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Analysis of Interstate Income Differentials: Theory and Practice

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The use of state boundaries for the geographic classification of economic data is deeply imbedded in the history and political institutions of the United States. The constitutional provision for a decennial census requires an enumeration of the population in each of the several states. The Constitution also provides that sovereignty resides in the states, and each of the states has developed a governmental framework complete with a legislature and governor, and many administrative departments, boards, and commissions. While many may argue that state officials cannot really alter the course of a state's economic development, few will assert that these state officials do not desire and need detailed statistical information about the economic activities within their state's borders.

Such statistical information is essential if the states are to carry out their governmental functions intelligently and economically, however limited the effects of these functions may be on the national economy.

This need has probably played the leading role in generating a continuing supply of state distributions of data collected on a national basis. So long as our basic form of government is maintained, the supply of state data seems assured. This paper is concerned almost entirely with the problems encountered in the analysis and interpretation of observed differences among states in one fairly recent statistical series, state income payments.[1]

The State as System of Geographic Classification

Every part of the entire area of the continental United States is assigned to one and only one of the forty-eight states or the District of Columbia. Changes in the boundaries have been infrequent.

NOTE: This report was developed as a part of the "Study of Differences in State per Capita Incomes," which is being financed jointly by Duke University and The Rockefeller Foundation.

[1] The series was initiated with Robert R. Nathan and John L. Martin, *State Income Payments, 1929–37*, Dept. of Commerce, 1939. Since 1944 annual estimates have been published in the August issues of the *Survey of Current Business*, Dept. of Commerce. Estimates for 1919–1921, though not entirely comparable

Their precise location is usually known to statistical respondents, so that reporting the location of residence or of an economic activity by state offers few problems.[2] Moreover, there are no borderline areas that are hard to classify satisfactorily: as a classificatory device states are particularly free of ambiguities. But are state boundary lines an appropriate form of reference for the classification of economic data, particularly income payments to individuals? In general, there are two ways of viewing this question.

According to one view, the state lines must have some economic significance if they are to be used as limits in the regional classification of economic activity. Just what is meant by "economic significance" is often left unspecified. Rutledge Vining's "natural trade area familiar to marketing specialists" implies that economically significant boundaries should pass between, not through, trade areas.[3] Walter Isard has said regional boundaries should group units "similar in terms of output or in terms of production processes" the way industrial boundaries do.[4] State lines satisfy neither description.

Further, it should be possible to define the economic significance statistically in terms of some cluster of economic characteristics. For example, state boundaries might be considered appropriate if these characteristics showed greater variation between states than within them. But what unit can be used to measure intrastate variation for this comparison? If income is the economic variable, the choice of the individual or family as the unit leads to a very disperse distribution of income by size. Even the choice of the next lower political unit in terms of area, the county, probably would show greater intra-area than interarea dispersion.[5]

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with the Department of Commerce series, are available in Maurice Leven, *Income in the Various States, Its Sources and Distribution, 1919, 1920, and 1921*, National Bureau of Economic Research, 1925.

[2] Problems do arise in the estimation of income payments to individuals who live in different states from those where the activities giving rise to the income payments are located. In passing from total to per capita payments, an adjustment is made for these differences for the District of Columbia, Virginia, and Maryland area; for the New York–New Jersey area; and for the Maine–New Hampshire area. Similar but short-lived difficulties in other areas, e.g. the Aiken, South Carolina–Georgia area, are ignored.

[3] Rutledge Vining, "Regional Variation in Cyclical Fluctuation Viewed as a Frequency Distribution," July 1945, pp. 183–213; "Location of Industry and Regional Patterns of Business Cycle Behavior," January 1946, pp. 37–68, particularly p. 38; and "The Region as a Concept in Business Cycle Analysis," July 1946, pp. 201–218; all published in *Econometrica*.

[4] Walter Isard, "Some Emerging Concepts and Techniques for Regional Analysis," *Zeitschrift fur die gesamte staatswissenschaft*, Band 109, Heft 2, 1953, p. 242.

[5] The coefficient of variation for per capita incomes among counties in seven

However difficult it is to define economic significance, it is easy to find assertions that state boundaries do not demarcate regions suitable for economic analysis.[6] The most frequent objection is that many states are too large, that they include all or parts of several "regions" having significantly different characteristics. It has also been argued that many of the states have similar characteristics and can be grouped into regions or divisions to reduce the amount of computation without a loss of essential information.[7]

Despite the constitutional prohibition against state-levied imposts and duties, some state legislatures have tried to make trade barriers of state boundaries, thus giving them economic significance.[8] There are also differences among the states in their tax systems, prohibitory and regulatory measures, labor laws, highway and educational systems, and, probably, in the efficiency of their administrative machinery. Similar differences may also be found among cities and counties within a state. These differences in governmental policy and performance may favor the location of certain economic activities in one place rather than another. It is doubtful, however,

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southeastern states in 1947 is greater than the coefficient of variation among the states for that year:

	(*per cent*)
Relative interstate dispersion	22.4
Relative intercounty dispersion	
Alabama	32.5
Georgia	35.8
Kentucky	33.1
Mississippi	30.5
North Carolina	30.1
Tennessee	34.7
Virginia	38.2

[6] Nathan and Martin (*op. cit.*, p. 4) say "state lines have limited significance as economic boundaries . . ." and justify the preparation of the official estimates by the needs of business groups for data relating to geographic area less extensive than the nation. Vining ("Location of Industry and Regional Patterns of Business Cycle Behavior" p. 38) says: "A state generally will be found to include parts of several 'regions.' . . ." Isard ("Interregional and Regional Input-Output Analysis: a Model of a Space Economy," *Review of Economic and Statistics*, November 1951, p. 320*n*) says: "States and regions formed from states, are in several respects imperfect economic areas. This is especially so with respect to the flow of goods and services from and to metropolitan local points." Donald J. Bogue (*State Economic Areas*, Bureau of the Census, 1951, p. 1) also looks on the states as being too large.

[7] Howard W. Odum (*Southern Regions of the United States*, University of North Carolina Press, 1936) gives the results of extensive work in constructing groupings of states.

[8] F. Eugene Melder, "Trade Barriers between States," *Annals of the American Academy of Political and Social Science*, January 1940, pp. 54–61. It is difficult to gauge the importance of the barriers discussed by Melder, although it is clear that they are associated with state lines.

whether the effects of differences in state policies are important enough to make the states qualify as separate economic regions.

Of more importance are the policies and regulatory devices of the federal government, which, with few exceptions, apply uniformly in all states. This is not to say that their economic effects are uniform. Acreage restrictions on, say, wheat may well have differences in effect in the middle western wheat belt and in the large urban communities along the Atlantic seaboard. But these differences need not follow political boundaries. Similarly, the effects of monetary and fiscal policies, legal devices for making and enforcing contracts, regulations governing the content of advertising, the use of radio and television time, which are essentially national in scope, may differ in various parts of the country. Only if it could be shown that the differences are related to state boundaries in some causal way could we conclude that the differences support the notion that state boundaries are economically significant.

If, as it appears, state boundaries do not delineate economic regions, we are forced to a second view—the states are not economic entities. But, if so, why should any attempt be made to analyze state income differentials? The answer to such a question depends upon the framework in which the proposed analysis is conducted.

It is conceptually possible to view the income of the United States (or of a state or a group of states, for that matter) as an aggregate of the income in some set of independently defined subareas or regions, an aggregate that should be interpreted only in terms of these subareas. Such a view would make geographic location a matter of primary classificatory importance. Before analysis could be undertaken, it would be necessary to formulate a set of criteria and to delineate a set of suitable subareas by using these criteria. Such a process might well require the reclassification of much of our economic data to put them in a usable form.[9]

Another framework is adopted in this paper. The United States is considered a single economy operating within the framework of a single set of institutions co-extensive with the national boundaries. The differences observed between states (or other regions, however defined) are looked upon as arising from the varying combinations of skills, industries, and resources found in the several states. These occupational, industrial, and type-of-resource categories are treated as the primary basis for separating observed facts into mean-

[9] Vining's suggested classification of industries as "residentiary" or "export" would apparently require extensive work before they could be used to classify subareas. Vining (in "Regional Variation in Cyclical Fluctuation Viewed as a Frequency Distribution") escapes part of this work by focusing his attention entirely upon the local area, rather than upon the local area as a part of a larger area.

ingful and homogeneous categories.[10] A textile plant in one part of the nation may, because of its location, vary from a textile plant somewhere else. This variation may be reflected in the organization of the productive process, in the composition of the skills of the workmen employed, or in the types of markets served. But though these may be important sources of variation, for the purposes of the present paper they are treated as being of the same order as the variation between two textile plants located in the same community, that is, as independent of location.

