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Measurement of Agricultural Income of Counties

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Inadequate data on farmers' receipts and expenditures for small areas and an incomplete theory of agricultural income formation hinder the direct measurement of county agricultural income. This paper describes the development and testing of a method of estimating such income that compensates somewhat for the lack of basic county data, although adjustments were necessary to make the receipts complete and statistically comparable with the Department of Agriculture estimates. The paper also discusses the second difficulty—the theory of net income formation in agriculture.

Current Methods of Estimation

Bureaus of business research and other organizations estimate county agricultural income by some type of allocation method. One method obtains residuals through an incomplete accounting of expenses against receipts, by county. Each residual is expressed as a percentage of the state total agricultural income and is used as a percentage allocator for the county. In the other usual method, both the receipts and expenditures are built up from various sources to make them comparable to items in the income and expenditure statement of the National Income Division of the Department of Commerce to obtain more refined residuals, which again serve to provide county allocators. (Table 3 below gives the results of a test of the latter method.)

Numerous attempts have been made to develop refined methods by which to prepare valid estimates of county agricultural income. One of the first research studies on methodology was made in the early 1930's by W. M. Adamson.[1] He developed methods, based on

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[1] W. M. Adamson, *Income in Counties of Alabama, 1929 and 1935*, Bureau of Business Research, University of Alabama, 1939; "Measurement of Income in Small Geographic Areas," *Southern Economic Journal*, April 1942, pp. 479–492.

receipts-expenditures differences, to allocate state net farm income to counties, modifications of which are still widely used.

Another approach was made by Byron L. Johnson and Carl G. Nordquist in 1951.[2] They applied to counties a regression equation derived from an analysis of the effect of two factors on net income formation in agriculture at the state level: farm receipts from crops (x_2) and farm receipts from livestock (x_3). These were related by correlation techniques to farm proprietors' net income (x_1) reported by the NID for states. (The data on farm receipts by states and by counties were from the 1945 census of agriculture.) The correlation coefficient was 0.91, representing a coefficient of determination of 83 per cent. In addition to leaving a large percentage of the variance "unexplained" (17 per cent), the use of regression equations based on large aggregates appears to lead to large variations in the extremes, particularly in the low values. Also, the transition from economic aggregates in millions of dollars at the state level to ones in thousands at the county level raises serious problems of proportionality. The authors recognized these difficulties, as well as others connected with differences in enterprise combination and in relative cost level among counties.[3]

Income Formation in Agriculture

The concept of agricultural income in this study begins with the NID farm proprietors' net farm income. Wages paid hired labor and rents allocated farm landlords are added. Government payments are deducted. Except for the deduction of government payments, this concept agrees with the definition of agricultural income employed by the NID.[4] It is also analogous to Department of Agriculture concepts, except that the imputed value of house rent and the corresponding expenses on farm dwellings have been omitted.

Since agricultural income by this definition includes the value of food consumed but no interest charges except those paid on borrowed capital, the result is the return to labor and management of farm operators and farm labor plus the return to the capital employed in agriculture owned by farm operators and farm landlords.

[2] Byron L. Johnson and Carl G. Nordquist, *An Estimate of Personal Income Payments by Colorado County, 1948,* University of Denver Press, 1951, pp. 22–25.

[3] For an excellent bibliography on the evolution of the methodology, see Lewis C. Copeland, *Methods for Estimating Income Payments in Counties: A Technical Supplement to County Income Estimates for Seven Southeastern States,* Bureau of Population and Economic Research, University of Virginia, 1952, pp. 84–91.

[4] See Robert E. Graham, Jr., "State Income Payments in 1953," *Survey of Current Business,* Dept. of Commerce, August 1954, p. 13.

However, the concept is defective in several respects. As noted, it omits the value of farm dwellings and corresponding maintenance costs. There are also important inadequacies in the basic data prepared by the Department of Agriculture. No account is taken of the value of fuel, game, and water furnished by the farm, and food furnished by the farm is credited at farm prices rather than at retail prices.

The theory of agricultural income formation is basically the same as the theory of income formation in any competitive industry. The price mechanism allocates resources to uses that maximize the marginal return per dollar of outlay to each factor of production. The earnings of the factors—land, labor, capital, and management —reveal the profitability and hence the income of agriculture. Yearly data are not widely available on market valuations of returns to land and capital for small areas. But the relative productivity of labor, as exhibited in farm wages, is the major source of the difference in income between agriculture and other industries and of differences within agriculture between geographic areas and can be used as a measure of the differences. Since management is included as a part of farm labor, I have ignored it as a separate factor.

ANNUAL COMPOSITE FARM WAGE RATE PER HOUR

The composite wage [5] rate per hour of labor is valuable in forecasting the agricultural income of areas. First, since the biggest share (around 60 per cent) [6] of agricultural income goes to farm labor as earnings for labor, there is at least an arithmetic relationship.

Second, farm labor, as a factor of production, participates in agricultural income formation and consequently receives its marginal value product. This is the result of an automatic adjustment of the supply of farm labor to the point where the wage offers of entrepreneurs equal the marginal value of the labor. Especially in areas where cropping and other simplified forms of tenancy exist, an excess supply of labor will leave the farm labor market; the laborers will either rent farms or move into industrial and city employment. Although most farm labor is done by the farm operator or his family,[7] its cost is fully reflected in the going farm wages of the community.

[5] The composite farm wage rate per hour was used to reflect the pattern of wage payments and perquisites of geographic units. Basic data for states were obtained from the January issue of "Farm Labor," processed, Dept. of Agriculture, 1951.

[6] See D. Gale Johnson, "Allocation of Agricultural Income," *Journal of Farm Economics*, November 1948, pp. 728–734.

[7] According to the 1950 census of agriculture, there were 5.4 million farm oper-

In addition to affecting the supply of farm labor, general economic conditions affect the demand for farm products and their prices. Changes in the prices of farm products raise or lower the marginal value product, and thus the price of labor. Finally, an increase in the profitability of farming stimulates an increase in the scale of operations. Bidding for farm labor occurs along with bidding for other factors.

RATIO OF 1950 COMPOSITE WAGE RATE TO 1949 WAGE

Farm wages do not fully reflect the marginal value product of farm labor since there are contractual inflexibilities in the wage rate, so corrections are made when the wage rate is renegotiated the following year if the market is reasonably competitive. Consequently, agricultural income per hour is reflected in farm wages both in the same year and in the following year. The composite wage rate in 1950 was expressed as a percentage of the 1949 rate, so that both rates could be used as factors in preparing these estimates of county agricultural income.

RATIO OF IMPUTED COST OF NONLABOR FACTORS TO HOURLY FARM WAGES [8]

A third distinguishing factor between the income patterns of areas is the relation of costs to total receipts. Since there is little information on expenditures, relative costs cannot be known precisely. But one can obtain an imputed cost of nonlabor factors from total receipts.

I have assumed that the value of the labor input in any geographic area bears a unique relationship to the imputed value of all other factors. Because substitution tends to keep the marginal value of the dollar input of different factors equal,[9] a ratio of the cost of nonlabor factors to the hourly wage rate should be consistent with the rate of income formation, and it can be calculated. The value of the fixed inputs, and hence their implicit annual cost, depends on the level of agricultural income, and the cost of variable inputs other than labor is related to labor cost because they are substituted for it or combined with it. Consequently, the ratio can be deduced approximately from the relationship between the farm wage rate and

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ators, and in the week prior to the enumeration in 1950 there were employed on these farms 1.9 million unpaid family workers of the farm operators' families and 1.6 million hired workers on only 13.1 per cent of the farms.

[8] The procedure given is in accord with the conditions of equilibrium in a competitive industry where total cost of inputs equals total value of outputs, assuming rents and normal profits are considered as inputs.

[9] In support of this theoretical model, see Alfred Marshall, *Principles of Economics*, 8th ed., London, Macmillan, 1938, pp. 514–515.

total farm receipts per hour. The wage rate per hour was deducted from total receipts and the remainder expressed as a ratio to it.[10] A high ratio indicates a high nonlabor cost structure in the area; a low ratio, a low cost structure.

Because total farm receipts reflect both the effect of weather and a composite of price effects, so does the ratio, and through it, the income estimates. Weather has more effect on the output and gross receipts of a small area than of a large one. Price changes stemming from supply variations has little effect on income if the farm products are produced for local consumption, but a great effect if the products are staple and produced nationwide or world-wide.

Table 1 presents the values for the four estimating factors for all the states: the average composite farm wage rate for 1949 (x_2), the 1950 rate as a percentage of the 1949 rate (x_3), the ratio of nonlabor costs to the hourly wage (x_4), and the agricultural hourly income (x_1). The exact procedure used in computing the last two factors is described in the notes to the table.

