers. This economic activity is tracked backward through input suppliers, suppliers of other inputs to input suppliers, and so on until the origin of the inputs falls outside of the state of Arizona either in another state or outside the United States. This backward chain of economic activity is referred to as *indirect* effects. Yet a third type of economic activity is measured when considering the total impact of agriculture on the state's economy. When laborers, employees, and owners earn income from agricultural activities, they spend that income on other goods and services. This purchasing of other goods and services with agricultural income is referred to as the *induced* effect. Here again, only the induced effects of spending income within the state of Arizona are tallied to arrive at the impact on Arizona's economy.

This nomenclature of direct, indirect, and induced effects is standard among input-output studies such as this particular study which used IMPLAN software [9] for calculating these effects. Two previous studies conducted by the Department of Agricultural and Resource Economics at the University of Arizona [1, 2] also used IMPLAN to make similar assessments of agriculture's impact on Arizona's economy. A recap of the distinct impacts measured in all three studies follows:

Direct Impact The monetary value of economic activity directly attributable to the industry of interest, e.g. agribusiness.

Indirect Impact The "backward" impact of the industry's purchases of inputs, the purchase of other inputs by input suppliers, and so on till the inputs are purchased beyond Arizona's borders.

Induced Impact The impact of laborers, employees and owners in the industry spending their incomes on goods and services elsewhere in the state.

Total Impact The sum of direct, indirect, and induced impacts.

Using this nomenclature, the results of the three studies mentioned are reported below in Table 3. Though the studies were not conducted at uniform intervals, they provide a means for comparing the various impacts of agriculture on Arizona's economy over time.

Table 3. Direct, Indirect, and Induced Economic Impacts of Arizona Farming ($Million Value Added, Current Prices)

Row	Category	1990	2000	2007
(1)	Primary Agriculture	595	1,102	1,568
(2)	Linked Industries	414	570	452
(1+2)	Direct Impact, Agribusiness	1,009	1,672	2,019
(3)	Indirect Impact , Other Industries	429	535	1,165
(4)	Induced Impact	1,265	815	837
(3+4)	Indirect + Induced Impact	1,694	1,350	2,002
(1+2+3+4)	Total Impact, Value Added	2,703	3,022	4,021
	% Change in Total Impact from Previous Period		11.8%	33.1%

Source: Calculations from IMPLAN model.

Although most of the impact categories are directly comparable across the three years, the IMPLAN software used for the 2007 contained a new classification of industry groups for (1) and (2) above. As a result, the magnitude of the direct effects is slightly smaller than would have been the case if IMPLAN's general industry classification and delineation had not changed. However, the value of economic activity not appearing as a direct impact is captured under the indirect impact category. Hence, the total impacts are directly comparable across all three years. It is worth emphasizing that these impact figures represent value added which is a *net* measure of economic activity, which is generally accepted as an appropriate measure.

A comparison of the direct and indirect effects over the three periods is not appropriate given the changes in the IMPLAN's industry classification. The sum of the two impacts—direct plus indirect—should be comparable across periods as should the indirect and total effects. Interestingly, the induced effects over the period from 2000 to 2007 increased by only 2.7% while the total impact of agriculture increased by one third over the same period. The small increase in induced effects is consistent with productivity increases requiring fewer laborers to produce more output.

Rather striking is the increase in total impact from 2000 to 2007 of 33.1 percent. In the prior decade from 1990 to 2000 the total impact only increased by 11.8%. Here again, the above-average increases in agricultural productivity registered since the mid-1990's are consistent with industry value added growing at this accelerated pace. If growth in value added continues at the rate displayed from 2000 to 2007, the total impact of agriculture at the end of 2010 would be $4,449 million, which translates to a 47 percent increase over the decade from 2000 to 2010.

Another important measure of the economic impact of agriculture on Arizona's economy is the number of jobs generated from agriculture. Agriculture's contribution to jobs in Arizona can be catalogued in precisely the same way value added is, namely, by the direct, indirect, and induced employment effects. Table 4 below provides the employment details for the same three years.