Location, thus, is treated as a secondary or subsidiary system of classification. It is secondary in the sense that classification by location alone is of doubtful value in analyzing the operations of the national economy. Without classification according to some set of economic criteria, area aggregates are likely to be so heterogeneous as to be uninterpretable. Once the data are classified by industry, their further classification by locational characteristics may increase their analytical value.[11] When the problems to be studied are local rather than national, some industrial detail may be sacrificed for more precise locational classification. But even then it is doubtful whether industrial classification at some level can be ignored.[12]

Of course, one reason for working with the forty-eight states is that data are available for them. For a moment let us assume that we could have data for any geographic area, however defined. There are many ways in which the total area of the United States could be partitioned into forty-eight subareas, particularly if we impose no greater limitation on areal or populational differences than now exist among states. For example, we could ask a group of third-grade students, who had learned to count to above forty-eight but

[10] Arguments about the specific categories in specific classification systems, e.g. the Standard Industrial Classification sponsored by the Bureau of the Budget, seem interminable. However, they are devoid of distinctions based on geographic location. Even the distinction between "fixed" and "portable sawmill" industries, while effectively separating the western states from the remainder of the country, is based on equipment rather than on location.

[11] One of the primary purposes of the "Study of Differences in State Per Capita Incomes" is to find out whether the further classification of economic data by state makes them more useful for studying national economic problems, and, if so, how.

[12] Much of this line of reasoning must be obvious, although the ardent regionalists who think that small observed differences in economic behavior have "reality" in terms of some regional concept may call location the primary classificatory system. Among the economists who have written on regional problems, I find none who has not made use of industrial classification. They have varied in the importance they attach to locational classification. Wassily W. Leontief and others (*Studies in the Structure of the American Economy*, Oxford University Press, 1953, Part II) apparently adopt an attitude very close to the one followed here. Isard, Vining, and Neff apparently would attach more importance to areal or locational classifications.

had not yet studied geography, each to divide all the area within the outline of the United States into forty-eight parcels. The per capita incomes and their distribution would probably differ for each set of forty-eight subareas. These sets would have been determined by approximately random selection, without regard to urban places, industrial composition, population concentrations, or other income-associated factors. How closely the forty-eight states conform to such a hypothetical situation is not known. To treat them as one of a number of possible randomly selected sets of subareas has certain advantages. Chief among these is that such a conception provides us with a framework for analyzing any observed changes in terms of economic factors other than location.

The income level attained by the people within a state is to some extent, at least, the consequence of chance forces. The states are endowed differently with natural resources—rivers, soils, mineral deposits, climate, etc. Then, too, as a result of historical development, states vary in the size and types of farms, composition of manufacturing activity, the number and type of trade organizations, the kinds of service industries it supports, and in the rates at which its population and economic activities tend to grow. Diligent historical research may provide valid information on the sources of this varied development in terms of by whom, when, and where the pattern-setting decisions were made. Yet it appears incapable of explaining why, for example, some Aztec did not chance upon the principle of the wheel, a discovery that might have been followed by a train of inventions similar to those being developed in Europe at the time. Such a chance discovery might well have given rise to a quite different economy for Columbus to discover.

Even the boundaries of the states often are the product of arbitrary, if not chance, decisions. Relatively slight changes in boundaries could have important effects on a state's per capita income. For example, if the Kansas-Missouri boundary had been fixed a few miles east of its present location, would Kansas City, a large urban center, have developed in Kansas instead of Missouri?

The assumption adopted in this paper, that the United States is a single economy, appears consistent with the observed differences among states. Although state per capita incomes are not distributed normally, as might be expected if their differences could be attributed wholly to chance forces,[13] the income differences are of a

[13] In two-thirds of the years the distributions (when data are grouped in $100 intervals and the District of Columbia is omitted) have well-marked modal groups near the center of the distribution; in the other years the modal group is either not clearly defined or the distribution is discontinuous. The departures from nor-

size that can be explained by differences in industrial composition, birth rates, age composition, educational achievements, racial composition, participation of women in the labor force, and a host of other income-connected factors. The observed differences in these characteristics could very well occur in a single economy.

Uses of State Per Capita Income Data

Data on state per capita incomes are relevant to the study of three interrelated types of problems. First, they are necessary when differences in other economic series are used to explain state differences in per capita incomes if a statistical—rather than a theoretical, causal—relationship is wanted. Conversely, they are necessary when state differences in per capita income are used to explain differences in such other variables as consumers' expenditures for certain consumers' durable goods, e.g. automobiles and housing, or governmental expenditures for education, local government functions, and highways. Thirdly, state per capita income data can provide a framework for the analysis of the relationship of other economic variables to each other, e.g. of state automotive repair expenditures per automobile to state average age of automobiles. In these problems, income itself need not be one of the variables.

Up to now, the state income data have been principally used for the analysis and understanding of the sources of state differences in per capita incomes—problems of the first type. Consequently, I shall discuss them more fully than problems of the other two types.

STANDARDIZATION PROCEDURES

The basic model used in explaining statistically the state differences in per capita incomes is one or another form of standardization. The states vary in industrial, occupational, age, racial, educational, and natural-resources composition, as well as in per capita income. The problem, then, is to find out how much of the variation in income can be explained by the variation in one or more of the other variables.

Thus stated, the problem sounds like one adaptable to correlation analysis in which the coefficient of determination would provide a direct answer. But correlation analysis is not used because of the many individual categories in a single set of variables, say, industrial

mality are too great to be attributed to sampling errors, but it is doubtful that the departures are sufficiently large to invalidate the measures used. Of course, any departure from normality reduces the precision with which correlation techniques and many other statistical measures may be interpreted.

composition.[14] When the number of independent variables in a correlation problem exceeds five or six, computation becomes unwieldy. The standardization procedures here adopted draw heavily upon, and suffer much the same limitations as, the logic underlying correlation analysis. They are constructed in much the same way as constant-weight index numbers.

General Description. A brief description of standardization procedures is in order.[15] The occupational composition of the states, as given in the 1950 census of population, is used as an illustration. Some of the limitations imposed by data considerations are ignored and the description is confined to the standardization of wage and salary earnings, although the procedures are applicable to incomes however defined.

The available data include an unpublished nationwide tabulation of wage and salary earnings by their own size and by sex for each of 422 detailed occupations from which the average annual earnings for each occupational or occupational and sex category can be computed.[16] There is also a published state tabulation which shows the number of persons in the experienced labor force by detailed occupation and sex, and another which shows wage and salary earnings by size and by sex for all wage and salary earners. From these data the aggregate wage and salary earnings of all persons in the nation can be computed by summing either the occupational earnings or the state earnings. Were both sets of

[14] There are some 430 manufacturing industries, 244 wholesale trade industries, and similar numbers in other broad industrial categories. Even so, finer classifications may be needed; some of the remaining intra-industry variation may be important enough to warrant separate treatment. Moreover, since there are only forty-eight (state) observations for each category, there would be no unique solution for more than forty-eight variables.

[15] For a fuller discussion, see Margaret J. Hagood, *Statistics for Sociologists*, Reynal and Hitchcock, 1941, pp. 837–847; and S. A. Stouffer and C. Tibbits, "Tests of Significance in Applying Westergaard's Method of Expected Cases to Sociological Data," *Journal of the American Statistical Association*, September 1933, p. 293, contains pertinent discussions of standardization methods. Examples of specific applications are provided in Howard G. Schaller, "Veterans Transfer Payments and State Per Capita Incomes, 1929, 1939, and 1949," November 1953, pp. 325–332, Frank A. Hanna, "Contribution of Manufacturing Wages to Regional Differences in Per Capita Income," February 1951, pp. 18–28, and "Age, Labor Force, and State Per Capita Incomes, 1930, 1940, and 1950," February 1955, pp. 63–69, all in *Review of Economics and Statistics.*

[16] This tabulation, identified as D-6, is based on a 3.3 per cent sample of 1950 census returns. Aggregate wages and salaries were computed by multiplying the midpoint of each class by the number in the class and summing over all classes. The midpoint of the $10,000-and-over class was assumed to be $17,500, a figure obtained by rounding averages of earnings reported in *Statistics of Income*, Part I, for several years. In computing the averages, only class 1 and 2 workers ("private wage and salary workers" and "government workers") reporting wage income were included.

tabulations completely comparable, the two totals would be identical. But differences in classifications give rise to small differences in the averages.[17]

By weighting the reported national average annual occupational earnings by the numbers in an occupation and state, one can compute a state average annual earnings that reflects the state's occupational composition. Since the occupational earnings rates are held constant, it is called the state's rate-constant occupational earnings.[18] Table 1 and Chart 1 compare the reported and rate-constant earnings.