TABLE 1

Values of Estimating Factors for States, 1949

Region and State	*Composite Farm Wage Rate* [a] *(cents per hour)* 1949 (x_5)	1950	*1950 Wage as a Percentage of 1949 Wage* (x_3)	*Imputed Cost of Nonlabor Factors to the Hourly Wage* [b] (x_4)	*Hourly Agricultural Income* [c] *(cents)* (x_1)
Northeast:					
Connecticut	73.4	72.1	98.2	2.90	125.6
Maine	63.3	63.3	100.0	3.46	118.1
Maryland	60.6	60.9	100.5	2.24	86.9
Massachusetts	71.1	69.7	98.0	2.78	118.5
New Hampshire	69.8	69.3	99.3	2.75	95.9
New Jersey	65.5	65.9	100.6	2.80	107.1
New York	66.5	67.0	100.8	1.89	65.0
Pennsylvania	56.1	56.6	100.9	2.76	77.9
Rhode Island	72.4	71.2	98.3	3.25	105.0
Vermont	67.9	65.5	96.5	1.55	52.0
South:					
Alabama	36.2	37.7	104.1	1.62	53.7
Arkansas	43.2	42.7	98.8	1.96	76.8
Georgia	36.4	37.6	103.3	1.83	56.0
Kentucky	43.6	44.5	102.1	2.01	81.1

(continued on next page)

[10] The method may be illustrated as follows: Assume that total farm receipts (cash farm receipts plus value of food used from the farm) for a given state was $4.00 per hour in 1949 and that the farm wage rate per hour excluding perquisites was $1.00. Then the difference would be $3.00. Dividing $3.00 by $1.00 would give a ratio of cost of nonlabor factors to labor of 3 to 1.

TABLE 1 (continued)

Region and State	Composite Farm Wage Rate [a] (cents per hour) 1949 (x_2)	1950	1950 Wage as a Percentage of 1949 Wage (x_3)	Imputed Cost of Nonlabor Factors to the Hourly Wage [b] (x_4)	Hourly Agricultural Income [c] (cents) (x_1)
Louisiana	39.8	41.2	103.5	2.02	75.8
Mississippi	37.2	37.4	100.5	1.49	47.6
North Carolina	43.7	44.3	101.4	1.53	69.0
South Carolina	33.0	33.1	100.3	2.02	55.6
Tennessee	36.9	37.1	100.5	1.83	61.6
Virginia	48.1	48.7	101.2	1.93	81.1
West Virginia	44.9	44.9	100.0	2.04	72.1
Corn Belt:					
Illinois	63.0	63.2	100.3	3.98	126.2
Indiana	57.2	58.7	102.6	3.84	129.6
Iowa	73.7	74.8	101.5	2.91	118.4
Michigan	59.4	60.6	102.0	2.22	88.9
Minnesota	70.9	69.4	97.9	1.95	96.3
Missouri	49.4	51.5	104.3	2.87	98.4
Ohio	56.8	58.4	102.8	3.14	101.6
Nebraska	70.1	71.0	101.3	2.98	118.8
North Dakota	73.4	71.8	97.8	2.98	107.7
South Dakota	73.5	71.8	97.7	2.14	93.5
Wisconsin	61.3	60.7	99.0	1.56	74.7
West:					
Arizona	63.7	62.9	98.7	2.52	131.4
California	88.5	88.4	99.9	1.68	115.3
Colorado	63.7	64.7	101.6	3.31	121.2
Kansas	70.5	69.8	99.0	3.35	121.5
Montana	72.0	73.1	101.5	1.80	106.6
Oklahoma	63.8	62.2	97.5	2.35	107.4
Oregon	91.8	92.5	100.8	1.30	92.7
New Mexico	54.1	53.1	98.2	2.72	109.6
Texas	54.9	55.4	100.9	2.28	121.8
Utah	68.9	71.4	103.6	1.78	92.1
Washington	94.8	93.3	98.4	1.73	110.0
Other:					
Delaware	61.0	59.7	97.9	4.49	124.9
Florida	46.3	46.7	100.9	3.10	122.6
Idaho	76.0	75.8	99.7	1.33	128.1
Nevada	68.4	69.6	101.8	2.63	148.2
Wyoming	70.5	69.4	98.4	1.83	77.6

[a] From "Farm Labor," processed, Dept. of Agriculture, January 12, 1951, pp. 11–12.

[b] This ratio was obtained as follows: The total farm receipts (cash and food consumed), as estimated by the Department of Agriculture in the *Farm Income Situation* (June 1951) was divided by the total hours of labor required by all farm enterprises in the state. The result was the total farm receipts per hour of labor. From this was deducted the 1949 composite wage rate. The difference remaining was then divided by the 1949 wage, resulting in the ratio as given for the respective states. For example, according to calculations, 366.8 million hours of labor were required by all the farm enterprises in Virginia in 1949. The Department of Agriculture esti-

(notes continued on next page)

Notes to Table 1 (continued)

mates show $516.9 million of total farm income, which results in 141 cents per hour of labor. To obtain the ratio of the imputed cost of nonlabor factors to the hourly wage, the composite farm wage (48.1 cents per hour) was deducted, leaving 92.9 cents per hour. The hourly wage rate was then divided into this residual, giving a ratio of 1.93.

[c] This column was derived by dividing agricultural income by the total hours of labor required on all farm enterprises. For example, Virginia agricultural income per hour was obtained by dividing agricultural income, as previously defined ($297.5 million), by the 366.8 million hours of labor required in Virginia. The quotient (81.1 cents) is agricultural income per hour.

Estimating County Agricultural Income

The basic method used here to estimate the agricultural income of counties involves the application of a regression equation of state relationships to counties. By regression analysis, the coefficients of factors associated with agricultural income per hour of labor of homogeneous groups of states for the census year 1949 were determined. After they were adjusted by correlation methods to the groups of states that are most alike in types of farming and associated political and social conditions, the state regression coefficients were applied to values of the corresponding independents (or variables) for counties to prepare the county estimates of agricultural income per hour for 1949. Multiplying the hourly income of a county by the total hours of farm labor required on all the farm enterprises in the county gave its total agricultural income. This procedure assumes that regression coefficients calculated for states with similar types of farms and reasonably similar political, social, and cultural institutions may be validly applied to independents that are similarly defined at the county level.[11] Estimates for intercensal years were based on income formation ratios for 1949 adjusted to the economic conditions of the particular year.

CORRELATION ANALYSIS OF REGIONS

Since the method of this study requires a regional treatment in order to reflect types of farming and institutional factors, four groups of states were analyzed: the South, the Northeast, the Corn Belt, and the West.[12] The results for the first three regions were statistically significant (see Table 2). The highest coefficient of determination was obtained for the Corn Belt (91 per cent) and the lowest for the rather unlike states in the Northeast (70 per cent). The standard error of the estimate of agricultural income

[11] The validity of this assumption is examined below.

[12] These regions do not correspond to the Census Bureau regions. For a list of the states included in each of these regions, see Table 1.

TABLE 2

Comparison of Regression Coefficients, Beta Coefficients, and other Correlation Results for Three Groups of States, 1949

FACTORS RELATED TO x_1	SOUTH [a]		CORN BELT [a]		NORTHEAST [a]	
	Net Regression Coefficient	*Beta Coefficient*	*Net Regression Coefficient*	*Beta Coefficient*	*Net Regression Coefficient*	*Beta Coefficient*
x_2, composite farm wage rate 1949, cents	1.955	0.766	1.025	0.504	1.645 [b]	0.368
x_3, 1950 farm wage as percentage of 1949 wage	0.847 [c]	0.117	1.898	0.255	1.751 [c]	0.107
x_4, ratio of imputed cost of nonlabor factors to the hourly wage	26.359	0.451	20.114	0.895	32.767	0.730
Constant A [d]	−146.7		−208.0		−274.8	
R^2	0.90		0.94		0.80	
$\overline{R^2}$	0.85		0.91		0.70	
$\overline{R}$	0.92		0.96		0.84	
$\overline{S}$	4.62		5.37		13.28	
Standard error, Per cent [e]	7.0		5.1		13.9	

[a] See Table 1 for the states included.
[b] Almost significant at the 5 per cent point by the F-ratio test.
[c] Not statistically significant by the F-ratio test.
[d] For an explanation of the symbolism and methods used, see Mordecai Ezekiel, *Methods of Correlation Analysis,* Wiley, 1930, pp. 121–122 and 174–178.
[e] Standard error expressed as a percentage of the mean.

per hour varied from 4.6 cents to 13.3 cents for the South and the Northeast, while the percentage standard error varied between 5.1 and 13.9 per cent, the Corn Belt and the Northeast being the extremes, respectively. Total agricultural income for geographic areas can therefore be estimated with even less error because of the effect of the total labor input when the estimated hourly agricultural income is inflated to total agricultural income. After agricultural income per hour was multiplied by the total hours of labor required, the results were compared with the NID estimate. The percentage mean discrepancy for each group of states was:

South	4.8
Northeast	9.8
Corn Belt	3.3
West [13]	6.1

[13] The results were not statistically significant, but the low standard error produced a satisfactory mean discrepancy. The equation is as follows: $x_1 = 249.8 + 0.0012\ x_2 - 1.619\ x_3 + 10.637\ x_4$; $R^2 = 0.48$; $\overline{R}^2 = 0.25$, the error of estimate being 10.5 cents.

