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How Diversified is Your State's Agriculture?

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Abstract

Each state's agricultural production diversification is measured for 1984 and 1988. Very little difference existed between the type of index used or the year computed. Linear regressions of the coefficient of variation of receipts on diversification measures implies diversification among states have no impact on variability of receipts.

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How Diversified is Your State's Agriculture?

Many states are promoting alternative agricultural commodities and enterprises in an attempt to diversify their farmers and agriculture. The belief is that additional diversification will reduce the exposure of individual farmers and the state to financial crises similar to those that occurred during the decade of the 80s. This paper measures each state's diversification of agricultural production in 1988 and 1984 using the Herfindahl and Entropy indices. This provides information on the current extent of diversification and any progress made from 1984 to 1988. The impact of diversification on variability of total state cash receipts is also estimated.

Diversification Indices

The study of industrial organization has devised various indices to measure the degree of concentration within an industry. In a review of those studies, Hannah and Kay state that most of the common indices are special cases of the form

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

where S_i is the market share of the ith firm and α is a parameter, $\alpha > 0$, $\alpha \neq 1$.

For $\alpha = 2$, this index becomes $1/\sum_{i=1}^{N} S_i^2$, or the inverse of the Herfindahl index. For the limit $\alpha \to 1$, the index becomes the Entropy index $-\sum_{i=1}^{N} S_i \ln S_i$.

This general index and it's special forms measures both the number of firms and the evenness of market share within the industry. The parameter α indicates how the index is influenced by the presence of larger firms; a high value for α will give more weight in the index to larger than to smaller firms. A value of $\alpha = 0$ simply counts the number of firms.

The field of ecology has used identical indices with different names to measure species diversification and number. Five common values of α used and the information they provide are: $\alpha = -\infty$, reciprocal of the proportional abundance of the rarest species; $\alpha = 0$, total number of species present; $\alpha = 1$, Shannon's Entropy; $\alpha = 2$, reciprocal of Simpson's index; and $\alpha = \infty$, reciprocal of the proportional abundance of the commonest species (Hill).

In this study S_i is the proportion of the commodity group (or commodity) to the total cash receipts for each state. Three measures of α are reported: $\alpha = 0$ (count), $\alpha = 1$ (Entropy) and $\alpha = 2$ (Herfindahl). A general index was also formulated in the LOTUS 123 worksheet for any value of α.[1]

Procedure

Cash receipts by commodity groups and selected commodities by state are available from the USDA in a LOTUS 123 worksheet of the publication, Economic Indicators of the Farm Sector: State Financial Summary, 1988 (USDA). That readily allowed computing a Herfindahl and an Entropy index using both commodity groups and the selected commodities under

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[1]The LOTUS 123 worksheets constructed are available from the author.

each commodity group. Indices were computed for 1988 and 1984 data from Table 5 of that publication.

The twelve commodity groups are: meat animals, dairy products, poultry/eggs, miscellaneous livestock, food grains, feed grains, cotton, tobacco, oil crops, vegetables, fruits/nuts, and all other crops. Most states had ten of the twelve groups. A few did not have oil crops, and many of the Southern states also had cotton and tobacco. The proportions of the commodity groups were used to compute Herfindahl and Entropy indices for 1988.

Indices were also computed using selected commodities. These selected commodities are listed under each commodity group and vary by state. The largest listing occurred under vegetables for those states that are major vegetable producers, such as California and Florida.

Some selected commodities were not used. For instance, milk retail and milk wholesale are listed under the dairy products group. At the same level of division cattle and calves are not divided into retail and wholesale. Thus, the group dairy products was used as the commodity milk. Likewise, the cotton group is broken up into the selected commodities cotton lint and cottonseed. However, the small grains are not broken up into seed and straw (i.e. for flax) so the cotton group was used as the commodity cotton. Some selected commodities are further broken up at another level of division. The most common is fresh versus processed vegetables or potato production by season. However, since a commodity like wheat is not separated in Table 5 by winter versus spring production, or by use, no third levels of division were used.