Effects of Standardization. Of the many methods that have been

[17] The D-6 tabulation excludes the wage and salary earnings of the self-employed; use of the occupational distribution of the experienced labor force attributes the same annual wage and salary earnings to the self-employed as is received by wage and salary workers in the same occupation, and the state tabulations by wage and salary income reflect the actual earnings of the self-employed, whether the self-employed are in categories specifically included or not. The self-employed categories (nonfarm proprietors and self-employed managers, etc., farm proprietors, and unpaid farm and self-employed farm service laborers) have been excluded from the analysis to the extent possible. The average annual earnings based on the unpublished tabulation is $2,528; on the state tabulation by earnings (*Census of Population 1950*, Bureau of the Census, State Tables 94), $2,556; and on the occupational averages computed from the unpublished tabulation weighted by the experienced labor force (State Tables), $2,517.

[18] If the symbolism of indcx numbers is adopted, aggregate rate-constant earnings for a state, V_{1o}, may be represented by $V_{1o} = \Sigma p_{1i} q_{oi}$, where p_{1i} is the average annual earnings of all persons in the *i*th occupation in the United States, and q_{oi} is the number of persons in the experienced labor force in the *i*th occupation in the particular state *o*. Aggregate rate-constant earnings were computed mechanically by the Bureau of the Census as a special tabulation. State average rate-constant earnings are then computed by dividing the state aggregate rate-constant earnings by the state experienced labor force, $\Sigma p_{1i} q_{oi} \div \Sigma q_{oi}$. Were data available on p_{oi}, the specific average earnings of the *i*th occupation in a particular state, it would also be possible to compute state composition-constant average earnings, V_{o1}. Where q_{1i} is the number in the *i*th occupation in the United States, and the other terms are as previously defined, $V_{o1} = \Sigma p_{oi} q_{1i}$. Since the rate-constant earning is designed to reflect differences in state occupational compositions without the distorting effects of varying compensation rates for similar work, and the composition-constant earning is designed to reflect differences in earning rates without the distorting effects of variations in occupational composition, there is no necessity for the two series to provide a similar ranking of the states. Efforts by demographers to approximate state composition-constant death rates or birth rates from rate-constant figures by the use of the approximation $(\Sigma p_1 q_1)\ (\Sigma p_o q_o) \div (\Sigma p_1 q_o) = (\Sigma p_o q_1)$ have led to the characterization of rate-constant computations as "indirect standardization" and composition-constant computations as "direct standardization." See Hagood, *op. cit.*, where this conversion formula is rearranged, so that, $\frac{\Sigma p_1 q_1}{\Sigma p_1 q_o} = \frac{\Sigma p_o q_1}{\Sigma p_o q_o}$

It may be seen that the left-hand side is weighted by national earnings, and the right-hand side by state earnings. The differences in state and national weights are too great in the occupational data to warrant the use of this approximation. Consequently, only rate-constant earnings are analyzed.

TABLE 1

Reported and Rate-Constant Occupational Earnings, by State, 1949

(dollars)

State	*Reported*	*Rate-Constant*	*State*	*Reported*	*Rate-Constant*
New England:			South Atlantic:		
Maine	2,065	2,346	West Virginia	2,412	2,490
New Hampshire	2,193	2,392	North Carolina	1,841	2,235
Vermont	1,997	2,363	South Carolina	1,740	2,169
Massachusetts	2,610	2,570	Georgia	1,801	2,241
Rhode Island	2,359	2,508	Florida	2,064	2,303
Connecticut	2,795	2,636	East South Central:		
Middle Atlantic:			Kentucky	2,024	2,399
New York	2,921	2,588	Tennessee	1,956	2,369
New Jersey	2,959	2,646	Alabama	1,832	2,292
Pennsylvania	2,630	2,542	Mississippi	1,408	2,180
East North Central:			West South Central:		
Ohio	2,797	2,644	Arkansas	1,594	2,244
Indiana	2,652	2,586	Louisiana	2,114	2,383
Illinois	2,936	2,629	Oklahoma	2,238	2,527
Michigan	2,974	2,660	Texas	2,277	2,445
Wisconsin	2,586	2,562	Mountain:		
West North Central:			Montana	2,461	2,443
Minnesota	2,472	2,546	Idaho	2,300	2,397
Iowa	2,312	2,482	Wyoming	2,557	2,498
Missouri	2,422	2,512	Colorado	2,412	2,526
North Dakota	2,007	2,400	New Mexico	2,364	2,422
South Dakota	2,028	2,397	Arizona	2,397	2,382
Nebraska	2,262	2,490	Utah	2,610	2,594
Kansas	2,372	2,564	Nevada	2,839	2,420
South Atlantic:			Pacific:		
Delaware	2,752	2,554	Washington	2,774	2,526
Maryland	2,652	2,552	Oregon	2,668	2,430
Virginia	2,277	2,401	California	2,870	2,551

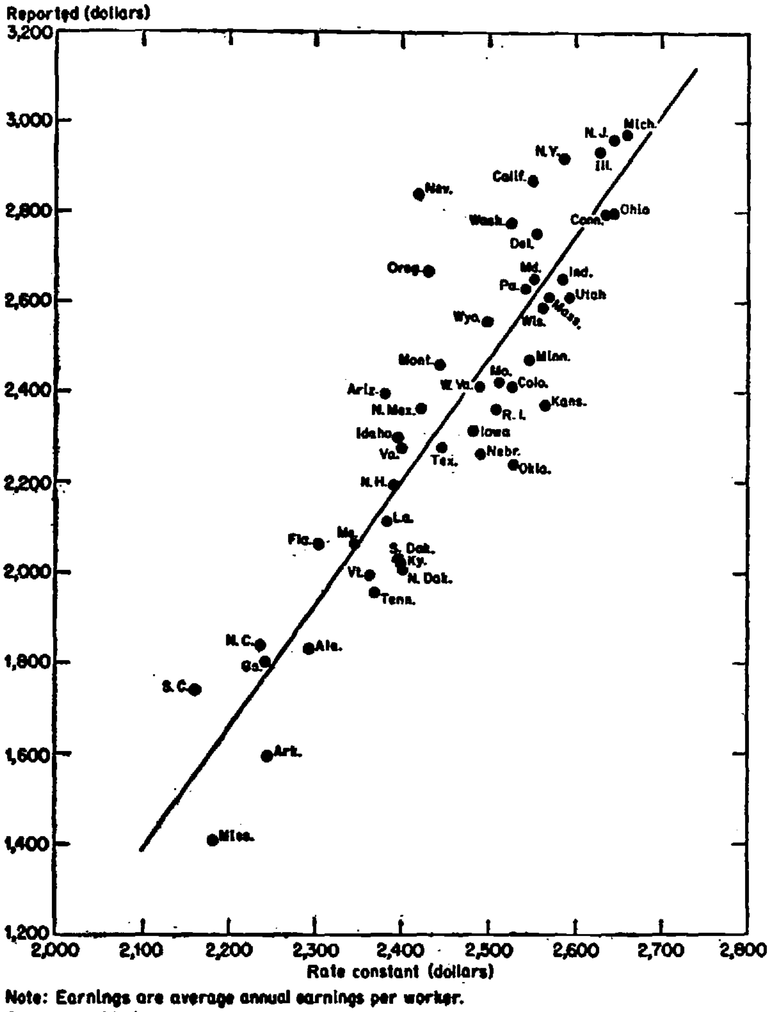
Note: Earnings are average annual earnings per worker.
Source: For methods of computation, see notes 17 and 18 in the text.

used to obtain a summary measure of the effects on a set of differences of holding constant one or more component variables, none is entirely satisfactory. For example, economists have long since given up as an impossible job the precise measurement of the proportion of a change in value of output that is due to price changes and to production changes.[19] When available data permit holding only the rates constant, an analysis will be necessarily restricted to one side. Even when complete data are available, any attempt to partition the joint influence of simultaneous changes in rates and

[19] This problem is discussed in Irving H. Siegel, *Concepts and Measurement of Production and Productivity*, Bureau of Labor Statistics, 1952, pp. 86ff.

CHART 1

Reported and Rate-Constant Occupational Earnings, by State, 1949



Note: Earnings are average annual earnings per worker.
Source: Table 1.

composition leads to results that are only approximate. The most that can be expected from such measures is that they make efficient use of the available data, that they yield consistent results, and that the results can be interpreted unambiguously. Only two of the available methods are considered here: (1) coefficient of determination between the reported and the standardized series, and (2) comparison of the coefficients of variation for the reported and the standardized series.