Table 4. Direct, Indirect, and Induced Employment Impacts of Arizona Farming (Number of Jobs)

Row	Category	1990	2000	2007
(1)	Primary Agriculture	34,390	20,573	21,600
(2)	Linked Industries	15,985	27,233	6,296
(1+2)	Direct Impact, Agribusiness	50,375	47,806	27,896
(3)	Indirect Impact , Other Industries	9,829	8,261	18,359
(4)	Induced Impact	34,135	16,853	12,811
(3+4)	Indirect + Induced Impact	43,964	25,114	31,170
(1+2+3+4)	Total Impact, Jobs	94,339	72,920	59,066
	% Change in Total Jobs from Previous Period		-22.7%	-19.0%

Before proceeding to interpret the jobs numbers, it should be recognized that the numbers here do not convert part-time jobs into full-time equivalents. With that caveat, the obvious trend is that of a declining number of jobs generated by agriculture. Because of the changes in IMPLAN linkages for the 2007 numbers, comparisons of employment in direct and indirect categories with the 2000 figures is not appropriate. The reductions in the number of jobs generated by induced impacts is notable. Summing to obtain the total impact reveals a drop in the number of jobs of 22.7% from 1990 to 2000 with a further decline of 19.0 percent from 2000 to 2007. If the decrease in total number of jobs continued at the same rate, the number of jobs owing to agriculture would decline further to 53,129, representing a decadal decline from 2000 of 27.1%. While the number of jobs is clearly declining, the accompanying productivity increases in agriculture suggest much of the productivity gains have been "labor saving." That is, more agricultural output can be produced with fewer laborers, employees, and owners.

Value added and the number of jobs generated in agriculture are two relatively easily quantified impacts calculated by input-output models like the IMPLAN model. One might also calculate the average remuneration of workers in agriculture as measured by valued added per worker. But such averages would disguise important variation in earnings per laborer from part-time workers to owners.

There are other non-monetary measures of the importance of agriculture that cannot be calculated by input-output models. For instance, the presence of viable farms and ranches in rural areas throughout Arizona is essential for maintaining the economic livelihood of rural communities. In some of these rural areas, agriculture's contribution to the local GDP could well be the largest portion contributed by any industry in the area. Farmers and ranchers also play a key role as stewards of land throughout the state. To the extent society as a whole values the existence of rural areas devoid of the signs of urbanization, agriculture provides an essential service in preserving land resources for future generations.

2. About the Use of Output Values in Impact Estimations

Output plays a pivotal role in the calculations made in input-output analysis. At its most basic level, output from one industry serves as an input in another until the sequence of processes ends in a final good for consumption. The input-output model must be able to link outputs across all industries in order to trace the sequence of processes and transformation of various outputs into final goods. In the value-added calculations presented earlier, the values of outputs are carefully tracked through various sectors so that double-counting of values does not occur.

2.1. Measuring Interaction Among Industries

Total impact calculations require that transactions between all industries can be uniquely mapped and, consequently, accounted for in the input-output model. In the particular IMPLAN model employed here, there are 440 industry categories for the state of Arizona. Of those 440, agriculture has some impact—direct, indirect or induced—on 400 industries. Of those 400, some industries such as milk manufacturing are very closely linked to agricultural production. Other industries such as ophthalmic manufacturers are only very remotely linked, most likely via induced effects.

If one were to attempt to track physically output from agriculture to other industries in order to assess the impact of agriculture on the economy, the process would be tedious if not impossible. How would one track alfalfa hay production through dairy cow use to milk manufacturing on to the final product of ice cream purchased by final producers at the supermarket? The physical transformation would require comparing tons of hay to gallons of milk produced per cow per time period as an input to ice cream of various types with varying degrees of butter fat. Of course, an economist's answer to this overwhelming problem is to track all output as measured in units of dollars.

The only feasible approach is to measure the intra-and inter-industry exchange in monetary terms. Periodically, the IMPLAN Group Inc. makes available an updated industrial transaction figures based on the BEA national accounts statistics. The IMPLAN model software makes use of a so-called transaction matrix, which provides the value of any particular industry's sales to and purchases from any of the other 440 industries. The total value of such sales to other industries plus the value of sales to final consumers constitutes the total value of an industry's production, or its total output value.