These discrepancies are satisfactory, considering the limited data available. The results are comparable to sampling errors found by actual field surveys of net farm income in Iowa.[14] According to results published in 1942, the sampling percentage of average net cash income of farm operators varied between 8.8 per cent and 15.1 per cent for type of farming areas, with 5.9 per cent for the state estimate.

For the South, the discrepancy of the estimate for 1949 from NID estimates varied from −6.1 per cent for North Carolina to +10.3 per cent for West Virginia, the mean discrepancy being 4.8 per cent. With the exception of West Virginia's 10.3 per cent, the individual state errors cluster about the mean discrepancy quite closely, indicating a high degree of success in applying the regression equation.

PREPARATION OF COUNTY ESTIMATES [15]

In preparing estimates of agricultural income of counties, the results must represent the standing of the county in net income in relation to other counties in the region. I think the regression method employed here meets this requirement sufficiently for practical use of the estimates. But in order to apply regression coefficients from state relationships to preparation of county estimates, two problems must be solved: the theoretical basis for the application of regression coefficients from larger geographic areas to smaller areas must be formulated, and a numerical series of independents for counties comparable with those of the states must be secured.

Regression relationships of larger areas may be validly applied to smaller ones because the input-output function in production and income formation is not dependent on the size of the geographic unit. This assumption becomes of unlimited applicability even between firms and geographic units when rents and profits are included as a part of the cost, as they are in x_4 (the ratio of the imputed cost of nonlabor factors to the hourly wage). Because this factor reflects input combinations (and also weather and price influences through total farm receipts) in dollars, the problems arising from variations in both enterprise and expense mix are avoided because all are in the same unit of measure.

The second major problem, that the variables must be equally available for both states and counties, was solved sufficiently for

[14] Raymond J. Jessen, *Statistical Investigation of a Sample Survey for Obtaining Farm Facts*, Iowa State College of Agriculture and Mechanic Arts, Research Bull. 304, June 1942, p. 14.

[15] The method is tested with Virginia counties because the basic labor requirements were worked out for Virginia counties in 1953. Clerical help was too limited to perform an additional set of calculations for other states.

the purposes of this study. x_2 (composite wage rate) and x_3 (1950 wage as a percentage of the 1949 wage) were not available by counties. Both factors, however, were deduced from data provided by the Department of Agriculture on April 1950 composite wage rates for economic areas.[16]

In order to compute x_4, the ratio of the imputed cost of nonlabor factors to the hourly wage, estimates of total farm receipts by counties [17] were built up from census data, Department of Agriculture statistics, and from data from the crop reporting service in Virginia. The total labor requirements for all enterprises of each county were computed by applying the labor input per unit [18] to all acres of crops grown, livestock on farms, and livestock products. Total labor requirements for each county were divided into the total farm receipts to obtain farm receipts per hour. From this point, the calculation of x_4 for counties employed the same procedure as for states. The resulting county ratio for x_4 is therefore analogous to the state ratio for x_4.

The values obtained for x_2 and x_3 by economic areas made up of several counties, however, are not directly analogous to these factors at the state level, but meet the requirements sufficiently. It would be preferable to have these factors for counties, but the error made from employment of area measures probably does not materially affect the county results. Since economic areas were defined in terms of economic factors, selected to meet a high degree of homogeneity, farm wages that result from them are likewise expected to be fairly homogeneous throughout the area.[19]

[16] Data on farm wage rates by economic areas are available from Special Statistics Branch, Agricultural Marketing Service, Department of Agriculture. For definition of economic areas, see Donald J. Bogue, "State Economic Areas," Dept. of Commerce, processed, 1951, pp. 1–9.

[17] Cash farm receipts in reasonably complete form are prepared by the cooperative crop reporting service of some states. In making application of the regression coefficients to a sample of twenty Virginia counties, however, it was necessary to adjust census reports of cash farm receipts to Department of Agriculture estimates by a ratio method, adjusting each enterprise independently to reflect a maximum for specialization. Estimates of value of farm products consumed on farms had to be built up approximately from the census of 1945.

[18] Labor requirements for most farm enterprises by states may be obtained from Department of Agriculture reports as follows: Reuben W. Hecht and Keith R. Vice, *Labor Used for Field Crops*, Statistical Bull. 144, June 1954, and Reuben W. Hecht, *Labor Used for Livestock*, Statistical Bull. 161, May 1955. For greater detail on labor requirements by type-of-farming areas, the applicable section of *Crop Production Practices: Labor, Power and Materials by Operation*, F.M. 92, 1952–1953 is recommended.

[19] There is no good substitute for farm wage data by counties, but the area wage data gives a good idea of the potentialities of the method. The use of the results as estimates can be justified under present conditions because nothing better is available.

The results of applying the regression equation to preparation of agricultural income for twenty counties, taken as a sample of Virginia agriculture, are shown in Table 3.[20] This table shows the 1947

TABLE 3

Comparisons of Estimates of Agricultural Income for Twenty Virginia Counties Prepared by Different Methods, 1947 and 1949

Area	1947 Ratio Estimate	1949 Estimates: Allocation Estimate	1949 Estimates: Regression Estimate	1949 Total Receipts [a]	1949 Income Formation Ratios [b]
	(thousands of dollars)				(per cent)
Accomac	$11,325	$ 9,788	$ 9,699	$ 17,490	55.5
Albermarle	4,097	2,735	3,818	6,453	59.2
Alleghany	603	416	574	948	60.5
Amelia	2,237	2,816	2,356	4,053	58.1
Amherst	2,437	1,888	1,857	3,188	58.2
Appomattox	1,853	1,787	1,573	2,699	58.3
Arlington	56	34	70	121	57.9
Augusta	9,820	7,893	9,379	16,142	58.1
Bath	990	661	843	1,414	59.6
Bedford	4,294	4,473	4,599	7,899	58.2
Bland	1,151	1,058	1,091	1,926	56.6
Botetourt	2,919	2,728	2,807	4,828	58.1
Brunswick	5,091	4,608	3,979	6,625	60.1
Buchanan	1,298	1,734	1,335	2,219	60.2
Buckingham	2,530	2,566	2,181	3,772	57.8
Campbell	3,755	3,432	3,329	5,728	58.1
Caroline	2,251	2,394	2,353	3,984	59.1
Carroll	3,234	4,118	3,570	6,358	56.1
Charles City	872	878	833	1,558	53.5
Charlotte	3,516	2,845	2,984	4,974	60.0
Total	$64,329	$58,852	$59,230	$102,379	58.2
Counties as an area [c]	$64,335	$58,852	$59,231	$102,376	57.9
State	$322,200	$297,500	$297,500	$516,900	57.6
Counties as percentage of state	19.97	19.78	19.91	19.81	

[a] Includes cash farm receipts plus value of products consumed on farm where produced.

[b] Regression estimate of agricultural income as a percentage of total receipts.

[c] Estimate prepared by method shown for twenty counties treated as an area.

[20] The calculation of the regression estimate will be illustrated for Accomac County, Virginia. Since Virginia was included in the South, the applicable regression equation is $x_1 = -146.7 + 1.955\ x_2 + 0.847\ x_3 + 26.359\ x_4$.

The values of the independents for Accomac County are: x_2 equals 52.2; x_3, 101.1; and x_4, 3.54. Substituting in the equation: $x_1 = -146.7 + 1.955\ (52.2) + 0.847\ (101.1) + 26.359\ (3.54)$. $x_1 = -146.7 + 102.1 + 85.7 + 93.3 = 134.4$ cents per

estimates, 1949 estimates prepared by two methods, total farm receipts for 1949, and the ratio of agricultural income formation for 1949. The 1949 regression estimate was prepared from the regression equation for the South for 1949 by application of the county variables discussed above. The 1949 allocation estimates was prepared by deducting from total farm receipts all farm expenses, both fixed and variable, which were calculated by numerous allocation procedures, some based on data given in the 1950 census of agriculture and such prior censuses as were necessary to fill the gaps. The results are obviously only rough approximations and are useful only in general comparisons with the regression estimate for 1949.