The coefficient of determination, (r^2), provides a direct measure of the portion of the variation in the dependent variable which is "explained" by the independent variable.[20] When 1949 reported state earnings are treated as the dependent variable and rate-constant state earnings as the independent variable (Table 1 and Chart 1), the coefficient of determination is found to be 0.80, thus indicating that variation in occupational composition explains 80 per cent of the variation in reported state earnings.[21]

Since the average earnings of each occupation was used in computing the rate-constant state earnings, presumably all of the forces making for differences in occupational averages were taken into account. However, the regression line in Chart 1 has a slope greater than unity, indicating that states with predominantly low-earning occupations tend also to have earnings lower than would be indicated by their occupational composition. This association between composition and rates, important as it is, raises troublesome problems of interpretation.

First, in addition to the forces making for differences between occupational averages, some, though not necessarily all, of the forces responsible for within-occupation dispersion must have helped to determine the position of the regression line. Consequently, the deviations from the line (the bases of the unexplained portion of the variation) are traceable to some unknown part of the within-occupation earnings differences.

Secondly, it may be asked whether regional location was one of the criteria for distinguishing between occupations. For example, subdividing "laborers" into two categories, "laborers, South" and "laborers, non-South," would increase the amount explained by holding rates constant, and only interstate differences within the South and the non-South would be left. Much of the same effect would follow if the detailed classification of operatives and labor-

[20] The coefficient of determination is defined as the ratio of the explained variation to the total variation. It is in this statistical sense that the words "explained" and "accounted for" are used throughout this paper.

[21] George H. Borts (pp. 185ff. in this volume) shows that, of this 80 per cent, 11 per cent may be attributed to the "independent" influence of occupational composition and 69 per cent to the joint influence of occupational composition and occupational rates changing simultaneously. This interpretation is acceptable. The 80 per cent figure is retained here (1) because the paper discusses state variations in composition rather than in rates, (2) inclusion of both the independent and joint influences of composition provides a measure apparently comparable between different classificatory systems, and (3) there is no attempt to compare the effects of composition and rate variations.

Borts' comments also show the need for weighting the regressions. When this is done, a coefficient of determination of 0.87 is obtained with 10 per cent attributable to "independent," and 77 per cent to correlated effects.

ers, which is based largely on industry, provided separate categories only for industries that display considerable regional concentration, and grouped all others in the "not-specified" categories. There is some evidence that industries highly concentrated regionally have been used as the basis for detailed occupational classifications, but the effects do not appear to vitiate the use of the data made here.[22]

There is no easy way to omit from the analysis or otherwise adjust for categories that appear to be regionally concentrated.[23] Moreover, low-skill industries are likely to be concentrated in low-wage areas. This phenomenon adds an element of uncertainty to an already crude measure, but there is as much or more reason for accepting the geographic concentration as a reflection of the distribution of skills than as wholly a reflection of geographic differentials in occupational wage rates.

Level of Classificatory Detail. The most detailed census occupational classification provides 844 categories, half male, half female. These can be successively telescoped into fewer and fewer categories. With each reduction, less of the interstate dispersion in average annual earnings is explained by rate-constant standardization (Table 2). For example, the coefficient of determination for

[22] Fifty per cent or more of the experienced labor force in 68 of the 422 detailed occupations are located in one of the four census regions. Most of these detailed occupations are found among operatives and laborers, in which industrial attachment is a classificatory criterion. The 68 detailed occupations showing high geographic concentrations are distributed as follows: Northeast, 31; North Central, 17; South, 19; and West, 1.

This problem is much more serious for manufacturing industry hourly earnings of production workers than for occupational earnings (see Frank A. Hanna, "Contribution of Manufacturing Wages to Regional Differences in Per Capita Income," p. 22).

[23] Omitting from the analysis industries with more than a specified percentage of their activity (measured, for example, by man-hours) in a particular state or region would reduce the proportion explained by standardization. The selection of the critical percentage would have to be arbitrary, and often made when there was no clear-cut evidence that location, rather than the technical requirements of the industry, was the real determinant of the earnings level. Moreover, the amount of adjustment would depend upon whether the industrial earnings level was above or below the average of all industries. Since individual judgment is involved in selecting the industrial categories for omissions, it seems preferable to include all industries and then, if need be, make some allowance for the possible error in the final figure. Some notion of the effect of the possible error from this source can be obtained from the 1947 data for North Carolina, the state with the most unfavorable, and Michigan with the most favorable, composition of manufacturing industry. If the amount explained by industrial composition in North Carolina were reduced one-third, the state would still be among the eight with the most unfavorable manufacturing industry composition, even in the absence of an adjustment for any other state. If an adjustment of one-third were made for Michigan alone, it would still have the most favorable industrial composition of any of the states (*ibid.*, Table 2)

TABLE 2

Effect of Level of Occupational Classification on Rate-Constant State Earnings, 1949

Level	*Number of Categories*	*Coefficient of Determination*[a]	*Coefficient of Variation*[b]
Reported earnings	...	...	16.0
Rate-constant earnings for:			
Detailed occupation and sex	844	0.81	5.1
Detailed occupation, sex omitted	422	0.80	5.1
Major occupational group and sex	24	0.77	3.4
Major occupational group, sex omitted	12	0.69	3.0
Sex	2	0.08	1.4
White collar and blue collar groups, sex omitted[c]	2	0.02	1.4

... not applicable.

Note: Earnings are average annual earnings per worker.

[a] The ratio of the total variation of the reported earnings to the variation explained by standardizing earnings.

[b] The standard deviation expressed as a percentage of the average state earnings. The average state earnings is the unweighted average of the forty-eight states (the District of Columbia is omitted).

[c] The first five major groups—professional, technical, and kindred workers; managers and officials; clerical and kindred workers; and sales workers—form the white collar category. All other groups are included in the blue collar category.

Source: *Census of Population, 1950*, Bureau of the Census. For methods of computation, see notes 17 and 18 in the text.

major occupational group (sex omitted) is 0.69; for detailed occupations (sex omitted), 0.80. Thus, the use of major occupational groups leaves unexplained the part of the interstate variation attributable to within-major-occupation variation among detailed occupations. Or this may indicate that the use of detailed occupations explains 35 per cent of the portion unexplained by major occupational groups.[24] When the occupational categories are telescoped to the point that only two categories remain, very little of the interstate differences are explained; most of the variation is within the two categories.

Coefficient of Variation. Some studies use the difference in the coefficients of variation as a measure of the effects of standardization. The coefficients are computed independently for the reported and

[24] Major occupational groups explain 69 per cent of the interstate dispersion and leave unexplained 31 per cent. Detailed occupations explain an additional 11 per cent, which is 35 per cent of the 31 per cent left unexplained by major occupational groups.

standardized series and do not take into account the interrelationships between them.[25] The difference in the coefficients should be used as a measure only when there is reason to exclude or ignore these interrelationships. Table 2 shows clearly that a reduction in the number of categories used in standardizing earnings is sufficient to reduce the coefficient of variation. This effect is to be expected from the simple fact that there is less room for variation. For example, when rate-constant state earnings are computed for sex and collar-color, the coefficients of variation are about 9 per cent of those for the reported series. When the interrelationships between the series are taken into account by computing a coefficient of determination, however, the differences in the sex composition of state labor forces explains about 8 per cent of the reported differences in earnings, and the differences in collar-color composition, about 2 per cent. Here the interrelations between the series make for wide differences in the explained variation. On the other hand, in a comparison between the interstate dispersion of per capita incomes based on the total population and one based on the population fifteen years and older, the interrelationships between the two series is unimportant.

When widely differing levels of classificatory detail are used in the standardization processes, a warning must be sounded against basing too much confidence in comparisons of the coefficients of variation. For it cannot be known how much of the reported difference is due to the variable not held constant and how much to the variation in the number of classificatory categories. The coefficient of determination provides more consistent results in such cases.

Comparison with Regression Analysis. The mechanical effects of the computational manipulations involved in standardizing state earnings can best be understood in terms of the more familiar logic of multivariate regression analysis, to which they are analogous.

Standardization is sometimes described in terms of the effect of some shift of factors, for example, the effect of shifting rates until every person in an occupation has the same annual earnings. Stand-

[25] The coefficient of variation and the coefficient of determination are related. When the reported and the standardized series have identical means, the difference in the coefficients of variation $(V_1 - V_2)/V_1$, where the subscript 1 relates to the reported series and 2 to the standardized series, is related to the coefficient of correlation by the constant b_{12} (the slope of the regression line), since $r = b_{12}\,(V_2/V_1)$ and the coefficient of determination is r^2. Also, the square of the ratio of the coefficients $(V_2/V_1)^2$ is equal to the portion of the variance attributed to the independent effect of holding rates constant (cf. Borts' comment). The condition that the means of the two series be the same is met only approximately when each of the states is treated as a single pair of observations.

ardization has been criticized because such a shift is held unrealistic and likely to produce unpredictable side-effects.