To understand how the output-input model functions, consider the stylized example of the 3-industry economy depicted in Table 5. Note, all numbers in the table are measured in dollar units. Intra- and inter-industry transactions are displayed inside the highlighted box. This 3x3 sub-table is the transaction matrix indicating how much each industry sells to others when reading across any row. For example, the first row indicated Industry 1 sells $1million of output to firms within the same industry, $1 million to firms in Industry 2, and $8 million to industry 3

Table 5. Input-Output Values, Simple Illustrative Three-Industry Economy ($ Millions)

	Industry 1	Industry 2	Industry 3	Final Demand	Total Sales
Industry 1	1	1	8	110	120
Industry 2	5	14	0	321	340
Industry 3	29	35	32	354	450
Total Inputs	35	50	40		
Labor	20	220	340		
Capital	65	70	70		
Value Added	85	290	410		
Total Outlays	120	340	450		

for a total of $10 million of output not sold to final consumers. Continuing across the table, Industry 1 sells an additional $110 million of output to final consumers for a total value of output of $120 million. Alternatively, reading down the first column indicates that Industry 1 buys $1million of output from firms in the same industry, $5 million of output from Industry 2, and $29 million of output from Industry 3. These "outputs" purchased from all three industries are used as inputs in the production of Industry 1's outputs. Accordingly, Industry 1 purchases a total of $35 million of total inputs from the three industries. Continuing down the column, Industry 1 must employ $20 million of labor services and use $65 million of capital in order to produce all its output. Summing the costs of all these inputs—those purchased from the three industries, labor, and capital—gives the entire outlay or cost of all inputs of $120 million. Not coincidentally, the value of total output sold, $120 million, is exactly equal to the total cost of producing that output.

Perhaps less obvious from Table 5 is how indirect impacts are tracked. Consider the case of Industry 3 which purchases inputs of $8 and $32 million from Industries 1 and 3. Though Industry 3 does not directly purchase inputs from Industry 2, Industry 3 affects Industry 2's economic activity indirectly through its purchase of Industry 1 output and Industry 1, in turn, purchases inputs of $5 million from Industry 2. Hence, Industry 3's impact on Industry 2 only occurs indirectly through Industry 1 and firms within Industry 3. But this indirect impact should be measured for a full accounting of economic transactions.

Finally, the induced impacts can be quantified by adding an additional row Table 5 to account for incomes earned by workers in the three industries. An additional column would be inserted to account for the value of final goods consumed with incomes earned in agriculture.

For more detail in interpreting the stylized example used here, consult Appendix A in the 2004 impact report [4]. The important lesson to be learned from this stylized example is that the dollar value of transactions—inputs purchased and outputs sold—must be meticulously tracked both within and between industries while accounting for the value of labor and capital used in the production process. If all such transactions are carefully tracked and tallied, the basis for avoiding double counting is established.

2.1 Dangers of Double Counting in Measuring Total Economic Impact

Whether the value of total economic impact should just tally all sales of output to other industries and final consumers is an open question. Considering Industry 1 in Table 5, the value of total sales is $120 million, $10 million to other industries and $110 to final consumers. However, Industry 1 had to purchase inputs from other industries valued at $35 million. If Industry 1 does not deduct the value of these inputs, which were, in fact, outputs produced by other industries, then total value could be overstated because each industry would claim the value of its inputs thereby leading to double counting.

A stylized example of beef production will serve to emphasize just how double counting can unnecessarily inflate the measurement of economic activity. In a highly abstract accounting of beef production, one might consider just four industries: fertilizer supply, hay farming, cattle production, and beef slaughtering. Of course, there are far more intermediate steps required to bring the product from inception to plate. Consistent with the accounting in Table 5, consider the sequence of operations and accounting for this stylized beef production example as depicted below in Table 6.

Table 6. Simple Stylized Example of Industry Transactions in Beef Supply ($ Millions)

	Sales	- Inputs	= Value Added
Beef Slaughtering	**100**	75	25
Cattle Production	75	35	40
Hay Farming	35	15	20
Fertilizer Supply	15	0	15
Sum	225	125	**100**

The first point to note is that this beef industry is valued at $100 million. The final sales of products by beef slaughtering facilities are $100 million. Not coincidentally, the value added in the beef supply industry is $100. To see why final sales and valued added are identical, trace the value of production and input costs starting with the fertilizer supply industry. For simplicity, ignore the input costs to the fertilizer industry. If the costs to fertilizer suppliers were incurred outside the state of Arizona, this would be an accurate accounting of fertilizer supplier transactions. Fertilizer suppliers sell their output, fertilizer, at $15 million to hay producers. Those same hay producers sell their output, hay, to cattle producers at a value of $35 million. Hay producers cannot legitimately lay claim to being responsible for generating the entire value of $35 million because fertilizer suppliers produced $15 million of value in the form of fertilizers. Hence, value added by hay farmers is $20 million. Following up the chain of production, cattle producers generate $40 million in value added by selling their cattle to slaughtering facilities for $75 million but deducting the $35 million generated by hay farmers. Finally, slaughtering facilities generate an additional $25 million in value added in an obvious way. By netting out the costs of inputs at each stage of production, value added exactly equals the value of final sales, namely, $100 million. An alternative way of observing why the equality must hold is to sum the total value of sales, $225 million, and subtract from it the sum of all input costs, $125 million. The difference, by definition, is the net value added.

