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Production Agriculture Diversification for each State in the United States

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The extent of agricultural diversification in a state has implications for stability of the agricultural sector in that state and how institutions that serve agriculture in that state complete their missions. A state with only a few commodities may find it easier to service those commodities, but may be susceptible to swings in aggregate income from agriculture over time. In contrast, a large number of commodities may challenge institutions to adequately address the concerns of each of the commodity groups, but may lead to stable aggregate agriculture income, especially if the commodities display low correlation of income across years.

The purpose of this article is to report the level of diversification of each individual state's production agriculture using various measures that place varying emphasis on the number of commodities produced versus the evenness of production across those commodities. A state may produce a large number of commodities but may find that the majority of revenue is from only a few commodities. That case is different from a state that also produces a large number of commodities but whose revenue is distributed more evenly across those commodities.

This replicates the earlier work by Tauer (1992) who measures the diversification of production agriculture across individual states for the production year 1988. That was 30 years ago, and agriculture has changed over those 30 years, including the quantity of individual commodities produced in each state.

Diversification Indices

Various indices from ecology and economics (among other fields) have been used to measure the diversification of flora and fauna, or a business and an economy. Most of these are special forms of the general index:

$$I_\alpha = (\sum_{i=1}^{N} S_i^\alpha)^{1/(1-\alpha)}$$

where S_i is a commodity's proportion of revenue to total agricultural revenue for state i, and α is a parameter that measures the extent of diversification over the N commodities, with α>0 and α≠1. If α=2 the index becomes: $1/\sum_{1=1}^{N} S_i^\alpha$, which is the inverse of the Herfindahl index, a commonly used index in economics to measure concentration. If α=0 the index simply counts the number of commodities produced in the state. For the limit as α approaches 1, the index becomes the Entropy index, used to measure information, which is calculated as:

$-\sum_{i=1}^{N} S_i \, lnS_i$.

As the parameter α increases in value, more weight is placed on evenness rather than simply the number of commodities produced. The upper limit for the index at any α value is the number of commodities produced, but then only if production is evenly distributed across the N commodities. Tauer (1992) has a discussion of these and other indices used in economics and ecology. Further discussion can be found in Hill (1973). In the current application α parameter values of 0, 1, 2, 5, and 100 are used to derive these indices for each state for the year 2016. These are later compared to comparable indices derived previously for the year 1988.

Data

Data were obtained from the USDA, Economic Research Service data-products portal for cash receipts by commodity. That data is composed from the U.S. Agricultural Census data with yearly modifications based upon sales data collected and released to the public by USDA's National Agricultural Statistics Service (NASS). Thus, sales during Agricultural Census years are from the 5 year agricultural census with data collected most recently for calendar years 2012, 2007, and 2002, with year 2017 in process.

However, to protect the confidentiality of individual survey respondents, NASS does not publish detailed sales data for all commodities in all States if necessary to protect confidentiality of individual producers. That would be the situation in states where only a few producers produce a commodity, because either it is a "minor" commodity, like peppermint, or it is a state with few producers even of a major commodity, such as corn. NASS maintains confidentiality by combining these commodity sales data across states. ERS worked with NASS to develop an algorithm to take the aggregated annual sales data and allocate it to a commodity by state using Agricultural Census proportions.

The following example is given on the ERS website to explain the adjustment process. "For example, in 2013 NASS was unable to separately publish Idaho and Washington hog sales data, instead reporting $32,031,000 as the combined receipts for the 2 States, under the group total for "Other States". "Hogs – Sales, Measured in Head" is available for both Idaho and Washington in the Census of Agriculture (2012) and used to allocate sales between the two states. Hog sales measured in head for these two States in 2012 were 144,932 (84%) for Idaho

and 27,141 (16%) for Washington. Applying these percentages to the "Other States" sales total, the hog cash receipts for Idaho is $26,979,000, while $5,052,000 is allocated to Washington."

The impact of this adjustment on cash receipts by commodity is relatively small for any single state. The documentation states that only three states had more than 5 percent of their average annual cash receipts estimated using this method, New Hampshire, Louisiana, and Rhode Island. New York only had 1.6 percent of total cash receipts allocated by this method.