To describe the method in these terms is both unnecessary and misleading. Though less precise than multivariate regression, standardization procedures are simply another attempt to take into account the effects of specific sources of variation so as to describe existing phenomena more accurately. It is the effect of a variable, and not the variable itself, which is held constant. In multivariate analysis about the only set of assumptions involved are those concerned with the linearity of the relationships among the variables; in standardization these relationships are assumed unimportant. Both methods are essentially descriptive of numerical relationships in specific sets of data, and both are silent on the existence or identification of chains of causation.

FURTHER OBSERVATIONS ON OCCUPATIONAL DATA

In many respects, the occupational distributions provided by the 1950 census of population are ideal for explaining state variation in incomes through standardization procedures; they also have important limitations. On the positive side, the ability to classify all recipients by their occupational characteristics is an advantage.[26] Available data, however, limit the present analysis to wage and salary income. Census information was obtained on self-employment income, but existing tabulations do not include state distributions of this type of income. Another alternative, the classification of total income from all sources by the occupational characteristics of the recipient, is precluded by the absence of distributions by income size for categories more detailed than the intermediate occupational group.[27] With proper handling at the processing level and the provision of categories for nonearners, the use of occupational characteristics to classify all recipients by their total income looks promising.

Although occupation cannot be interpreted unambiguously in economic terms, it seems clear that it reflects economic factors primarily. Differences in occupational earnings may be based on the relative scarcity of basic skills, but there is no assurance that the

[26] It would be necessary to add several categories, such as investor, to the usual classification of earners for this statement to be strictly accurate.

[27] There is some doubt whether present census classification rules, which are directed toward the occupational classification of persons by the source of their *earned* income, are appropriate for this use. To the extent that there are persons primarily dependent upon property incomes who also receive wages and salaries or self-employment income in minor amounts from occupational activities unconnected with the sources of their property incomes, the within-occupation dispersion would be increased.

relationship is very exact at any time or place or that appropriate adjustments are made as demand changes over the business cycle.[28] Consequently, observations taken for a single year may reflect more the distribution of opportunities for gainful employment than that of basic skills. In either case, occupation relates to an economic activity giving rise to income, rather than to the size of the income resulting from economic activity.[29] Furthermore, since occupation is a characteristic of individuals, it is easily cross-classified by other individual characteristics, such as sex or color, which may explain part of the within-occupation dispersion. This preoccupation with economic factors is, of course, a matter of choice in the present study. Other students may find demographic or sociological factors of more interest than those based on economic criteria.

There is some question whether sex is intended to be, or should be, treated as a criterion for distinguishing occupations, for example, whether male bookkeepers and female bookkeepers are one or two occupations. In combining the detail occupations into an intermediate occupational classification, the Census Bureau maintains the sex distinction, and different numbers of intermediate occupations are provided for each sex. At this time and the major group level, sex is probably a valuable distinguishing criterion.[30]

Fortunately, the occupational data are in sufficient detail to permit standardizing state earnings both using and omitting the sex distinction. Thus, interpretation can be left to the user of the results. The need for interpretation remains, however. If state differences are to be explained in economic terms only, then one must decide whether the sex criterion in occupational classification represents differences in the work performed. If sex cannot be judged an economic criterion for classifying occupation, then only the 422 detailed occupational categories should be used in standardizing state earnings; the additional variation in state earnings that is explained by the addition of the sex criterion and the use of the 844 occupational-sex categories then provides a measure of the within-occupation dispersion explained by sex.[31] This makes the occupation series one of the few that are sufficiently cross-classified to per-

[28] Edwin Mansfield, "Wage Differentials in the Cotton Textile Industry, 1933–1952," *Review of Economics and Statistics*, February 1955, pp. 77–82, and the literature there cited.

[29] Classifications based on size of income received would lead to a tautology in a standardization framework.

[30] In this study no use is made of the intermediate occupations and only limited reference is made to major groups.

[31] Only 5 per cent of the interstate dispersion not explained by the 422 detailed occupations is explained by using sex as a classificatory criterion (see Table 2). In part this is due to a lower correlation between rate-constant male and female

mit any measurement of a noneconomic source of the effect of within-category dispersion on state differences.

There seems to be no lower common unit in which occupation can be defined. The varying occupational composition among firms within an industry, on the other hand, builds into an industrial series some within-industry dispersion that can be described in occupational terms.

Occupational income data are available in sufficient detail to permit their use for standardizing state earnings only for one year, 1949.[32] Although 1949 was in part a year of minor recession, it was also a year of relatively high employment. But without data for a series of years spanning periods of full employment and recessions, it is not possible to do more than gauge the general direction of the bias involved in taking a single reading of cyclically sensitive phenomena. With a high level of economic activity, the within-occupation dispersion that comes from short workweeks or periods of unemployment is at a minimum. This tendency is reinforced if the level of employment is stabilized and there is minimal frictional employment.

CHANGES, 1919–1949

State per capita income estimates are available for 1919–1921 and 1929–1953.[33] This sets a maximum on the number of years that can be analyzed. Although explanatory series are not available for all of the years, the state per capita income estimates provide an opportunity to describe the differential behavior of the several states for an extensive period.[34]

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earnings ($r^2 = 0.62$) than between reported male and female earnings ($r^2 = 0.91$). The rate-constant earnings of women in the three southern divisions appear to be about $100 lower than would be expected on the basis of a regression line fitted to male and female rate-constant earnings in other states. Apparently, this is partly due to the larger than average percentages of women in private household work in the southern states. In part it is due to a combination of low female participation in the labor force, the prevalence of rural residences, and the lack of opportunities for female employment in the more remunerative occupations in the southern states.

[32] State frequency distributions of the employed experienced labor force by occupation are based on the census week, usually a week in April 1950. The occupation of the unemployed experienced labor force is based on the last job held.

[33] See note 1.

[34] A draft report, "Changes in State Per Capita Incomes, 1919–21 and 1929–49," was prepared in 1952. This report contains many of the tables and charts only referred to in this presentation. Data for 1950–1953, and revisions of earlier estimates, which have become available since the analyses included here were

The mean state per capita income varies from a low of $321 in 1933 to $1,576 in 1953 (Table 3).[35] The absolute dispersion around these means, as measured by the standard deviation, tends to rise and fall with the means. However, the relative dispersion, as measured by the coefficient of variation, tends to move inversely to the movement of the means. Although the period is too short for tested conclusions, there is some evidence of a downward trend in the coefficients of variation—evidence that the states became more

TABLE 3

Averages, Standard Deviations, and Coefficients of Variation of State Per Capita Incomes, 1919–1921 and 1929–1953, by Year

Year	*Average*[a]	*Standard Deviation*	*Coefficient of Variation (per cent)*
1929	$ 592	$209	35.2
1930	518	197	38.0
1931	434	176	40.5
1932	328	136	41.4
1933	321	124	38.5
1934	370	132	35.7
1935	411	139	33.8
1936	475	158	33.3
1937	500	167	33.3
1938	456	147	32.1
1939	486	161	33.1
1940	520	176	33.9
1941	631	200	31.6
1942	834	247	29.6
1943	992	267	27.0
1944	1,078	255	23.7
1945	1,108	243	21.9
1946	1,130	257	22.8
1947	1,222	274	22.4
1948	1,307	276	21.1
1949	1,235	264	21.4
1950	1,343	305	22.7

(continued on next page)

first undertaken, are sometimes, though not always, included in the tables. There are apparent inconsistencies between the tables taken from the several studies which, because of insufficent time, could not be removed or reconciled. In preparing a final report on the study, I shall recompute many of the measures to take advantage of the 1929–1954 state series on personal income published in *Survey of Current Business*, Dept. of Commerce, September 1955.

[35] The mean state per capita income is an unweighted average of the per capita incomes for the forty-eight states. The District of Columbia, being entirely urban and having extreme income differentials, is omitted from most parts of this study.

TABLE 3 (continued)

Year	*Average* [a]	*Standard Deviation*	*Coefficient of Variation (per cent)*
1951	1,486	329	22.2
1952	1,534	333	21.7
1953	1,576	355	22.5
1919	584	155	26.5
1920	608	193	31.7
1921	500	175	35.1

[a] The unweighted average of the forty-eight state per capita incomes (the District of Columbia is omitted).