Unfortunately, selected commodity proportions did not sum to one for all states since selected commodities under a commodity group often

do not total to the value listed for the commodity group. The discrepancies were determined for those states whose proportions summed to less than .99. The corrections (in $1,000) for 1988 by state were as follows: Colorado $78,250 was added to other poultry; Connecticut $588 added to other poultry, $832 to miscellaneous fruits and nuts, and $19,354 to other field crops; Louisiana $150,717 to farm chickens; Maine $4,378 to other poultry; Missouri $79,134 to other poultry; Tennessee $113,274 to farm chickens; Texas $72,297 to other poultry; Utah $5,500 to other field crops; West Virginia $10,140 to other poultry; and Wisconsin $59,622 added to other poultry. Similar adjustments were made to the 1984 data.

Results

Computed 1988 State indices using the commodity groups are reported in Table 1. The Herfindahl index ranged from a low of .13 for Louisiana and South Carolina (most diversified) to a high of .50 for Vermont (least diversified). Both Louisiana and South Carolina have an even mix of livestock and crops. In contrast, Vermont produces mainly milk. Most of the other more diversified states have a mixture of livestock, crops, vegetables and fruit. In contrast, poorly diversified states tend to have a major crop (Kansas, wheat) or a major livestock (Wisconsin, dairy).

The Entropy indices produce similar results. South Carolina and then Louisiana are the first and second most diversified, and Vermont is the least diversified. Since the Herfindahl has a larger alpha value of 2 compared to an alpha value of 1 for the Herfindahl, the Herfindahl gives more weight to larger group proportions. The strong relationship

Table 1. Diversification of States' Agriculture Using Twelve Commodity Groups

State	1988					Average Cash Receipts (Million $)		Coefficient of Variation	
	Count	Herfindahl	(Rank)	Entropy	(Rank)	1984-1988	(Rank)	1984-1988	(Rank)
Alabama	12	.27	32	1.70	31	2,170	25	.068	23
Alaska	7	.30	34	1.49	37	27	50	.088	34(t)
Arizona	11	.19	13(t)	1.87	16	1,711	31	.098	40(t)
Arkansas	11	.24	28(t)	1.73	26(t)	3,385	14	.107	47
California	10	.16	5(t)	1.99	7(t)	15,194	1	.065	21(t)
Colorado	9	.43	44(t)	1.30	43	3,301	16	.070	25(t)
Connecticut	9	.23	26(t)	1.71	30	372	45	.036	10
Delaware	10	.50	48	1.22	45	523	41	.080	32
Florida	12	.22	25	1.72	28(t)	5,102	8	.098	40(t)
Georgia	12	.21	21(t)	1.96	11(t)	3,352	15	.065	21(t)
Hawaii	7	.34	37(t)	1.35	39(t)	554	40	.031	4(t)
Idaho	9	.19	13(t)	1.83	18	2,136	26	.074	29
Illinois	10	.26	31	1.50	35(t)	6,774	5	.104	44(t)
Indiana	11	.21	21(t)	1.77	22(t)	4,171	10	.092	38
Iowa	10	.34	37(t)	1.28	44	9,002	3	.032	6(t)
Kansas	11	.43	44(t)	1.19	46	5,950	7	.075	30
Kentucky	11	.18	11(t)	1.90	15	2,613	22	.088	34(t)
Louisiana	11	.13	1(t)	2.15	2	1,576	32	.132	50
Maine	8	.20	18(t)	1.77	22(t)	406	42	.070	25(t)
Maryland	11	.19	13(t)	1.96	11(t)	1,200	34	.033	8(t)
Massachusetts	9	.23	26(t)	1.68	32	397	44	.033	8(t)
Michigan	10	.14	3	2.07	4	2,720	21	.052	14
Minnesota	10	.19	13(t)	1.84	17	6,128	6	.047	13
Mississippi	11	.17	8(t)	1.97	9(t)	2,117	27	.104	44(t)
Missouri	12	.21	21(t)	1.80	19	3,680	12	.031	4(t)

t = tied for that rank.

Table 1. Diversification of States' Agriculture Using Twelve Commodity Groups, continued.