Detailed commodity information is provided on some commodities, including seasonal production, or whether the commodity was sold fresh or after further processing. For instance, cotton is further separated into lint (either long staple or upland) and cottonseed. However, soybeans were not similarity separated into meal and oil, but only reported as soybeans, so it was decided to use as a defined commodity the value of cotton sold with no separation of those sales into components. Similarity, potatoes were reported by fall, spring, or summer crop, but only potatoes were used in the analysis. However, oil crops were separated into types of crops such as flaxseed, sunflower, soybeans, etc. and those individual crop units were used as defined commodities. The commodities defined and used for U.S. are in appendix table A. There were 102 commodities identified, but each state produced only a subset of this listing of commodities.

Results[1]

Index values for each state at the various alpha values of 0, 1, 2, 5, and 100 for the production year 2016 are shown in table 1. An index with an alpha value of 0 simply counts the number of commodities by receipts in the state. The state with the greatest number of commodities is California with 76 of the 102 possible, and the state with the lowest number of commodities produced is Alaska with only 9. Other states with a large number of commodities (over 40) include Michigan, North Carolina, Oregon, Texas, and Washington. Other states with the lowest number of commodities (under 20) includes Connecticut, Hawaii, Iowa, Kentucky, Maine, Massachusetts, Nevada, New Hampshire, Rhode Island, Vermont, and Wyoming.

As the alpha parameter increases more emphasis is place on evenness rather than the number of commodities. At all alpha levels California has the higher index. Thus not only does California produce the most commodities, but that production is evenly spread over those commodities. The second highest index at an alpha value of 1 is Florida followed by Michigan. At the alpha value of 2, the second highest is Washington followed by Virginia at third. At these lower alpha values these are still states that produce a large number of commodities. At the alpha value of 5, the second highest is Kentucky (California is first), and the third is Louisiana. Both of these states produce fewer commodities, with Kentucky producing only 18. So although these states produce fewer commodities, the receipts are spread more evenly over those commodities than for many states that produce more commodities. Finally at the alpha level of 100, the state with the second highest index is again Kentucky followed again by Louisiana.

[1] Anvita Khosla, an undergraduate student in the Charles H. Dyson School, assisted in deriving the indices

The lowest index at the alpha values of 1, 2 and 5 is Delaware followed by Rhode Island. The state with the lowest index at the alpha value of 100 is North Carolina with an index value of only 1.08. Although North Carolina produces many commodities, half of the receipts from those 42 commodities are from hogs and broilers.

There are some interesting patterns. Iowa only produces 19 commodities but the alpha 100 index at 3.19 is higher than most states producing more commodities. Nebraska for instance, produces 27 commodities by has an alpha 100 index of only 1.94. New York produces 37 commodities but has an alpha 100 index of only 2.01. In contrast, Michigan produces 43 commodities but has an alpha 100 index value of 4.53. Both New York and Michigan produce similar number (and types) of commodities, but Michigan commodity receipts are more evenly distributed.

Tauer (1992) earlier did a similar analysis using state receipts from the year 1988, which is 28 years earlier than the year 2016 data used here. Tauer reported individual state indices from 1988 for alpha levels of 0, 2, and 100, and those values are inserted into Table 2 which lists the corresponding individual state's indices at those same alpha levels using the data from the year 2016. Some state experienced increases in index values at some or all alpha values while more states experienced decreases in index values between the two years. Two examples are Arizona which saw a decrease in the number of commodities from 39 to 29, but saw increases in the index at both alpha levels of 2 and 100, which shows more evenness in receipts. California saw an increase in the number of commodities from 70 to 76, but saw decreases in the indices at both alpha values of 2 and 100.

Some states experienced significant decreases in the alpha 100 index representing evenness, including North Carolina, Oregon, and South Carolina. States that experienced increases in the 100 alpha index include Kentucky and Tennessee. New York experienced more evenness of commodity receipts from the year 1988 to the year 2016.

Summary

State level agriculture diversification across receipts by commodities were calculated from commodity receipts received during the year 2016. Various indices were used that show first the number of commodities to the evenness of receipts among those commodities. These indices were then compared to indices that were published previously for the year 1988 to show how diversification changed between the years 1988 and 2016.