Source: *1929–1943:* Computed from *Survey of Current Business,* Dept. of Commerce, August 1951, Table 8, p. 18. *1944–1953:* Computed from *ibid.,* August 1954, Table 4, p. 15. *1919–1921:* Computed from Maurice Leven, *Income in the Various States: Its Sources and Distribution, 1919, 1920, and 1921,* National Bureau of Economic Research, 1925, Tables 46–48, pp. 260–265.

tightly grouped around the mean state per capita income than would be expected from the rising level of income.[36] While the King-Leven estimates for 1919–1921 are well within the range of the Department of Commerce estimates for 1929–1949, the coefficients of variation do not follow this behavior and suggest that, if there is a trend toward declining coefficients, its onset was after 1921.

The coefficients of variation go far toward describing the behavior of the states as a group but tell little about the behavior of individual states. Gauging the behavior of individual states is largely the problem of choosing a model that provides a theoretically justifiable set of expectations. It may be informative to say that a state's income has changed by a given percentage, but it is more informative if one can add that the given percentage change is more or less than could be expected on the basis of relevant relationships.

A state's per capita income is often said to have increased (decreased) by a larger (smaller) percentage than did the national per capita income. Implicit in such statements is the notion that the forces making for a change in national per capita income would produce the same relative effects in each state. Since the national per capita income is a weighted average of the per capita incomes

[36] When the 1929–1949 percentage changes in the mean state per capita income are compared with the percentage changes in the coefficient of variation, the coefficient of determination is 0.91. When time is added as an independent variable and multiple correlation used, a coefficient of multiple determination of 0.95 is obtained. This is a significant improvement over the coefficient of simple determination. More conclusive evidence is presented in the next section.

of the forty-eight states and the District of Columbia, the changes in each of the states is taken into account, although on an undifferentiated basis.

Some differentiation is provided if a regression line is fitted to the state per capita incomes for the two years compared. The regression line treats the changes in the states as a linear function of the size of the state's income at the beginning of the period. It recognizes that a state that has previously achieved a high per capita income may have great difficulty in achieving a further increase of the same percentage size as a low-income state, particularly when the larger absolute increases in the high-income states may be smaller percentage increases. It seems reasonable to suppose that states with their resources already highly developed, as indicated by a high income level, may have more difficulty expanding them than would states with large banks of unused resources. The very notion of the allocation of scarce resources should lead us to expect a comprehensive measure, such as per capita income, to regress toward the mean.[37] Thus a regression line, if it adequately describes the pattern of change among the states, provides a better set of expectations against which to gauge the behavior of a particular state than does the percentage change in national per capita income.

The regression lines used in this study were fitted by means of least squares to the absolute amounts of state per capita incomes.[38] There are reasons to prefer the relative changes implied by a regression line fitted to the logarithms of the state per capita incomes. But the differences between the regressions fitted to the absolute amounts and to logarithms tend to be small and often insignificant.[39] Although the correlation coefficients tend to be uniformly high and the standard errors small, several other tests were made of the linearity of the regression lines.[40] Each test cast some doubt on the linearity of the regressions, though inconclusively. Some pairs of

[37] Harold Hotelling, "Review of Horace Secrist's *The Triumph of Mediocrity in Business*," *Journal of the American Statistical Association*, December 1933, pp. 463–465.

[38] Since there is no one "standard" year, regression lines were fitted to each pair of years, 1929–1949. This required some 210 regression lines. These were supplemented by fifteen regression lines based on 1919–1921, consisting of the combinations of 1919–1921 among themselves and each of these three years with 1929, 1933, 1939, and 1949.

[39] Regression lines were fitted to the logarithms of state per capita income for some forty-five pairs of years. These pairs of years were chosen largely on the basis of a visual inspection of the scatter diagrams for evidence that a curvilinear regression might provide a better fit. In only eighteen cases did the logarithmic regression provide a fit which was significantly superior at the 0.05 probability level.

[40] In one test, the departures of group averages from the regression lines were examined to see if there were patterns that would suggest nonlinearity. The groups

years that appear linear by one test do not appear so by another. For 42 of the 210 regressions there is no evidence that the regression is not adequately described by a straight line. Experiments in fitting parabolas were not promising.

The results of still another test of linearity, in which the departures of each of the states from the linear regression lines were tabulated, are given in Table 4. The test is based on the hypothesis that, if the linear regression adequately describes the changes, and if any

TABLE 4

Relation of Commerce Department Estimates to Linear Regression Estimates of State Per Capita Incomes, 1929–1949

STATE [a]	AVERAGE 1929–1950 PER CAPITA INCOME	SIGN OF COMMERCE DEPARTMENT ESTIMATE MINUS LINEAR REGRESSION ESTIMATE [b] *Frequency* *Plus*	*Equal*	*Minus*	RANK (*from most plus to most minus*)
New York	$1,156	46	13	151	34
Connecticut	1,075	105	31	74	19
Nevada	1,060	158	16	36	5
California	1,051	122	29	59	16
Delaware	1,048	96	23	91	25
New Jersey	1,036	32	28	150	33
Illinois	986	142	16	52	11
Massachusetts	977	26	12	172	46
Rhode Island	960	31	12	167	43
Washington	914	155	20	35	7
Maryland	893	109	28	73	18
Ohio	890	145	26	39	9
Michigan	885	138	18	54	13
Pennsylvania	867	30	50	130	31
Oregon	842	165	18	27	2
Montana	828	174	15	21	1
Wyoming	828	100	31	79	21
New Hampshire	777	34	16	160	40
Wisconsin	773	140	35	35	12
Colorado	770	101	35	74	20
Indiana	770	164	18	28	3
Missouri	743	57	32	121	29
Iowa	730	145	18	47	10
Nebraska	729	131	16	63	14
Minnesota	726	89	34	87	23
Kansas	716	123	26	61	15

(continued on next page)

used were $100 income classes in the year treated as independent. In another, runs of five or more states on one side of the regression lines were counted and their position noted. In 36 of the 210 regressions, the three or more terminal $100 classes lay on one side of the line, and there were runs of five or more states on one side of the line in 131 of the 210 regressions.

TABLE 4 (continued)

STATE [a]	AVERAGE 1929–1950 PER CAPITA INCOME	SIGN OF COMMERCE DEPARTMENT ESTIMATE MINUS LINEAR REGRESSION ESTIMATE [b] Frequency: *Plus*	*Equal*	*Minus*	RANK (*from most plus to most minus*)
Maine	711	26	15	169	45
Vermont	708	23	25	162	42
Utah	701	111	46	53	17
Idaho	696	146	25	39	8
Arizona	663	59	28	123	30
North Dakota	662	158	25	27	4
South Dakota	662	157	15	38	6
Florida	651	81	42	87	24
Texas	634	90	57	63	22
Virginia	616	73	30	107	26
West Virginia	584	37	21	152	35
Oklahoma	571	51	41	118	28
New Mexico	544	49	49	112	27
Louisiana	539	28	28	154	37
Tennessee	498	33	36	141	32
Georgia	488	24	26	160	41
Kentucky	481	11	25	174	47
North Carolina	481	36	19	155	38
Alabama	434	23	29	158	39
South Carolina	431	36	21	153	36
Arkansas	425	17	25	168	44
Mississippi	358	11	17	182	48

[a] In order of 1929–1950 per capita income.

[b] The signs were ascertained by an inspection of scatter diagrams on which the later of the pair of years was plotted on the y-axis, the earlier of the pair on the x-axis, and the regression line was shown. Because of the size of points and the scales used, a state per capita income might depart from the regression line as much as $10 and still be counted as being on the line (that is, as the Commerce Department estimate being equal to the regression estimate).

Source: *Survey of Current Business*, Dept. of Commerce, August 1951 (see note 38 for the method of computation).

departure from a regression line is due solely to extreme circumstances peculiar to a particular year, there will be a random pattern in the direction of the departures for a particular state.[41] When the

[41] Were each of the 210 regressions independent and the departure due to chance forces, the expected mean number of departures above (or below) or on the regression line would be 105, with a standard deviation of 7.25, and as many as 124 departures in one direction could be expected to occur only once in 100 times. The independence and randomness criteria are not net. Since the earlier of a pair of years was treated as the independent variable, a year such as 1929 was thus the independent variable for twenty of the regressions; its peculiarities affected some twenty regressions. A year such as 1939 was treated as the dependent variable for the ten years 1929–1938, and as the independent variable for the ten years 1940–1949.

states departing with high frequency from the regression lines are distributed by size of their 1929–1950 average per capita income, the states most frequently below the regression lines are concentrated in the lowest quartile, and those most frequently above, in the third quartile.[42]

The pattern of departure of the states from the linear regression lines given in Table 4, together with a visual inspection of the scatter diagrams on which the results of the various tests of linearity had been noted, led to the conclusion that a regression line that started somewhat below the linear regression line at the lower end of the distribution, rose somewhat more rapidly to somewhere within the third quartile, and leveled off to about the same or a slightly lower position than the linear regression line at the upper end of the distribution would reduce the number of states departing from it with excessive frequency in one direction. Such a line, though its exact position is unknown, describes the 1929–1949 average pattern of observed year-to-year changes somewhat better than does a straight line. As compared with linear regression, a regression line curved downward slightly at its ends suggests that states with incomes so high as to indicate an approach to full resource use, and those with incomes so low as to indicate many unused resources, found it difficult to expand production as rapidly as the states in the central income quartiles during the period of a generally expanding economy covered by the analysis.