The regression estimates are preferable to the estimates prepared by allocation procedures from several standpoints. First, the allocation estimate is subject to error due to the mixed use of farm capital in some counties. In practically all farm counties, off-farm work, mainly in towns, is performed by farmers and farm laborers. Part of the investment in farm buildings, farm automobiles, and trucks is chargeable to off-farm work. This is also true of the maintenance costs on all three items, and of gasoline, oil, and other operating costs on farm trucks and automobiles. To my knowledge, this mixed use of farm capital is ignored by allocation procedures currently in use. The regression procedure avoids this problem because the estimates are based on the value of inputs of labor and its relation to other factors of production employed solely in agricultural production.

Second, the income formation ratios for 1949 conform more closely to a normal curve than the ratios from the allocation procedures. Despite the fact that the regression estimates of agricultural income per hour for twenty counties varied between 49 cents and 152 cents per hour, the income formation ratios showed a coefficient of variation of less than 3 per cent, compared to 20 per cent for the allocation estimates. The abnormality of the latter estimates is further shown by the relatively large negative skewness. Theoretically, the ratio of income formation should not vary greatly between counties, since under competitive conditions, capital and other resources tend to move to the more profitable counties, correcting most of the differential.

Third, relative variations between net income from the regression estimates and gross income conform more closely to the generally

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hour. The total 134.4 cents per hour gives $9,917,000, which required a downward adjustment of 2.2 per cent to $9,699,000, in order to be in line with the twenty county share of the state total. This 2.2 per cent discrepancy happens also to equal the error made in estimating the state total from the regression equation.

accepted theory of expected variations than variations between net income from allocation procedures and gross income. Net income estimated from regression coefficients showed a coefficient of variation of 87 per cent compared to 83 per cent for net income estimated from allocation procedures. The coefficient of variation of gross income to which both are comparable was 81 per cent. Thus, the relative variability of net income derived from regression estimates was substantially greater (7 per cent rather than 2 per cent) and therefore in accord with theoretical expectations.

In the preparation of estimates of agriculture income of counties for 1947, a simple procedure was employed. The 1949 income formation ratio for each county (last column of Table 3) was adjusted for the difference between the state income formation ratio for 1947 and 1949, and the result was applied to the corresponding county farm receipts for 1947. This procedure is based on the assumption that differentials between county income ratios remain fairly constant during a period of two or three years. New enterprises are accepted slowly on a wide scale. Shifts in the pattern of old enterprises in response to changes in prices do not seriously disturb the relationship, because resources are fairly completely utilized by enterprise substitutions.

Another problem is the relationship between the prices received by farmers and prices paid by farmers (the parity ratio). A change in this affects directly the level of income formation in geographic units. Between any two years a rise in the parity ratio raises the rate at which income is formed; a fall lowers it. Such a change is reflected in the NID estimates of state incomes and shows up clearly in income formation ratios for the respective states. The adjustment of the county income formation ratios was introduced to handle this problem. The income formation ratio of Virginia for 1947 was expressed as a percentage of the 1949 ratio. Since the ratio in 1947 was 59.3 per cent and in 1949, 57.6 per cent, the percentage relationship was 103. Each county income formation ratio for 1949 was raised by 3 per cent to obtain the estimated income formation ratio for 1947 on the assumption that any regional differences in the parity ratio effects were adequately reflected in the respective state income formation ratios.

Application of the same percentage adjustment to each county ratio of the census year causes the absolute effect of the adjustment to vary with the size of the county ratio. Thus, counties with low income formation ratios (high cost ratios) receive comparatively less adjustments from changes in the parity ratio than the counties with high income formation ratios. The result is in accord with the

observed tendencies for counties with high ratios to be more volatile to inflation and deflation than counties with low income formation ratios. The adjusted ratios were applied directly to total farm receipts of counties for 1947 to obtain a net income estimate for 1947 (first column of Table 3). The main details of the step involved in preparing the estimates are given in Table 4.

The income formation ratio for 1947 was obtained by multiplying the 1949 ratio by 1.03, derived from the state relationship between the two ratios (see the last lines in Table 4). Total farm receipts were estimated from Department of Agriculture data by procedures analogous to those used for the census year 1949, except the nearest census distributions of receipts was the basic method for allocation of the Department of Agriculture estimates of receipts for intercensal years. The estimates of agricultural net income were then prepared by applying the 1947 ratios in the second column to total farm receipts.

The method is a rapid but crude procedure by which to obtain estimates for intercensal years with a minimum of labor. The income formation ratio for 1947 was 3 per cent higher than for 1949, reflecting mainly the difference in the parity ratio. Each county income formation ratio obtained by the more precise regression methods applicable to census years was increased by 3 per cent. Thus, the ratio for Accomac county was raised from 55.5 per cent to 57.2. Total receipts in 1947 were $19,799,000; in 1949, $17,490,000. Therefore, the corresponding estimates of net income were $11,325,000 and $9,699,000. In other words, an increase in total receipts of $2,309,000 produced an increase in agricultural income of $1,626,000. The method will practically always produce estimates for intercensal years that vary in the same direction as total receipts, as do all twenty counties in Table 4. Other methods tried by the writer failed to do so consistently. Obviously, changes in taxes and contract interest, the only two overhead charges rigidly fixed in the concept of agricultural income here used, are not fully reflected by this method. But the effects are minor in most counties. However, if desired, a separate adjustment could be attempted for both items. Thus, the results, although rougher than estimates by regression equations (which could also be computed for intercensal years), are restricted to uses where refinements in the series are not required. The method should be a valuable aid, however, in providing county estimates of agricultural income cheaply until better methods are developed.

In conclusion, I believe that the regression methods that have been tested experimentally for one census year (1949) and the one

TABLE 4

Agricultural Income for Twenty Virginia Counties for 1947

Area	*Income Ratio 1949*	*Income Ratio Corrected to 1947*	*Total Farm Receipts 1947*	*Estimated Agricultural Income 1947*
	(*per cent*)		(*thousands of dollars*)	
Accomac	55.5	57.2	$ 19,799	$ 11,325
Albermarle	59.2	61.0	6,716	4,097
Alleghany	60.5	62.3	968	603
Amelia	58.1	59.8	3,741	2,237
Amherst	58.2	59.9	4,069	2,437
Appomattox	58.3	60.0	3,089	1,853
Arlington	57.9	59.6	94	56
Augusta	58.1	59.8	16,421	9,820
Bath	59.6	61.4	1,612	990
Bedford	58.2	59.9	7,168	4,294
Bland	56.6	58.3	1,975	1,151
Botetourt	58.1	59.8	4,881	2,919
Brunswick	60.1	61.9	8,224	5,091
Buchanan	60.2	62.0	2,093	1,298
Buckingham	57.8	59.5	4,252	2,530
Campbell	58.1	59.8	6,279	3,755
Caroline	59.1	60.9	3,696	2,251
Carroll	56.1	57.8	5,596	3,234
Charles City	53.5	55.1	1,583	872
Charlotte	60.0	61.8	5,689	3,516
Total				$ 64,329
Counties as an area	57.90	59.60	$107,945	$ 64,335
State	57.55	59.28		322,200
Counties as percentage of state				19.97
State ratio of 1949 to 1947		1.03		

intercensal year (1947) point the way toward reasonably reliable estimates of agricultural income of counties. The methodology may need further refinements for some purposes. In any event, the procedure emphasizes the high importance of farm labor to income formation in agriculture. Considering the inadequate emphasis given by the Department of Agriculture to the statistical coverage and reporting of farm wage rates of counties, the good results obtained even with an inadequate wage series show that the deficiencies in such a vital set of agricultural data should be corrected. Equally obvious, both the further refinement of the methods presented here and their efficient use in the future depend greatly on accurate data of unit labor requirements of farm enterprises, which data happily have been receiving increased emphasis from the Department of Agriculture in recent years.

COMMENT

ERNEST W. GROVE, Agricultural Marketing Service, Department of Agriculture

For a number of years I have had intimate working contact with national and state estimates of agricultural income. I know their weaknesses, the numerous problems encountered in their development, and the large amount of work needed for their improvement, especially at the state level. Under the circumstances, I cannot quell a feeling of impatience and frustration when I learn of the large volume of work being done in the allocation of these inadequate state estimates on a county basis.

Since last fall the Department of Agriculture has been reappraising its national estimates of farm production expenses and developing state estimates of production expenses. These will, in turn, permit reinstatement of the series on net farm income by states. The National Income Division of the Department of Commerce is also reappraising and revising its state income payment series, and we have been cooperating in revision of the agricultural components. Therefore, state estimates both of total and of agricultural income may shortly be available on a more satisfactory basis than hitherto.

I also have an instinctive distrust of mechanical formulas of the type proposed by John L. Fulmer. If, however, county estimates are really required, then the difficulties of ordinary allocation procedures are all too evident in the case of agricultural income. Any formula or method that can either improve the accuracy of county agricultural income estimates or reduce the work required with no loss in accuracy will clearly be worthwhile. In what follows, I shall try to shed my natural biases and consider Fulmer's method from that standpoint.