References

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Table1. Agricultural Commodity Diversification Indices by State at Various Alpha Values for Year 2016

	Alpha Values				
	0	1	2	5	100
State	Index Value	Index Value	Index Value	Index Value	Index Value
United States	102	2.98	11.47	7.86	5.61
Alabama	24	1.66	2.80	1.98	1.74
Alaska	9	1.40	2.65	1.96	1.73
Arizona	28	2.36	7.41	5.80	4.57
Arkansas	24	1.95	4.67	3.23	2.59
California	76	3.11	13.52	9.49	7.63
Colorado	28	1.95	3.68	2.42	2.04
Connecticut	15	1.39	2.47	1.85	1.64
Delaware	23	1.14	1.81	1.47	1.37
Florida	38	2.67	8.57	5.01	3.69
Georgia	37	2.15	4.20	2.65	2.20
Hawaii	17	1.69	3.30	2.30	1.96
Idaho	34	2.08	5.10	3.04	3.04
Illinois	29	1.43	2.97	2.50	2.18
Indiana	25	1.94	4.86	3.73	3.18
Iowa	19	1.66	4.41	3.85	3.19
Kansas	23	1.60	3.16	2.24	1.92
Kentucky	18	2.24	7.95	6.90	6.02
Louisiana	22	2.32	8.35	6.71	5.02
Maine	16	1.99	5.63	4.40	3.52
Maryland	25	2.02	4.52	2.95	2.40
Massachusetts	18	1.84	4.17	2.89	2.37
Michigan	43	2.58	8.86	6.18	4.53
Minnesota	34	2.15	6.32	4.88	3.82
Mississippi	23	1.93	4.11	2.80	2.31
Missouri	28	2.22	6.92	5.42	4.27
Montana	27	1.97	4.42	3.18	2.59
Nebraska	27	1.38	2.83	2.25	1.94
Nevada	16	1.56	3.30	2.43	2.05
New Hampshire	15	1.75	4.29	3.21	2.61
New Jersey	31	2.16	3.86	2.43	2.05
New Mexico	24	1.67	3.52	2.82	2.41
New York	37	1.94	3.54	2.37	2.01
North Carolina	42	2.44	6.63	4.27	1.08
North Dakota	28	2.28	6.91	5.21	4.12
Ohio	31	2.17	6.20	4.47	3.50
Oklahoma	25	1.81	3.49	2.39	2.02

Table 1 continued					
	Alpha Values				
	0	1	2	5	100
State	Index Value	Index Value	Index Value	Index Value	Index Value
Oregon	46	2.54	7.04	4.42	3.36
Pennsylvania	32	2.41	7.47	4.63	3.46
Rhode Island	13	1.24	2.20	1.69	1.53
South Carolina	27	2.25	5.02	3.05	2.46
South Dakota	24	1.88	4.87	4.15	3.77
Tennessee	23	2.35	8.16	6.32	4.78
Texas	44	2.16	4.91	3.14	2.52
Utah	23	2.12	5.88	4.19	3.26
Vermont	14	1.39	2.57	1.91	1.69
Virginia	32	2.50	9.18	6.41	4.60
Washington	49	2.75	10.27	6.17	4.38
West Virginia	21	2.11	6.29	4.84	4.10
Wisconsin	38	1.88	3.75	2.58	2.15
Wyoming	18	1.53	2.45	1.80	1.61

As the alpha parameter increases in the index greater importance is placed on the evenness among commodities produced compared to the number of commodities produced. An alpha value of zero simply counts the number of commodities produced out of 102 commodities.

Table 2. Agricultural Commodity Diversification Indices Values by State for Years 2008 and 2016