While the position of a "best" regression line is left ambiguous, it is clear that such a line lies fairly close to the linear regression line. With the exception of a few pairs of contiguous years, when both the income level and coefficients of variation changed moderately, the difference between a curvilinear and linear regression would be much less than the difference between a curvilinear regression and a line of proportional change (that is, a line passing through the origin and either the unweighted mean state income or the weighted national per capita income). Thus, in describing the behavior of an individual state, less error is likely in comparing its position with the linear regression line than with a line of proportional change. Although the linear regression line provides an imperfect measure, it recognizes that economic forces

[42] Of the 18 states with 124 or more departures below the regression lines, 10 are in the lowest 1929–1950 income quartile; 7 of the 14 states with similar numbers of departures above the regression line are in the third quartile. The coefficient of rank correlation between the position of the state with respect to the regression lines, ranked from the most frequently above to the one most frequently below the line (last column of Table 4), and the state's 1929–1950 average per capita income, ranked from highest, is 0.41.

make for differential changes among the states. Comparisons with the linear regression lines have been summarized in Table 4. About the most that a similar summary of comparisons with the line of proportionality would show is that there was some regression, that is, that the states below the mean were above, and those above the mean below, the line of proportionality.

CYCLICAL AND SECULAR CHANGES [43]

The comparisons of the state distributions in one year with those of other years in the preceding section did not try to identify the forces responsible for the observed changes. In this section attention is focused on two groups of such forces: the changes in the state distributions associated with the level of the national income and those that appear to have a persistent and differential influence on the development of a state's income.

As a measure of the state changes associated with a change in the level of the national income, crude sensitivity indexes were computed by ordinary regression methods for each state for the period 1929–1950.[44] The crude sensitivity index states the percentage change in the state's per capita income associated with a 1 per cent change in the per capita income of the United States. The differences between the Commerce Department per capita incomes and those computed from the crude sensitivity indexes were tested to see if they contained any significant time order.[45] When the differences between the two series were not time ordered, the crude sensitivity index was accepted as an adequate description of the association between the relative changes in the state's and the nation's per capita incomes. When the time order of the differences proved sig-

[43] The material in this section is treated more extensively in Frank A. Hanna, "Cyclical and Secular Changes in State Per Capita Incomes, 1929–50," *Review of Economics and Statistics,* August 1954, pp. 320–330.

[44] If for a particular state we let X_1 represent the state per capita income, and X_2 represent the United States per capita income for each of the twenty-two years 1929–1950, and to the logarithms of X_1 and X_2 we fit a least squares regression line of the type $\log X_{12} = \log a + b \log X_2$, the coefficient b is the crude sensitivity index. Since income is a comprehensive measure of the results of economic activity, both on a national and state level, it is presumed that any economic force operating to change the level of national income would also affect the several states. Consequently, all of the years 1929–1950 were included in the analysis. This decision treats the economic effects of deflation of the 1930's on a par with those of the inflation of the 1940's, and the economic effects of the Great Depression on a par with those of the war mobilization.

[45] This was done by introducing a third variable, X_3, time (year minus 1940), and computing the multiple regression $\log X_{1.23} = \log a' + b_{12.3} \log X_2 + X_3 \log b_{13.2}$. Analysis of variance was then used to test the significance of the additional variance accounted for by the addition of the third variable. The 0.05 probability level was used.

nificant, the coefficient computed net of the influence of time was accepted as the sensitivity index and the net time-factor index was retained for further analytical use (Table 5).

TABLE 5

Sensitivity and Time-Factor Indexes, by State, 1929–1950

State	*Average 1929–1950 Income*	*Sensitivity Index*	*Time-factor Index*[a] *(per cent change per year)*	*Average Error*[b] *(per cent)*
New England:				
Maine	$ 711	0.936		3.5
New Hampshire	777	0.844		3.0
Vermont	708	0.909		2.3
Massachusetts	977	0.808	−0.4	1.9
Rhode Island	960	0.791		2.6
Connecticut	1,075	0.863		3.1
Middle Atlantic:				
New York	1,156	0.909	−1.1	2.5
New Jersey	1,036	0.914	−0.6	1.7
Pennsylvania	867	0.989	−0.4	1.1
East North Central:				
Ohio	890	1.019		2.7
Indiana	770	1.068	0.9	3.0
Illinois	986	1.087	−0.7	2.9
Michigan	885	1.039		4.8
Wisconsin	773	1.126		1.4
West North Central:				
Minnesota	726	0.989	0.6	3.0
Iowa	730	1.292		6.1
Missouri	743	1.043		2.5
North Dakota	662	1.383	1.7	5.6
South Dakota	662	1.560		7.5
Nebraska	729	1.400	−0.9	4.5
Kansas	716	1.276		4.1
South Atlantic:				
Delaware	1,048	0.876		4.5
Maryland	893	0.825	0.7	3.0
District of Columbia	1,225	0.452		6.2
Virginia	616	0.849	1.9	3.2
West Virginia	584	0.936	0.7	3.9
North Carolina	481	0.858	2.7	4.9
South Carolina	431	0.898	3.2	5.3
Georgia	488	0.986	1.8	4.2
Florida	651	0.962	1.0	3.1
East South Central:				
Kentucky	481	1.062	0.7	3.3
Tennessee	498	1.068	1.4	4.3
Alabama	434	1.141	1.4	4.9
Mississippi	358	1.339		5.3
West South Central:				
Arkansas	425	1.118	1.7	5.3
Louisiana	539	1.020	0.8	3.0
Oklahoma	571	1.243		3.6
Texas	634	1.047	1.3	2.8

(continued on next page)

TABLE 5 (continued)

State	Average 1929–1950 Income	Sensitivity Index	Time-factor Index [a] (per cent change per year)	Average Error [b] (per cent)
Mountain:				
Montana	828	1.054	1.4	4.6
Idaho	696	1.269		4.2
Wyoming	828	1.016		4.2
Colorado	770	1.071		3.0
New Mexico	544	1.078	1.5	3.1
Arizona	663	1.078		3.4
Utah	701	1.156		4.2
Nevada	1,060	1.001		5.5
Pacific:				
Washington	914	1.112		5.4
Oregon	842	1.127		4.5
California	1,051	0.953	−0.5	2.5

[a] Time-factor indexes are shown only when they are significant (see note 45, in the text).

[b] The difference between the observed and the per capita incomes computed from the sensitivity and time-factor indexes for each year, expressed as a percentage of the observed figures, and averaged over the twenty-two-year period. The averages are of the absolute figures.

Source: For methods of computing indexes, see notes 44 and 45.

The state per capita incomes computed from the national per capita income and these sensitivity and time-factor indexes differ from the Commerce Department estimates by an average of 3.7 per cent (these differences are called "errors" in Table 5). The errors tend to be smaller during the years of gradual recovery (1936–1939) and larger during the war years (1941–1944); the largest errors are found in 1942, the first year in which the full effects of mobilization were felt. The use of a time-factor index apparently accounted for most of the time-associated differences, and there does not seem to be any pattern by years of the remaining errors for individual states. Consequently, these data do not support the hypothesis that either the Great Depression of the 1930's or the war mobilization of the 1940's left a permanent impact in the form of differential changes among the states. Rather, the errors appear to stem from short-lived irregular and nonrepetitive forces, such as major construction work, the timing of major war contracts, and vagaries of the weather.[46]

[46] One possible source of error, the intercensal population estimates, is difficult to evaluate. Some of the revisions incorporated in successive estimates are substantial and could account for relatively large differences between the per capita incomes computed from the indexes and those estimated by the Department of Commerce, and may even affect the size of these indexes. The state per capita incomes