Although I cannot be sure, I do not think Fulmer's formula is properly described as a work-saving device. For example, his method requires as a first step the multiplying out of all the unit labor requirements by acreage, production, or numbers of each commodity to get total man-hours of farm labor required in each county and state. If I am right in concluding that the formula is not a short-cut, then it must stand or fall on its merits as a device for improving the accuracy of county agricultural income estimates.

I shall discuss each of the independent variables in turn. I have no quarrel with x_2, the composite hourly cash wage. Net agricultural income represents the net income of farm operators plus farm

wages, and it is not unreasonable to suppose that a total may be correlated at least to some extent with one of its parts.

I doubt if x_3, the index of wage change, is a significant variable in its own right. At the county level, the absolute change in the composite hourly wage for the state as a whole had to be used for each county, and the result is that x_3 turned out to be almost a constant at the county level and insignificant as a means of differentiating among the various counties as to size of agricultural income.

The independent variable x_4 is what Fulmer refers to as the ratio of wages to other inputs. It was derived, however, by dividing total gross receipts per hour by the hourly cash wage, and subtracting 1 from each of the resulting ratios. The final subtraction step had no effect on x_4 as a variable in the regression analysis, so it may be considered simply as the ratio of gross receipts to cash wages.

Although I do not have the information necessary to prove this, I suspect that the ratio of gross receipts to cash wages varied among the states in much the same manner as gross receipts alone. Or perhaps it varied more nearly like gross receipts minus cash wages. But in either case, if the index of wage change were left out of the analysis, then agricultural income would be correlated (1) with cash wages paid and (2) with gross receipts—all expressed on an hourly basis. Reduced to its simplest terms, therefore, I think Fulmer's analysis correlates agricultural income with one of its parts and with the gross total of which it is a part.

Fulmer provides a rationalization of his procedure, largely in terms of the assumed working out of competitive forces in agriculture. Without going into the pros and cons of this underlying theory, I think that a considerable degree of correlation is to be expected in this type of analysis. Yet I cannot share Fulmer's confidence in the predictive value of his formula at the county level.

He reports that the coefficients of correlation were statistically significant for three of the four regions analyzed. But correlation coefficients that are significantly greater than zero are not enough for this type of analysis. With only eleven observations for the southern states, and with three independent variables used, my own feeling is that the correlation ought to have been practically perfect at the state level before the resulting regression could be used with any confidence as a predictor of agricultural income at the county level. When there are so few observations, the theoretical basis for the relationship also should not be subject to any question.

I do not think that Fulmer's formula has met either of these tests. Nevertheless, he has used it to estimate agricultural income in

twenty counties of Virginia, and in about half of these counties estimates based on the regression formula are significantly different from estimates derived by the usual allocation procedures. Fulmer cites the greater uniformity in "income formation ratios" as an indication of the superiority of his regression estimates. But there is no reason to suppose that the ratio of net to gross income is the same, or nearly the same, in the various counties. The possibility —indeed, the probability—of differences in this ratio is the essence of the problem. Ordinary allocation procedures may lead in some cases to exaggerated differences in the ratios of net to gross income. But may not the regression method tend to understate such differences?

On the whole, my conclusion must be that the formula is interesting and provocative, but certainly far from having been proved. But my suspicions concerning Fulmer's formula do not prevent me from concluding that it may be just about as good as any other method, if county income estimates *have* to be made. It may even be superior to the usual methods, as Fulmer claims. But that, I think, is the proposition that remains unproved, and personally I do not believe it.

Any method of allocating agricultural income by counties remains somewhat suspect until its validity can be proved beyond question. And it is not likely that the validity of Fulmer's method or any other method will be fully established until its results can be tested against independent and reliable data on agricultural incomes in the counties.

Where are we going to get these check data? So far it seems to me that the very basis for proof has been lacking.

ROBERT H. JOHNSON, University of Iowa

My comments on John L. Fulmer's paper fall into three categories: those related primarily to the data problems, those related to the theoretical framework, and an evaluation of the results of the regression equation technique employed.

Data Problems

So far as I can determine from Fulmer's paper, the state agricultural income total being allocated by counties reflects cash receipts from farm marketing plus the value of home consumption. Apparently, there is no adjustment for the fact that cash receipts may be greater than, or less than, income produced in any given time period. The National Income Division of the Department of Com-

merce state estimates, employed as a control figure, include the value of changes in farm inventories. Thus, there is a conceptual gap between the agricultural income being allocated by Fulmer and the similar measure employed by the NID.

Although there is no direct, easy solution to this problem, the discrepancy may be important and the value of changes in inventory may not be spread uniformly among counties. Hence, a state control figure may be unsatisfactory. In a two-stage agricultural economy, such as Iowa, it is not uncommon for inventories of some products (feed grains) to be changing in one direction, while the inventories of other products (livestock) are moving in the opposite. As some counties are predominantly specialized in one or the other of these products, inventory changes, by counties, cannot be viewed as proportionate to change in inventories in the state as a whole.

While the choice of regional boundaries is apparently in some degree arbitrary, placing in the same region such dissimilar agricultural economies as those of Kansas and Oklahoma, on the one hand, and Oregon and California, on the other, or Iowa and North Dakota, leaves much to be desired. Fulmer's four-constant regression equation approach creates the dilemma that to obtain statistically significant measures of correlation the number of observations (states) must be kept fairly large, but to get enough states in each regression, the regions must be so large as to cast serious doubts on the homogeneity of their agricultural processes and institutions.

In the absence of detailed county information on labor input, Fulmer's method relies on standard ratios for each state.[1]

Are such averages capable of reflecting the intrastate differentials in income formation in agriculture? For example, the average man-hour per acre ratio for corn in Iowa was 8.8 in 1950; in the adjacent states of Missouri and Minnesota the ratios were 14.3 and 10.8, respectively. Yet, in the southern border counties of Iowa, the input requirements are probably much closer to those of Missouri than to the state-wide average in Iowa. And the same condition probably prevails on the northern border.[2]

The inadequacy of state-wide ratios of labor requirements is somewhat obscured by the character of the estimating equation, in which labor hours required enters in as a divisor (in the computation of gross receipts per man-hour of labor input), and as a multiplier (of net income per hour of labor input). Thus, it seems to

[1] In Virginia, separate ratios were available by crop districts.

[2] Labor requirement ratios for Iowa and adjoining states from Reuben W. Hecht and Keith R. Vice, *Labor Used for Field Crops*, Dept. of Agriculture, Bureau of Agricultural Economics, Stat. Bull. 144, June 1954, Table 3, p. 11.

make little difference in the final estimate of county income what figures are used for "labor required." Using the value of the coefficients for estimation of agricultural income in Accomac County, Virginia, for example, if labor input is arbitrarily reduced 18.7 per cent, from 7,399 thousand man-hours (Fulmer's estimate) to 6,000 thousand man-hours, the total agricultural income estimate for this county is reduced by only 2.2 per cent. A regression equation that yields estimates so insensitive to variations in values of the independent variables may contain more internal offsets than is consistent with the proper degree of differentiation among county income levels.

The whole estimating procedure would probably be improved if the "composite wage rate," x_2, could be obtained by counties rather than by "economic areas" composed of several counties. For example, in some of these economic areas, strictly rural counties are combined with other counties containing major industrial employers with effectively unionized employees. It would be surprising if farm wage rates were uniform in such nonhomogeneous labor markets. Again, however, the internal offsets in Fulmer's regression equation minimize the net results of differences in farm wage rates, including any errors arising from the use of average rates not typical of particular counties. For example, if the wage rate used in Fulmer's computation for Accomac County is arbitrarily reduced by, say, 20 per cent (from 52.2 to 41.8 cents per hour) the total agricultural income estimate for the county is *increased* by 7.2 per cent, from $9,917 thousand, to $10,633 thousand.

The use of the state average rate of change in the ratio of income formation as an "adjustor" for each county may give distorted results. If the product mix and the cost structure are highly uniform in all counties, the results from this method of preparing intercensal year estimates are probably as good—or as bad—as the estimates for census years, or the years for which the regression equations are computed. But the ratio of prices received to prices paid by farm producers does not change uniformly for all types of producers. Over short periods (and it is the short run which is relevant here), income per dollar of gross receipts may be changing at different rates for producers of, say, feed grains and producers of cattle and hogs. If there is substantial specialization, by counties, the application of a state-wide rate of change in the income formation ratio gives distorted results.

The preparation of intercensal year estimates would be improved by using a composite rate of change in each county. This composite would reflect the change in the income formation ratio for each

major agricultural product, weighted according to the composition of output in each county. Admittedly, this is a more complicated, time-consuming process than that employed by Fulmer. But the results are logically defensible.