Now suppose we consider the same stylized beef supply industry but conduct a more detailed accounting of the production processes required to arrive at the same value of final sales, $100 million. Consider the slightly less simple stylized example in Table 7. Here there are eight separate industries included instead of the four in the previous example.

Table 7. Less-Simple Stylized Example of Industry Transactions in Beef Supply ($ Millions)

	Sales	- Inputs	= Value Added
Processing & Marketing	**100**	90	10
Slaughtering	90	75	15
Feed Lots	75	55	20
Ranches	55	35	20
Feed Suppliers	35	25	10
Hay Farms	25	15	10
Fertilizer Suppliers	15	10	5
Fertilizer Production	10	0	10
Sum	405	305	**100**

Because the beef supply industry is the same whether considered in a simple or a not-so-simple accounting, the value added and the value of final sales by beef slaughtering facilities is identical across the two examples, $100 million. Without tracing all the transactions from industry to industry in the example in Table 7, it is clear that with the more detailed accounting the value of total sales across the 8 industries is $405 million whereas with only the 4 industries in Table 6, the value of total sales is just $225. Remember, these two examples depict the same industry producing the same $100 million of final sales but because the level of accounting differs, the value of total sales across all industries increases. However, and this is the key point, by netting out the value of inputs used at each stage of production, the value added is identical regardless of the detail of accounting, namely, $100 million.

The not-too-subtle message of this simple stylized example is that analysts, policy makers, and citizens at large should be leery of figures which represent the sum of individual industry's sales without netting out input costs. The more detailed is the accounting in arriving at such figures, the more inflated will theses totals be relative to the more appropriate value added. The title of this section uses the term "double counting" but, in fact, the value of total sales can exceed value added by more than a factor of two. Consider the two stylized examples just discussed. In the simple case, the ratio of the value of total sales to value added is (225/100 = 2.25). With more detailed accounting the ratio becomes (405/100 = 4.05).

In what follows, the value of total agricultural sales are presented (see Table 8 below). These numbers necessarily exceed value added by substantial amounts. However, because total value-added figures have been quoted in past reports [1,2], comparably calculated total agricultural sales figures are reported here. We caution that these figures taken in isolation may be misleading owing to the "double counting" inherent in their calculation.

As expected, the total impact figures reported exceed their corresponding value added figures by more than a factor of two (see Table 8). Nonetheless, the ratio of the value of total sales to total value added is relatively stable over time, ranging from 2.18 in 2000 to 2.57 in 2007.

Table 8. Total Value of Agricultural Output and Value Added, Current Dollars

Row	Category	1990	2000	2007
(1)	Primary Agriculture		2,339	3,969
(2)	Linked Industries		2,157	3,095
(1+2)	Direct Impact, Agribusiness	3,443	4,496	7,064
(3)	Indirect Impact , Other Industries	711	886	1,954
(4)	Induced Impact	2,111	1,211	1,324
(3+4)	Indirect + Induced Impact	2,822	2,097	3,279
(1+2+3+4)	Total Impact	6,265	6,593	10,343
	Total Value Added	2,703	3,022	4,021
	Ratio, Total Impact to Value Added	2.32	2.18	2.57

Source: Calculations from IMPLAN model.

3. Conclusion

In Arizona, agriculture is a dynamic and innovative industry, registering growth in total factor productivity well above the average for agriculture in the United States. Both value added and the value of total sales have increased consistently over the three years studied here (1990, 2000, and 2007). The growth in economic activity has been accompanied by a declining number of jobs generated from direct, indirect, and induced impacts of agriculture. Though the input-output models employed here cannot explain the causes of the decline in employment as output and value added have increased, it is plausible that most of the productivity gains have been labor saving, meaning that more output can be produced with fewer laborers and employees.

Arizona's agricultural sector currently accounts for just under one percent of state GDP, a proportion of economic activity on par with many states in the West like California and

Colorado. The shrinking share of state GDP accounted for by agriculture is driven in large measure by Engel's Law, which indicates that as consumers' real income grows, the proportion of income spent on food declines. The declining share of agriculture in state GDP is not at odds with a growing agricultural industry. It simply means that other non-agricultural industries have grown proportionally more over the past two decades.