State	1988					Average Cash Receipts (Million $)		Coefficient of Variation	
	Count	Herfindahl	(Rank)	Entropy	(Rank)	1984-1988	(Rank)	1984-1988	(Rank)
Montana	9	.36	40	1.32	41	1,295	33	.088	34(t)
Nebraska	10	.46	46	1.13	48	7,185	4	.069	24
Nevada	9	.34	37(t)	1.36	38	233	47	.044	11
New Hampshire	8	.21	21(t)	1.77	22(t)	121	48	.130	49
New Jersey	10	.19	13(t)	1.91	14	596	39	.071	27(t)
New Mexico	11	.37	41	1.50	35(t)	1,110	35	.101	42
New York	10	.32	35	1.59	33(t)	2,606	23	.013	1
North Carolina	12	.18	11(t)	1.99	7(t)	3,966	11	.053	15
North Dakota	10	.20	18(t)	1.78	21	2,472	24	.064	19(t)
Ohio	11	.17	8(t)	1.94	13	3,675	13	.063	18
Oklahoma	11	.33	36	1.59	33(t)	2,863	19	.111	48
Oregon	9	.17	8(t)	1.97	9(t)	1,862	29	.077	31
Pennsylvania	11	.24	28(t)	1.74	25	3,185	17	.022	3
Rhode Island	8	.48	47	1.18	47	74	49	.088	34(t)
South Carolina	12	.13	1(t)	2.23	1	1,019	36	.103	43
South Dakota	10	.38	42	1.35	39(t)	2,782	20	.093	39
Tennessee	12	.16	5(t)	2.08	3	2,008	28	.046	12
Texas	11	.28	33	1.72	28(t)	9,389	2	.064	19(t)
Utah	9	.24	28(t)	1.73	26(t)	600	38	.086	33
Vermont	8	.57	50	.96	50	402	43	.032	6(t)
Virginia	12	.16	5(t)	2.06	5	1,756	30	.058	17
Washington	9	.15	4	2.00	6	2,981	18	.071	27(t)
West Virginia	10	.20	18(t)	1.79	20	240	46	.055	16
Wisconsin	11	.41	43	1.31	42	4,990	9	.017	2
Wyoming	9	.56	49	.99	49	628	37	.104	44(t)
United States	12	.15		2.18		142,602		.041	

t = tied for that rank.

between the two indices are indicated by a correlation coefficient of -.96 based upon their numerical values.

There is little relationship between the size of a state's agriculture, as measured by average cash receipts from 1984 through 1988, and the level of diversification. By size Louisiana and South Carolina ranked 32 and 36 respectively but are the most diversified. Nebraska has a diversification rank of 46 or 48 but is ranked number 4 by cash receipts. The correlation between average cash receipts and the Entropy index for all fifty states based upon numerical values is only .03.

There also appears to be little relationship between a state's diversification and the variability of it's cash receipts as measured by the coefficient of variation (standard deviation divided by the average of cash receipts from 1984 through 1988). The correlation between the Entropy index and the coefficient of variation is only .09. Variation of cash receipts may be more a function of commodity group. New York and Wisconsin have the lowest and second lowest coefficient of variation; both are major dairy states but neither are well diversified, especially Wisconsin. Also having low coefficients of variation are Pennsylvania and Vermont.

Using selected commodities rather than commodity groups results in slightly different state rankings (Table 2). California, with its vast number of vegetables and fruits, as well as other crops and livestock (70 commodities), is ranked as the most diversified state in 1988 and 1984 using either the Herfindahl or the Entropy index (Table 2). Ranked second is Oregon. Previously, using commodity groups, California was ranked five or seven and Oregon was ranked eight or nine. Florida