Conceptual Framework

Two assumptions appear basic to Fulmer's technique. First, the factors of production must be combined in such proportions that marginal returns per dollar of outlay are equated for all units of input—land, labor, capital, and management. Second, in order to apply the constants and regression coefficients derived from state data for regions to the estimation of county agricultural income, the independent variables must have the same meaning when they represent counties as when these independent variables represented the several states composing the regions.

I think it is particularly hazardous to rely on the farm wage rate as a predictive device in the estimation of agricultural income by counties on the ground that "the biggest share (around 60 per cent) of agricultural income goes to farm labor as earnings for labor." Available wage rate data are for explicit wage payments to hired workers, which account for from 15 per cent to 20 per cent of total factor earnings in agriculture.[3] The 60 per cent return to labor is from two-thirds to three-fourths residual income. It is improbable that "workers" shift from the status of laborer to that of entrepreneur with sufficient ease, and in adequate numbers, to make the explicit wage payment for agricultural laborers a reliable measure of the rate of residual labor earnings from agriculture. Immobilities attributable to inadequate capital, knowledge of alternatives, skills required for farm management, and the limited supply of land available for laborers-turned-tenant raise serious questions on the efficacy of the price mechanism as a device for the equalization of factor rates of return—even in a competitive industry.

However, Fulmer's regression equation contains certain compensating features, since the composite area wage rate appears as a numerator in x_2, and in both the numerator and the denominator in x_4. *Ceteris paribus,* a lower wage rate will decrease the value of x_2 and increase the value of x_4. Only if gross receipts per hour of (standard) labor input and the money wage rate of hired labor change in the same ratio will the value of x_4 be constant.

In terms of the theory of regional income formation, the most

[3] *National Income Supplement, 1954, Survey of Current Business,* Dept. of Commerce, Tables 13 and 15.

serious defect in Fulmer's technique is his use of the independent variable, x_4, computed by counties with a coefficient derived from a multiple correlation analysis employing data for a number of not very homogeneous states. Basically, x_4 is a computed "independent variable," derived by dividing gross receipts per hour of (standard) farm labor minus the wage rate for agricultural hired labor, by the wage rate. Thus, x_4 is a ratio of nonlabor costs of production (including rents, interest, and imputed returns to management) to the hourly earnings of hired labor. But the x_4 variable is *not* a ratio of other *factor* costs to labor costs, because the numerator includes all outlays, whether for factor costs or for purchases of intermediate goods. And this characteristic is true of both the state and of the county values of X_4. *But, unless the internal structure of the x_4 variable is the same at both levels, i.e. unless the proportion of x_4 accounted for by intra-area purchases of intermediate goods is the same for states and counties,* the application of the state coefficient will not—even conceptually—yield a measure of *factor* earning accruing to farm labor and property residing in the particular county.

In two counties having the same values of x_2, x_3, and x_4—and hence the same values for net income per hour—the ratio of net agricultural income to gross receipts may be very different, depending upon the proportion of the x_4 representing returns to factor owners other than hired labor compared with the share of x_4 representing purchases of intermediate goods which may or may not give rise to factor earnings *from agriculture, in the particular counties* for which estimates were being made.

In the larger regions from which the regression coefficients were computed—and even in a state as a whole—the ratio of factor to nonfactor costs embodied in the x_4 may be characterized by uniformities not present in the ratio for individual counties. For one thing, sales by one farm unit of, say, feeder cattle, feed grains, or hay, to another farm unit may be intraregional or intrastate, but are much less likely to be intracounty. Thus, x_4 may represent varying amounts of *factor returns* to other than hired labor, depending upon the relative importance of intermediate purchases contained in the ratio. In addition to the tendency for transactions with units outside the area to increase as the size of the economic area is reduced from region to state to county, the stability of mass data for an area as large as a state can be expected to make for a greater degree of uniformity in the composition of x_4 for different states, than for different counties, even in the same state.

Evaluation of the Estimates

For the twenty Virginia counties for which Fulmer has computed agricultural income by his regression equation with coefficients derived from eleven southeastern states, the ratio of income formation to gross receipts is remarkably stable. Fulmer finds confirmation of the validity of his estimating procedure in the consistency of the ratio. I do not share his assurance that the uniformity of the income formation ratios from county to county demonstrates the superiority of his regression equation technique over the somewhat cumbersome, less formally precise allocation techniques widely employed in the preparation of county agricultural income estimates.

In his own estimates of county agricultural income by the allocation method, the range of the income formation ratio (excluding Arlington County) is from about 42 per cent of gross receipts to almost 80 per cent of gross receipts, or approximately a 1 to 2 ratio. In estimates of agricultural income for the ninety-nine counties of Iowa for 1939 (using concepts essentially the same as those employed by Fulmer), I found that income formation as a percentage of gross receipts ranged from about 44 to 74 per cent, a ratio of 1 to 1.7. As might have been expected, the lower limit of the range was observed in a county specializing in the fattening of purchased feeder cattle, primarily with purchased corn; the upper limit, in a county located in the "cash grain" area. Even among states, agricultural income formation as a percentage of gross receipts ranged from about 30 to almost 70 per cent, or a ratio of 1 to over 2.

The uniformity of Fulmer's county ratios of agricultural income formation to gross receipts is attributable to several features of the estimating procedure. As already noted, the x_4 independent variable does not reflect the substantial differences in the proportions of factor to nonfactor costs. By applying the coefficient computed from state data to the independent variable based on county data, real county-to-county differences in income formation ratios may be obscured. Secondly, substantial differences in the values of the wage rate variable and in the hours of labor required have little effect on the final income estimates because of internal offsets that, together, comprise powerful "built-in equalizers" of the income–gross-receipts ratio. The labor input requirements seem to be particularly powerful in this respect. Despite a broad range in the estimates of net income per hour of farm labor (roughly a 3 to 1 ratio for the twenty Virginia counties) the multiplication of these hourly

estimates by labor requirements eliminates most of the differentials in the income–gross-receipts ratios.

Finally, on Fulmer's statistical technique, the regression equation comprises three "independent variables." Yet, one of these variables (x_2, the hourly wage rate) enters directly into the computation of the other two. I am not sure in what sense the three variables can be said to be *independent*. Certainly they are not independent of one another. It may also be questionable whether or not a coefficient of determination (R^2) computed from such an equation can be evaluated in terms of the usual criteria.

EDWARD F. DENISON, Department of Commerce

My brief comment is confined to the theoretical basis offered by John L. Fulmer for expecting a high positive correlation among counties between the average wage rate and the value of total factor income per man-hour worked.

Customary theoretical analysis would assume the existence of geographical mobility of farm labor, and hence a tendency for wage rates (and the marginal value product of labor) to equalize among the counties of a state. A similar tendency toward equalization of interest return would be assumed, while the entire differential return resulting from differing qualities of the land and from locational factors would, following the Ricardian analysis, appear in differences among counties in the amount of economic rent. Statistically, economic rent appears in the income data as either rental income or farm proprietors' income.

In equilibrium, therefore, according to customary economic theory, the labor return per unit of labor would be equal in all counties (except for the influence of non-wage-rate advantages and disadvantages of the location) while the nonlabor return would be unequal, and no stable relationship between labor and nonlabor returns would be anticipated. The differences in wage rates among counties upon which Fulmer relies would, from this approach, be presumed to result from immobility and other imperfections in the labor market and to bear no necessary relation to nonlabor returns. It seems to me that Fulmer needs to supply a reconciliation of his viewpoint with the conclusions reached by other theorists.

JOHN A. GUTHRIE, State College of Washington

John L. Fulmer has prepared an interesting and provocative paper on a difficult subject. He has used some ingenious methods of

obtaining an estimate of agricultural income. His approach is also intriguing because he uses economic theory as a basis for arriving at his results. However, he makes a number of assumptions that strike me as being questionable, particularly when his theoretical model is applied to specific situations.

He states that the relative productivity of labor as exhibited in farm wages is the source of differentiation between agriculture and the rest of the economy, and also within agriculture between geographic areas. He assumes that all farm labor is paid its marginal value product and that the operator is paid for his labor at the same rate as hired labor. In other words, he seems to say that the wages paid to hired labor in agriculture give a measure of labor returns to management. I question these assumptions, particularly if applied to areas where farm income is very high, and there are many such areas in the state of Washington. Is the farm operator likely to pay, in each small area and under all circumstances, the marginal value product to his laborers? Fulmer says this will be true because, if the farm laborer is not paid the full marginal value product, he will become a renter. In the area of which I speak, renting is difficult. There is little rental land available and the renter must supply the necessary equipment, which may cost $30,000 to $40,000. Most of the renting is done by farm operators who already have a farm and who rent a piece of adjacent land.