The characterization of Arizona's agriculture growing in real terms while representing a declining proportion of state GDP and declining number of jobs is perhaps incomplete. These are the impacts easily measured with the aid of an input-output model such as IMPLAN. The less easily quantified impacts relate to agriculture playing a continued important role in sustaining rural communities throughout Arizona. Further, as the stewards of much private and even some public land, farmers and ranchers play a key role in preserving land resources for current and future generations. To the extent society now and in the future values rural landscapes and ways of life, the impact of agriculture on Arizona's economy calculated from an input-output model may be understated.

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APPENDIX A

Table A.1. GDP by State, All Industry and Farming, Average 2005-07

State	All Industry $M	All Industry % of US	All Industry Rank	Crops & Livestock Farms $M	Crops & Livestock Farms % of US	Crops & Livestock Farms Rank	Farms % of of All Industry
United States	13,048,506	100		110,831	100		0.85
Alabama	157,988	1.2	25	1,835	1.7	26	1.16
Alaska	42,504	0.3	45	34	0.0	50	0.08
Arizona	**232,527**	**1.8**	**19**	**1,617**	**1.5**	**28**	**0.70**
Arkansas	90,774	0.7	34	2,504	2.3	14	2.76
California	**1,719,320**	**13.2**	**1**	**18,301**	**16.5**	**1**	**1.06**
Colorado	**224,494**	**1.7**	**20**	**1,916**	**1.7**	**25**	**0.85**
Connecticut	201,462	1.5	23	324	0.3	41	0.16
Delaware	59,477	0.5	38	424	0.4	39	0.71
Florida	**711,090**	**5.4**	**4**	**4,360**	**3.9**	**4**	**0.61**
Georgia	375,468	2.9	10	2,707	2.4	12	0.72
Hawaii	58,671	0.4	39	322	0.3	42	0.55
Idaho	49,084	0.4	42	2,040	1.8	23	4.16
Illinois	586,409	4.5	5	3,702	3.3	7	0.63
Indiana	240,651	1.8	17	2,493	2.2	15	1.04
Iowa	**122,254**	**0.9**	**30**	**5,866**	**5.3**	**3**	**4.80**
Kansas	**109,925**	**0.8**	**32**	**2,755**	**2.5**	**11**	**2.51**
Kentucky	145,681	1.1	27	2,052	1.9	21	1.41
Louisiana	195,999	1.5	24	1,015	0.9	34	0.52
Maine	46,271	0.4	43	244	0.2	45	0.53
Maryland	252,961	1.9	15	795	0.7	36	0.31
Massachusetts	334,691	2.6	13	247	0.2	44	0.07
Michigan	375,695	2.9	9	2,179	2.0	20	0.58
Minnesota	242,055	1.9	16	4,352	3.9	5	1.80
Mississippi	83,650	0.6	35	1,463	1.3	29	1.75
Missouri	220,619	1.7	22	2,439	2.2	16	1.11
Montana	31,950	0.2	47	1,099	1.0	31	3.44
Nebraska	**75,423**	**0.6**	**36**	**4,185**	**3.8**	**6**	**5.55**
Nevada	121,147	0.9	31	205	0.2	46	0.17
New Hampshire	55,801	0.4	40	96	0.1	48	0.17
New Jersey	444,163	3.4	8	546	0.5	37	0.12
New Mexico	71,659	0.5	37	1,054	1.0	32	1.47
New York	1,031,828	7.9	3	2,050	1.8	22	0.20
North Carolina	372,486	2.9	11	3,445	3.1	9	0.92
North Dakota	26,065	0.2	49	1,923	1.7	24	7.38
Ohio	450,118	3.4	7	2,333	2.1	17	0.52
Oklahoma	128,864	1.0	29	1,834	1.7	27	1.42
Oregon	149,158	1.1	26	2,274	2.1	18	1.52
Pennsylvania	508,058	3.9	6	2,685	2.4	13	0.53
Rhode Island	45,113	0.3	44	36	0.0	49	0.08