Table 2. Diversification of States' Agriculture Using Selected Commodities

State	1988						1984			
	Count	(Rank)	Herfindahl	(Rank)	Entropy	(Rank)	Herfindahl	(Rank)	Entropy	(Rank)
Alabama	29	19(t)	.21	31(t)	2.11	25	.15	16(t)	2.36	14(t)
Alaska	9	50	.27	37	1.63	42(t)	.27	39	1.68	42
Arizona	39	8	.15	15(t)	2.36	12	.16	21	2.39	11
Arkansas	30	18	.16	21(t)	2.21	20(t)	.15	16(t)	2.25	18
California	70	1	.06	1	3.31	1	.06	1	3.32	1
Colorado	32	17	.39	46(t)	1.68	41	.34	45(t)	1.80	37
Connecticut	17	44(t)	.19	28	2.01	33(t)	.19	25(t)	1.96	32
Delaware	22	37(t)	.46	48	1.41	48	.42	48	1.51	48
Florida	48	3	.10	4(t)	2.77	3(t)	.09	3(t)	2.87	3
Georgia	33	14(t)	.14	13(t)	2.48	10	.11	5(t)	2.54	9
Hawaii	21	40	.20	29(t)	2.07	30(t)	.26	36(t)	1.91	35
Idaho	33	14(t)	.15	15(t)	2.32	15(t)	.13	12(t)	2.38	12(t)
Illinois	22	37(t)	.22	34	1.76	38	.22	32(t)	1.72	39
Indiana	28	21(t)	.16	21(t)	2.10	26(t)	.17	22(t)	2.09	27
Iowa	25	32(t)	.21	31(t)	1.70	40	.21	30(t)	1.71	40(t)
Kansas	27	26(t)	.37	45	1.50	47	.33	43(t)	1.54	47
Kentucky	22	37(t)	.15	15(t)	2.12	24	.17	22(t)	2.05	28(t)
Louisiana	26	29(t)	.12	9	2.39	11	.13	12(t)	2.34	17
Maine	17	44(t)	.17	24(t)	2.08	28(t)	.19	25(t)	1.95	33(t)
Maryland	29	19(t)	.16	21(t)	2.27	18	.17	22(t)	2.24	19
Massachusetts	20	41(t)	.18	27	2.10	26(t)	.20	28(t)	2.00	31
Michigan	44	6(t)	.10	4(t)	2.76	5	.11	5(t)	2.76	4
Minnesota	34	12(t)	.13	10(t)	2.30	17	.13	12(t)	2.36	14(t)
Mississippi	24	34(t)	.15	15(t)	2.21	20(t)	.15	16(t)	2.20	20(t)
Missouri	26	29(t)	.15	15(t)	2.26	19	.15	16(t)	2.19	22(t)

t = tied for that rank.

Table 2. Diversification of States' Agriculture Using Selected Commodities, continued.

State	1988						1984			
	Count	(Rank)	Herfindahl	(Rank)	Entropy	(Rank)	Herfindahl	(Rank)	Entropy	(Rank)
Montana	23	36	.32	42	1.63	42(t)	.30	41	1.60	44
Nebraska	27	26(t)	.35	44	1.55	46	.33	43(t)	1.59	45
Nevada	15	46	.31	39(t)	1.57	45	.29	40	1.63	43
New Hampshire	13	48(t)	.17	24(t)	2.08	28(t)	.26	36(t)	1.81	36
New Jersey	35	9(t)	.15	15(t)	2.52	9	.12	9(t)	2.72	5
New Mexico	28	21(t)	.34	43	1.81	36	.25	35	2.05	28(t)
New York	45	4(t)	.31	39(t)	2.01	33(t)	.34	45(t)	1.95	33(t)
North Carolina	35	9(t)	.11	7(t)	2.59	7	.12	9(t)	2.53	10
North Dakota	28	21(t)	.17	24(t)	2.20	23	.19	25(t)	2.14	24
Ohio	35	9(t)	.14	13(t)	2.32	15(t)	.13	12(t)	2.35	16
Oklahoma	27	26(t)	.31	39(t)	1.77	37	.32	42	1.71	40(t)
Oregon	52	2	.07	2	3.16	2	.08	2	3.00	2
Pennsylvania	33	14(t)	.20	29(t)	2.21	20(t)	.21	30(t)	2.20	20(t)
Rhode Island	13	48(t)	.29	38	1.71	39	.26	36(t)	1.77	38
South Carolina	28	21(t)	.08	3	2.73	6	.09	3(t)	2.68	6
South Dakota	26	29(t)	.26	35(t)	1.90	35	.22	32(t)	2.01	30
Tennessee	25	32(t)	.13	10(t)	2.34	13	.12	9(t)	2.38	12(t)
Texas	45	4(t)	.26	35(t)	2.07	30(t)	.24	34	2.12	25
Utah	24	34(t)	.21	31(t)	2.07	30(t)	.20	28(t)	2.11	26
Vermont	14	47	.57	50	1.03	50	.64	50	.86	50
Virginia	28	21(t)	.11	7(t)	2.56	8	.11	5(t)	2.55	8
Washington	44	6(t)	.10	4(t)	2.77	3(t)	.11	5(t)	2.67	7
West Virginia	19	43	.13	10(t)	2.33	14	.15	16(t)	2.19	22(t)
Wisconsin	34	12(t)	.39	46(t)	1.59	44	.39	47	1.58	46
Wyoming	20	41(t)	.49	49	1.30	49	.50	49	1.30	49
United States	125		.10		3.04		.09		3.04	