I also question his assumption that, when conditions outside agriculture affect the price of farm products and raise or lower correspondingly the marginal value product of labor, the change in income is reflected in the asking price of labor and the bidding price of farmers for labor. In the part of the country of which I speak, the farm operator has to bid against industrial plants, such as Boeing Aircraft, Kaiser Aluminum, and others. But if the price of farm products goes up considerably while general wages in the area do not, farm laborers do not necessarily get any higher wages. Similarly, if farm income declines, the farm operator still has to pay the opportunity cost to attract the labor he needs. Fulmer agrees, of course, that farm wages do not fully reflect the marginal value product for farm labor because of contractual inflexibilities in wage rates, but he assumes that corrections are made when the wage rates are renegotiated the following year. It seems to me that there may be wide changes in farm income not reflected appreciably in the wages of farm labor.

His assumption that farm wages are a proportion of farm income may be true as a generality, but I question whether it should be used as a basis for estimating income between counties or between dif-

ferent types of agriculture. Also, the assumption of the complete substitutability of factors is somewhat questionable. Generally, the farm operator has a certain amount of equipment and hires a necessary amount of labor. If the price of labor goes down somewhat, he may hire some additional labor, or if the price of labor goes up, he may hire less. But if hiring another man requires the purchase of a substantial amount of equipment, he may not make any such adjustment.

I wonder also how some of the factors needed in Fulmer's equation are secured for intercensal years, for example, the x_4 factor in the equation, the ratio of labor input to the computed cost of other factors. Is one to assume that the ratio is the same in each county for all years? If that is the assumption, I think it highly questionable. Also, how are the total hours of farm labor worked in each county obtained from year to year? This information is crucial to the use of the formula. Assuming that total hours of labor can be computed for a census year, they may change considerably.

Fulmer also points out that it was necessary to build up estimates of total farm receipts by counties from census data. This information is not normally available by counties for other than census years. He also says that it was necessary to compute total labor requirements for all enterprises in the county by applying the labor input per unit of all acres of crops grown and livestock products. Again, how is this information obtained for other than census years? He says that the composite wage rate, unavailable by counties, was available by economic areas from the Department of Agriculture. However, the economic areas frequently comprise a group of counties, and in my state these economic areas do not necessarily comprise counties that are homogeneous from an agricultural standpoint. In short, Fulmer's method raises a number of questions. Some pertain to the validity of applying theoretical models to actual conditions; others, to the lack of data to do the sort of thing that he wants to do. To apply his method, dependence must be put on data obtained in census years which are not necessarily applicable to intercensal years.

Fulmer states that the series he gets for county income payments is more consistent than the estimates prepared by allocation procedures based on rough and inexact methods in calculations of expenditures. I think that the very nature of his estimating procedure makes the results more consistent. Does it necessarily follow that a series that is consistent is better? I am inclined to doubt this. There may be wide variations in the agricultural income of counties from

year to year because of variations in price, or of droughts, or of other things.

Reply by the Author

I am glad that Ernest W. Grove commented on the inadequacy of the state estimates of agricultural income. I had come to suspect this during the course of my analysis. Obviously, if the basic data are inadequate, highly significant results cannot be obtained by any method, and the one I described will not have a fair test until the greatly improved data he promises are available.

But those of us in the South and elsewhere who labor on economic development at the local level must proceed with the methods at hand. Often a series must prove its usefulness before it can secure the financial support necessary for its refinement. *Sales Management* [1] has been publishing county income estimates annually since the 1930's. They are of the roughest sort, yet they are constantly used by businessmen and others to reach important decisions. My method attempts to improve the farm income component of that series until a better method is developed or the proposed one refined.

Grove recommends that x_3 be omitted because it made little contribution to the county estimates. This was true for 1949 to 1950, when farm wages rose only 0.6 cents per hour. Had the wage series changed by 5 to 10 cents, as it did in 1951, x_3 would have made a significant contribution. The factor was retained because of this contingency, and also to give a more refined net value to x_2 and x_4.

With regard to x_4, which reflects the relationship of the value of the imputed cost of other factors to the hourly farm wage, he concludes that it measures about the same thing as gross receipts on an hourly basis. This is an important misconception, because the former is a relative while the latter puts the factor in terms of dollars and cents. By actual trial, x_4 was found to be both more highly related to the dependent variables than total hourly receipts and more consistent in its behavior between regions.

Grove considers the coefficients of determination unsatisfactory for predictive purposes in view of the small number of states represented in each case. However, since the coefficient of correlation was statistically significant at the 1 per cent level for three of the regions, the existence of a functional relationship is satisfactorily established. Reliable estimates depend on the scatter of the data about the mean relative to the slope of the line.[2] By this test, the

[1] See *Sales Management: Survey of Buying Power*, May 10, 1953, pp. 20–27.
[2] See Mordecai Ezekiel, *Methods of Correlation Analysis*, Wiley, 1930, p. 138.

equations for all four groups of states gave good estimates, varying from 5.1 to 13.9 per cent. The rather heterogeneous group of western states will produce good estimates also with a 9.2 per cent error, because the variance about the mean of the individual states was comparatively small.

I wrote that the greater uniformity of the county income formation ratios obtained by the regression method than by the allocation method showed that the first procedure is better. Grove, Robert H. Johnson, and John A. Guthrie either question whether this uniformity has any bearing on the validity of the method or consider that it discredits the method, since a high degree of uniformity of income is not to be expected among counties. Part of the difficulty arises from differences in income concepts. My discussants are apparently thinking of farm proprietors' net income, but my agricultural income concept is both broader and more refined than this. I exclude rents paid farm landlords, wages to hired help, government payments, and also errors that may occur in estimating these components.

I used this concept to get a measure of income consistent with factorial earnings in the agricultural industry itself. Since the amount of tenancy and of hired labor varies greatly between states, these adjustments should make for greater uniformity in the income formation ratios. This is exactly what happened, as shown by the percentage variations of the ratios in 1949:

	Northeast	*Corn Belt*	*South*	*West*
Agricultural income [a]				
Mean	38.86	44.11	57.74	50.07
Standard deviation	5.18	3.78	3.97	8.09
Coefficient of variation	13.3	8.6	6.9	16.2
Farm proprietors' net income [b]				
Mean	24.44	37.34	47.84	36.46
Standard deviation	6.84	4.28	5.33	9.57
Coefficient of variation	28.0	11.5	11.1	26.2

[a] The concept as defined in this paper. Farm proprietors' net income of the National Income Division of the Department of Commerce, adjusted by adding rents paid farm landlords plus wages paid hired labor. Government payments are deducted.

[b] Farm proprietors' net income as defined by the NID.

The coefficient of variation of agricultural income is 25.2 to 52.5 per cent less than the variation of farm proprietors' net income. In both comparisons, the Corn Belt and the South are substantially less, indicating greater homogeneity in their income formation ratios.

In both concepts, however, the mean of the income formation ratios varies greatly between regions. Institutional factors may be important in explaining the differences among geographic units in their rates of income formation. Had the concept of agricultural income been further refined to allow for rents paid to nonfarm landlords and interest paid for capital obtained outside agriculture, the ratios would have been even more uniform.

Another factor responsible for the greater uniformity of the regression estimates is the mixed nature of resource use in numerous counties. The typical allocation procedures make no allowance for the share of the expenses for maintenance of buildings and the repair, maintenance, and operating expenses on automobiles and trucks that are chargeable to the activities of farmers away from their farms. Without an adjustment for this outside activity, the reported total farm receipts of the counties are too low (39.9 per cent of the counties reported off-farm work by farm operators in 1950).

Also, if industrial and other employment opportunities exist in or near a county, the land and buildings carry an inflated value and are not properly sensitive to bona fide farm earnings in the capitalization process. This raises the rate of charge against receipts and makes it inflexible. The Census Bureau procedure of valuing farmland and buildings by estimating the selling price of a sample gives an average of farmers' opinions over a period of years. The valuation will consequently not be sensitive to the current rate of earnings from farm operations. This leads to further error in the imputed charges deducted from farm receipts.