South Carolina	145,599	1.1	28	826	0.7	35	0.57
South Dakota	32,365	0.2	46	2,197	2.0	19	6.79
Tennessee	235,016	1.8	18	1,048	0.9	33	0.45
Texas	**1,066,965**	**8.2**	**2**	**7,368**	**6.6**	**2**	**0.69**
Utah	97,663	0.7	33	508	0.5	38	0.52
Vermont	23,685	0.2	50	292	0.3	43	1.23
Virginia	367,681	2.8	12	1,379	1.2	30	0.38
Washington	290,694	2.2	14	3,640	3.3	8	1.25
West Virginia	55,536	0.4	41	133	0.1	47	0.24
Wisconsin	224,382	1.7	21	3,332	3.0	10	1.49
Wyoming	29,373	0.2	48	356	0.3	40	1.21

APPENDIX B

Arizona GDP by Industry, Average 2005-07, Million Dollars and Percent of State Total

Industry	Million Dollars	% of all
All industry total	232,527	100.0
Private industries	203,833	87.7
Agriculture, forestry, fishing, and hunting	2,167	0.9
Crop and animal production (Farms)	1,617	0.7
Forestry, fishing, and related activities	550	0.2
Mining	3,728	1.6
Oil and gas extraction	1	0.0
Mining, except oil and gas	3,552	1.5
Support activities for mining	174	0.1
Utilities	3,842	1.7
Construction	16,161	7.0
Manufacturing	18,596	8.0
Durable goods	15,659	6.7
Wood product manufacturing	458	0.2
Nonmetallic mineral product manufacturing	1,271	0.5
Primary metal manufacturing	489	0.2
Fabricated metal product manufacturing	1,528	0.7
Machinery manufacturing	668	0.3
Computer and electronic product manufacturing	5,284	2.3
Electrical equipment and appliance manufacturing	233	0.1
Motor vehicle, body, trailer, and parts manufacturing	251	0.1
Other transportation equipment manufacturing	4,184	1.8
Furniture and related product manufacturing	558	0.2
Miscellaneous manufacturing	734	0.3
Nondurable goods	2,938	1.3
Food product manufacturing	976	0.4
Textile and textile product mills	131	0.1
Apparel manufacturing	30	0.0
Paper manufacturing	265	0.1
Printing and related support activities	498	0.2
Petroleum and coal products manufacturing	20	0.0
Chemical manufacturing	671	0.3
Plastics and rubber products manufacturing	345	0.1
Wholesale trade	13,230	5.7
Retail trade	19,424	8.4
Transportation and warehousing, excluding Postal Service	6,352	2.7
Air transportation	1,611	0.7
Rail transportation	684	0.3
Water transportation	10	0.0
Truck transportation	1,797	0.8
Transit and ground passenger transportation	297	0.1
Pipeline transportation	43	0.0
Other transportation and support activities	1,454	0.6
Warehousing and storage	454	0.2

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Industry	Million Dollars	% of all
Information	6,365	2.7
Publishing including software	1,405	0.6
Motion picture and sound recording industries	147	0.1
Broadcasting and telecommunications	3,921	1.7
Information and data processing services	892	0.4
Finance and insurance	19,204	8.3
Federal Reserve banks, credit intermediation and related service	13,248	5.7
Securities, commodity contracts, investments	1,327	0.6
Insurance carriers and related activities	4,431	1.9
Funds, trusts, and other financial vehicles	197	0.1
Real estate and rental and leasing	35,405	15.2
Real estate	31,865	13.7
Rental and leasing services and lessors of intangible assets	3,539	1.5
Professional and technical services	13,723	5.9
Legal services	2,323	1.0
Computer systems design and related services	1,903	0.8
Other professional, scientific and technical services	9,498	4.1
Management of companies and enterprises	2,727	1.2
Administrative and waste services	10,380	4.5
Administrative and support services	9,744	4.2
Waste management and remediation services	635	0.3
Educational services	1,704	0.7
Health care and social assistance	16,277	7.0
Ambulatory health care services	9,784	4.2
Hospitals and nursing and residential care facilities	5,328	2.3
Social assistance	1,166	0.5
Arts, entertainment, and recreation	2,236	1.0
Performing arts, museums, and related activities	1,054	0.5
Amusement, gambling, and recreation	1,182	0.5
Accommodation and food services	7,758	3.3
Accommodation	2,697	1.2
Food services and drinking places	5,062	2.2
Other services, except government	4,554	2.0
Government	28,693	12.3
Federal civilian	5,048	2.2
Federal military	2,527	1.1
State and local	21,118	9.1

Source: Based on BEA statistics.