t = tied for that rank.

increased rank significantly from 28 to four. At the other end Vermont is still ranked as the least diversified. Decreasing their rank under selected commodities compared to commodity groups were Kentucky, Louisiana, Mississippi and Tennessee. Although these Southeast states are well diversified into livestock and crop commodity groups, including cotton and tobacco, they do not have a large number of specific commodities. Although there is some additional shifting in rank the shift is minor. The correlation of the numerical value between the commodity group Entropy index and the selected commodities Entropy index for the 50 states for 1988 was .87. In fact, all the indices were highly correlated. This has been previously observed in indices of industry concentration, and is due to the close mathematic relationships of the indices (Scherer).

Of interest is that state diversification has changed little from 1984 to 1988. The average of the selected commodity Entropy Index for the 50 states was 2.11 in 1984. The standard deviation in 1984 was .46. The average and standard deviation in 1988 was also 2.11 and .46, respectively. The average and standard deviation for the Herfindahl were also identical for 1984 and 1988.

States whose diversification increased from 1984 to 1988 often did so because of lowered production of their major commodity with a resultant evenness but often decrease in the size of the state's agricultural production. Examples include some of the Northeast states with reduced dairy production; New Hampshire had an increase in it's Entropy index from 1.81 in 1984 to 2.08 in 1988.

To determine the relationship between measures of diversification and variability of cash receipts, six linear regressions were estimated.

The dependent variable in each equation was the coefficient of variation (computed from 1984 through 1988 data). The independent variable was one of the six diversification indices. Constant terms were estimated. The explanatory power of the six equations were all zero with slightly negative adjusted R-squared values, and t-values on the diversification variables all less than absolute one. Thus, diversification does not appear to reduce the relative variability of cash receipts. However, with a state average coefficient of variation of only .070 (standard deviation of .029), there is little variability of cash receipts anyway.

Summary and Conclusions

Diversification indices were computed using 1984 and 1988 state data on cash receipts by commodity groups and by selected commodities. Very little difference existed between the type of index used or the year computed. Some differences resulted when detailed selected commodities were used rather than more aggregated commodity groups.

These results imply that it makes little difference whether the Herfindahl or Entropy index are used to measure the diversification of a state's agriculture. Also, there has been only small changes in individual state's diversification of agriculture from 1984 to 1988. States that have many vegetables or fruits are measured as more diversified using the selected commodity list rather than commodity groups.

A linear regression of the coefficient of variation of cash receipts (1984-1988) on each measure of diversification implies that diversification among states had no impact on reducing variability of total cash receipts. However, it may be that additional diversification

within a state may reduce it's cash receipts variability. A longer time series would be necessary to test that hypothesis.

This study did not measure commodity diversification at the farm or county level. The fact that a state is well diversified does not mean that it's farmers are, as state diversification can result from the heterogeneity of its farms.

The tradeoff between diversification and specialization at the firm level is well known. Diversification can lead to more stable but lower incomes if diversification prevents farmers from capturing any economies of scale. The same tradeoff can occur at the state level from research and extension efforts. The existence of a major commodity in a state may allow a state to concentrate it's research and extension efforts on that commodity, capturing any economies of size in research and extension. Those economies may not be captured if the state has to target a large number of commodities, especially if the state's overall research and extension funding of agriculture is small, possibly because it's agriculture is relatively small.

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