However, the appearance of uniformity of the income ratios can be misleading. While the twenty counties were taken as a sample of Virginia agriculture, they are not fully representative of the state, as shown by the following percentage coefficients of variation:

	Coefficient of Variation:	
	Eleven Southern States	*Twenty Virginia Counties*
x_1, Agricultural income per hour	18.0	34.1
x_2, Composite wage rates per hour	11.6	10.5
x_3, 1950 composite wage as percentage of 1949 wage	1.6	0.1
x_4, Ratio of imputed value of other costs to 1949 wage	11.1	43.1

The twenty counties vary less in x_2 and x_3, but substantially more in x_4, than do the eleven states. Although data are available only by economic areas for x_2, the coefficient of variation of wages for

the ten economic areas of Virginia was 13.7 per cent compared to 10.5 per cent for the twenty-county sample, indicating 23 per cent less variation than in the factor studied by the regression analysis. Since x_2 accounts for about two-thirds of the coefficient of determination and is jointly related to x_4, its lower variability becomes highly important in explaining the comparatively greater uniformity of the income formation ratio of the sample counties. It is interesting, however, that despite the smaller variability of two of the variables, agricultural hourly income was nearly twice as variable for the twenty counties as for the eleven states: the range of hourly earnings of the twenty counties was from 151.6 to 48.9 cents compared to 78.1 cents for Virginia. One expects greater variation in hourly earnings as the size of the geographic unit decreases: it is a big factor in favor of the formula that it gives this result. There is danger of forgetting this and concentrating too much on the income formation ratio. Finally, to return to the question of the value of x_4 in the equation, the very large variability for the twenty counties shows the power it possesses to reflect extreme variations in the total receipts of small geographic areas.

I wish to comment on a few points raised in Johnson's critical analysis of my paper. First, my formula assumes that the state inventory adjustment rate can be used as the adjustment rate for the counties. Obviously, this is an oversimplification. Perhaps inventory charges should be adjusted independently where they are important and particularly volatile, as in a grain and hay state such as Iowa.

Next, labor requirements should, of course, be calculated as accurately as possible, particularly for counties. However, the lack of annual, current labor data is not important, since the income formation ratio method obviates the use of labor requirements in making estimates for intercensal years.

Johnson is correct in stating that errors in the computation of x_4 may be largely offset by the interrelationships between x_2 and x_4. He arrived at this conclusion by arbitrarily changing the labor input of Accomac County to test the effect on agricultural income. When total labor requirements were reduced by 18.7 per cent, the estimate of agricultural income was reduced by only 2.2 per cent. This result seems startling. But, if he had included an increase in wages, a necessary condition to a reduction in labor input, the estimate of agricultural income would have been raised, not reduced, as his later calculation shows.

Johnson questions whether the factors are independent of one

another. Conceptually, they were not intended to be so, since it is assumed that the factors combine in a joint function to give something more than a linear, additive function. He also questions whether changes in the parity ratio can be applied uniformly to the income formation ratio of counties in adjusting from censal to intercensal years. This is a serious challenge to a basic assumption of farm policy as it operates in this country at present. The same parity index (with minor adjustment in the base for some crops) is applied to all crops uniformly regardless of location in the calculation of parity prices and price supports on the assumption that prices and costs in different regions of the United States move together to such an extent that the aberrations are minor.

However, the method outlined for intercensal estimates is not so hide-bound by this assumption as Johnson believes. While shifts in the parity ratio from year to year are the major force causing change in the income formation ratios between years, the adjustment percentage was not computed from the changes in the parity ratio but from the changes in the income formation ratios of the respective states. To the extent that agricultural income accounting by states was based on a separate determination of individual components of expenses and receipts, the effects of the changes in the parity ratio were differentiated to the individual states and therefore were reflected in the income formation ratios.

Both Johnson and Guthrie question the applicability to agriculture of the equimarginal assumption, holding that resource allocation operates imperfectly between agricultural and nonagricultural enterprises and also within agriculture. But the well-known differential between farm and city wages is largely or completely compensated for by the tangible and intangible differences between the country and the city. Farm perquisites are valued at farm prices and not at retail prices. The required standard of life permits cheaper living in the country than in the city.[3] Some may place even more importance on the intangible values of farm life. But other things being equal, the farm to city migration picks up as the wage differential widens, although some authorities who have studied the matter place more emphasis on employment opportunities.[4] If the farmer has to bid higher for labor, he selects it more carefully, utilizes it more efficiently, and adds capital. He has to adjust all inputs to the

[3] Paul D. Converse, Harvey W. Huegy, and Robert V. Mitchell, *The Elements of Marketing*, 5th ed., Prentice-Hall, 1953, p. 35.

[4] See Howard L. Parsons, *The Impact of Fluctuations in National Income on Agricultural Wages and Employment*, Harvard Studies in Labor in Agriculture, June 1952, pp. 36–46.

point where a dollar of outlay in every direction returns the same marginal value product. He may not do this consciously or accurately, but competition makes this true for farmers as a group.

Obviously, the equimarginal principle does not work perfectly; it is only necessary, however, that the principle exist as a dominant force for it to have value as a predictive factor. That this has occurred even in the state of Washington is indicated by the number of farm operators working in industry and the number who are tenants.

Johnson places great emphasis on the fact that, even though about 60 per cent of all farm income is allocable to farm labor, including the labor of farm operators, only 15 to 20 per cent is paid out for hired labor. I contend that this is a sufficient percentage to make the principle operative. Less than that percentage of the great American crop, corn, is sold, yet no one has ever questioned the market value of the remainder.

One final comment on Johnson's discussion. He is disturbed that the proportions of the imputed values of other factors, including intermediate goods, rents, interest, and returns to management, expressed as a ratio to farm wages, varies between states and between counties. He believes this variation invalidates the use of x_4 as a predictive factor. Production economics indicates that numerous combinations of factors may be used to obtain a given product. The important objective is to get production that returns opportunity costs to the different factors. There are obviously limits to substitution, but within them variations in the combination of factors between industries and between farms occur. Intermediate goods may be substituted for land or fixed equipment. Such inputs as fertilizer, seed, fuel, and numerous others are used up in the process of production. Even where there are monopoly elements present, will not the capitalization process cause the assets to take on the additional value to represent the difference? It is apparent, therefore, that the input mix, like the output mix, becomes homogeneous through its dollar denominator. The ratio of other factors to labor provides a major point of differentiation in view of the relative importance of labor. My contention is that, for estimating purposes, it is all the differentiation needed.

Denison suggests that I provide a reconciliation of my theoretical model with that of conclusions reached by other theorists. My view is that agricultural income of counties is a function of the composite hourly wage rate and two other factors that influence the dependent in a joint function with the wage rate. The basic postulate is that

farm labor, as a participant in production, receives approximately its marginal value product. Denison states that under customary economic theory only land rent would reflect a differential between counties, being dependent upon locational and productivity differences. Under the assumption of geographic mobility of labor and capital, the usual theory aims at equality of both interest and wage returns per unit between counties.

In actual practice, the farmer with investments in land capitalizes the rental returns. Thus, in an entrepreneurial sense, the farm operator lumps investments in land with other capital outlays, adjusting the factorial combination to equalize marginal returns per dollar of outlay, taking into account the limits of substitution between the two factors and each with labor independently or in combination.

Farm labor, while somewhat immobile in farm to industry movements because of intangible values associated with farm life, is, however, highly mobile between farms and between communities. Beyond counties, the mobility of farm labor drops rapidly. Despite imperfections in the mobility of farm labor and the fact that only 15 to 20 per cent is employed as hired labor, I consider that there is sufficient mobility and bargaining over wages in labor contracts to make the marginal productivity principle effective. With land and capital treated in the same way by the entrepreneur through the capitalization process, it appears that the only fixed factor is the entrepreneur. He adds factors in the proper proportions until he maximizes entrepreneurial returns. Of course, the entrepreneur almost never makes full utilization of his capacity because of capital rationing. I believe what I have said to this point is in accord generally with economic theory.

Now to the problem of explaining the differences in wages between counties. Equality of the marginal value product of labor within a geographic unit requires that the labor unit be of equal quality, an assumption violated in agriculture. The basic labor unit is far from equal throughout agriculture because of inherent differences of ability and education within the labor force. The principal reason farm wages averaged in 1949 only 40.3 cents in the South compared to 70.9 cents in the Corn Belt was the difference between types of labor.

The dilution of the labor force that accompanies migration is also a significant source of county differentials. The more alert and intelligent laborers, who are also the most efficient, move first and farthest.[5] In the process, they move into types of agriculture with a better market advantage, as dairying, or more highly mecha-

[5] *Ibid.*, pp. 36–46.

nized. This gives rise to county differentials within states and regions and between regions.

In my model, I did not intend to explain the county differences in income entirely by the wage differential, because the volume of work and other inputs vary so widely between counties. I had reference to the hourly agricultural income, and even in this connection the model would be equally applicable if there were no labor differentials between counties. The three factors, especially because of the joint functions in which they are defined, are capable of a great variety of combinations and therefore widely varying agricultural income per hour between counties.

Guthrie is correct in his conclusion that I assumed that farm labor is paid its marginal product, but not that the "wages paid to hired labor in agriculture give a measure of labor returns to management." Returns to management include two components, the wages earned by the operator as a laborer and the return he gets in his capacity as a manager. The wages of hired labor determine the lower limits of operator's returns. Operator's returns would average higher than the wage returns of laborers, rising with the level of farm wages and conversely. There are geographic areas and circumstances where there may be little or no relationship, as in the state of Washington, but in general throughout the United States, they vary together.