	Alpha Values					
	0		2		100	
State	Year 1988	Year 2016*	Year 1988	Year 2016	Year 1988	Year 2016
United States	NA	102	NA	11.47	NA	5.61
Alabama	29	24	4.85	2.80	2.59	1.74
Alaska	9	9	3.67	2.65	2.20	1.73
Arizona	39	28	6.67	7.41	3.83	4.57
Arkansas	30	24	6.28	4.67	3.22	2.59
California	70	76	17.90	13.52	8.15	7.63
Colorado	32	28	2.54	3.68	1.63	2.04
Connecticut	17	15	5.36	2.47	3.32	1.64
Delaware	22	23	2.17	1.81	1.50	1.37
Florida	48	38	9.69	8.57	4.57	3.69
Georgia	33	37	7.38	4.20	3.35	2.20
Hawaii	21	17	5.02	3.30	2.70	1.96
Idaho	33	34	6.79	5.10	3.52	3.04
Illinois	22	29	4.62	2.97	3.30	2.18
Indiana	28	25	6.08	4.86	4.08	3.18
Iowa	25	19	4.69	4.41	3.81	3.19
Kansas	27	23	2.71	3.16	1.74	1.92
Kentucky	22	18	6.63	7.95	4.73	6.02
Louisiana	26	22	8.48	8.35	5.25	5.02
Maine	17	16	5.97	5.63	4.10	3.52
Maryland	29	25	6.18	4.52	3.13	2.40
Massachusetts	20	18	5.44	4.17	3.10	2.37
Michigan	44	43	9.72	8.86	4.23	4.53
Minnesota	34	34	7.48	6.32	5.20	3.82
Mississippi	24	23	6.87	4.11	4.40	2.31
Missouri	26	28	6.89	6.92	4.26	4.27
Montana	23	27	3.17	4.42	2.01	2.59
Nebraska	27	27	2.86	2.83	1.82	1.94
Nevada	15	16	3.26	3.30	2.05	2.05
New Hampshire	13	15	5.96	4.29	3.49	2.61
New Jersey	35	31	6.48	3.86	2.94	2.05
New Mexico	28	24	2.93	3.52	1.78	2.41
New York	45	37	3.27	3.54	1.88	2.01
North Carolina	35	42	9.42	6.63	4.94	1.08
North Dakota	28	28	5.86	6.91	3.68	4.12
Ohio	35	31	7.38	6.20	4.22	3.50
Oklahoma	27	25	3.20	3.49	1.91	2.02

Table 2 continued						
	Alpha Values					
	0		2		100	
State	Year 1988	Year 2016	Year 1988	Year 2016	Year 1988	Year 2016
Oregon	52	46	15.13	7.04	6.51	3.36
Pennsylvania	33	32	4.89	7.47	2.47	3.46
Rhode Island	13	13	3.47	2.20	2.08	1.53
South Carolina	28	27	12.28	5.02	6.92	2.46
South Dakota	26	24	3.88	4.87	2.15	3.77
Tennessee	25	23	7.92	8.16	3.93	4.78
Texas	45	44	3.83	4.91	2.10	2.52
Utah	24	23	4.81	5.88	2.60	3.26
Vermont	14	14	1.75	2.57	1.35	1.69
Virginia	28	32	9.16	9.18	4.56	4.60
Washington	44	49	10.37	10.27	6.53	4.38
West Virginia	19	21	7.64	6.29	4.41	4.10
Wisconsin	34	38	2.59	3.75	1.69	2.15
Wyoming	20	18	2.03	2.45	1.45	1.61

*Some states saw an increase or decrease in the number of commodities produced between years 1988 and 2016 due to the listing and non-listing of commodities. For instance, in 2016, sheep were dropped as a separate listing and included instead in the group or other livestock.

Appendix: List of 102 Commodities Used to Compute Year 2016 Indices

Cattle and calves	Beans, Green lima	Blueberries
Hogs	Beans, Snap	Coffee
Dairy products, Milk	Broccoli	Cranberries
Broilers	Cabbage	Kiwifruit
Chicken eggs	Carrots	Papayas
Farm chickens	Cauliflower	Raspberries
Turkeys	Celery	Strawberries
Catfish	Corn, Sweet	Almonds
Trout	Cucumbers	Hazelnuts
Honey	Garlic	Macadamia nuts
Mohair	Lettuce	Pecans
All other animals and products	Pumpkins	Pistachios
Mink pelts	Onions	Walnuts
Wool	Peas, Green	Sugarcane
Rice	Peppers, Chile	Maple products
Rye	Peppers, bell	Sugar beets
Wheat	Spinach	Hops
Barley	Squash	Mint
Corn	Tomatoes	Mushrooms
Hay	Cantaloupes	Miscellaneous crops
Millet	Honeydews	
Oats	Watermelon	
Sorghum	Grapefruit	
Cotton	Lemons	
Tobacco	Oranges	
Flaxseed	Tangelos	
Canola	Tangerines	
Mustard seed	Apples	
Rapeseed	Apricots	
Peanuts	Avocados	
Safflower	Cherries	
Soybeans	Dates	
Sunflower	Figs	
Dry beans	Grapes	
Dry peas	Nectarines	
Lentils	Olives	
Potatoes	Peaches	
Sweet potatoes	Pears	
Taro	Plums and prunes	
Artichokes	Bananas	
Asparagus	Blackberry group	

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