The tendency for the coefficient of variation for state per capita incomes to move inversely to national per capita income has often been observed.[47] Some understanding of the mechanism by which this accordion effect operates can be gained by making use of state per capita incomes computed from the sensitivity indexes for the states and the per capita income of the nation. Such a series of computed state per capita incomes is expected to reflect only the effects of changes in the nation's per capita income payments and the responses of the states to these changes. The coefficients of variation for such a computed series, 1929–1950, shows a more pronounced accordion effect than does the Commerce Department estimates (Table 6).[48] The coefficients based on the computed series start somewhat lower, rise with every decrease in the national income, and decrease with every increase. Table 5 shows some tendency for the states with lower incomes to be more sensitive to changes in the level of income. As the national income increases, the more sensitive states near the lower end of the distribution would increase relatively more, and the less sensitive states near the upper end of

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used in this analysis are from the *Survey of Current Business* for August 1951, and reflect the revised intercensal population estimates of March 1951 (cf. *Current Population Reports*, P-25, No. 47, March 1951). For example, these revisions for 1944 ranged from 5.3 per cent downward to 3.8 per cent upward, averaging 1.2 per cent. Similar figures for 1947 show a range of −10.5 to 8.2, with a 2.8 per cent average. Subsequent revision of the 1940–1949 population estimates (*Current Population Reports*, P-25, No. 72, May 1953), which have not been incorporated in these figures, is almost as large as the earlier revisions, although they often relate to different states, and (for 1944 and 1947) more than half of the changes are in a different direction. The net effects of these revisions in the population estimates on the state per capita incomes may be seen from the following coefficients of variation:

	1944	*1947*
August 1950 Commerce estimates	24.1%	22.9%
August 1951 Commerce estimates	23.4	22.3
Based on May 1953 population estimates	23.9	22.4

It is possible that none of the population estimates for particular states for particular years adequately reflects the timing and magnitude of interstate migration. For example, the problem of defining and reporting the employment and payrolls, particularly for large construction projects, such as are found in armed service installations or the Savannah River project, is much easier than accounting for the short-lived interstate population shifts which accompany them.

[47] Charles F. Schwartz and Robert E. Graham Jr., "State Income Payments in 1949," *Survey of Current Business*, Dept. of Commerce, August 1950; John L. Fulmer, "Factors Influencing State Per Capita Income Differentials," *Southern Economic Journal*, January 1950, p. 273; and Edgar M. Hoover and Joseph L. Fisher, "Research in Regional Economic Growth" in "Problems in the Study of Economic Growth," mimeographed, National Bureau of Economic Research, 1949, p. 201.

[48] Since the same number of observations (states) is used in the computation of the coefficients of variation for each income variant and for each year, the coefficients in Table 6 may be compared without being subject to the limitations noted above (particularly the discussion of Table 2).

TABLE 6

Coefficients of Variation for Observed and Computed State Per Capita Incomes, 1929–1950

YEAR	NATIONAL PER CAPITA INCOME [a]	COEFFICIENT OF VARIATION BASED ON STATE PER CAPITA INCOME: *Estimated by Commerce Department*	*Computed from Sensitivity Index* [b]: *Alone* (*per cent*)	*Computed from Sensitivity Index* [b]: *Plus Time Index*
1929	$ 680	35.2	30.4	36.4
1930	596	38.0	31.5	36.8
1931	500	40.5	33.1	37.7
1932	380	41.4	35.7	39.7
1933	368	38.5	36.1	39.5
1934	420	35.7	34.7	37.6
1935	460	33.8	33.8	36.3
1936	531	33.3	32.5	34.4
1937	561	33.3	32.0	33.4
1938	509	32.1	32.9	33.7
1939	539	33.1	32.4	32.7
1940	575	33.9	31.8	31.5
1941	693	31.7	30.2	29.4
1942	876	29.6	28.6	27.2
1943	1,059	27.0	27.5	25.5
1944	1,160	23.4	27.1	24.6
1945	1,191	21.8	27.0	23.9
1946	1,211	22.4	26.9	23.3
1947	1,293	22.3	26.7	22.6
1948	1,383	21.1	26.6	21.9
1949	1,325	21.4	26.7	21.5
1950	1,439	22.4	26.5	20.9
1951	1,581	22.2	26.4	20.3
1952	1,644	21.7	26.4	19.9
1953	1,709	22.5	26.4	19.5

[a] *1929–1950: Survey of Current Business,* Dept. of Commerce, August 1951. *1951–1953: Survey of Current Business,* August 1954. The District of Columbia is omitted.

[b] The sensitivity and time indexes are based on 1929–1950 data only (see notes 44 and 45). The entries for 1951–1953, thus, are beyond the range of years from which the indexes were computed, and are presented only as memoranda.

the distribution would increase relatively less, than the national income. Thus, an increase in the national per capita income would result in both extremes being nearer the mean state per capita income. Conversely, with a decrease in the national income, the more sensitive states would go down relatively more, and the less sensitive states relatively less, resulting in relatively larger interstate differences. Although not all the low-income states have high sensitivity indexes and the high-income states low sensitivity indexes,[49] this tendency is pronounced in the two extreme quartiles. In the lowest quartile (based on mean 1929–1950 incomes), eight of the twelve states have sensitivity indexes above unity. In the highest quartile, the situation is reversed, and eight of the twelve states have sensitivity indexes below unity. It is the extreme quartiles that have the most effect on the coefficient of variation.[50]

Although the sensitivity indexes appear to account for the direction of change in the coefficients of variation, the changes are smaller than those based on the Department of Commerce series. This might be expected, since no account is taken of the differential changes among the states reflected in the time-factor index.[51] Similar coefficients of variation of the series of state per capita incomes estimated from both the sensitivity and time-factor indexes behave very much like those for the series computed from the sensitivity indexes alone, but their size is closer to those computed from the

[49] The coefficient of rank correlation is 0.33.

[50] The differential behavior of the two ends of the distribution also helps to account for the positive intercept of regression lines fitted to years in which income increased, as noted in the previous section. The area of possible curvilinearity is largely confined to the central quartiles.

[51] The time-factor index cannot be interpreted as a measure of secular trend, although it probably contains a large element of differential trend. (1) The techniques used to compute the sensitivity and time-factor indexes are inadequate to distinguish on economic grounds between persistent changes that arise from cyclically connected forces, such as inflation with its differential price increases and consequent changes in demand schedules, and those that arise from secular forces, such as an influx of higher productivity industries. (2) In the absence of differential changes in the national income, the sensitivity indexes would reflect both trend and cyclical changes and would not be reversible. During the period 1929–1950 there were fifteen instances of increases and only six instances of decreases from the previous year. Although a different distribution of increases and decreases would affect the results, the actual distribution appears to be such that the method may be applied validly. (3) The period for which data are available provides only twenty-two pairs of values, so the time order of the differences between the computed and observed per capita incomes must be pronounced before a time index will be significant at the 0.05 probability level. (4) The time-factor index assumes a constant percentage change annually, which need not be the shape of a secular trend line. This limitation is not serious if the period covered can be selected so that all cyclical influences are eliminated (cf. Schwartz and Graham, *op. cit.*, in which an attempt is made to eliminate cyclical influences by the use of selected years thought to be cyclical peaks).

Basically, the sensitivity indexes are one species of standardization procedure. If the changes in the income paid out by each industry in the United States could be weighted by an appropriate number of recipients in a state, and the results summed for all industries in the state, approximately the same volume of income would be expected as that estimated by the sensitivity indexes. In effect, the sensitivity index approach handles all industries simultaneously, and since each state's industrial composition is continuously changing, the index may be expected to reflect the sensitivity of the average composition over the period studied. The time-factor index then may be expected to reflect significant changes in industrial composition.

Commerce Department series—the largest difference is about 10 per cent.

A rough measure of the relative contribution of the sensitivity and time factors to the observed reduction in the coefficient of variation can be obtained from a comparison of the several series in Table 6 and from a similar series based on the time-factor index alone.[52] To overcome the differences in timing, the average size of the coefficients for the two four-year periods (1930–1933 and 1947–1950) are used to measure the reduction in the coefficients of variation over the period. The percentage reductions are 45.2 per cent for the Commerce Department estimates, 43.5 per cent for the estimates based on both sensitivity and time-factor indexes, 22.0 per cent for the estimates computed from sensitivity alone, and 24.0 per cent for the estimates computed from the time-factor index alone. Thus, the increases in the national per capita incomes and the forces associated with the differential time-factor indexes appear to have contributed approximately one-half each to the total reduction in the coefficient of variation. Although such measures are subject to wide error, they tend to substantiate the existence of a persistent decline in the relative differences in state per capita incomes during the period 1929–1950, after account is taken of the effects of changes in the national per capita incomes.[53]

COMPONENTS, 1919–1951 [54]

For 1929, 1933, and annually since 1939, the Department of Commerce has prepared state distributions of the four principal components of income: wages and salaries, proprietors' income, property income, and "other" income (mainly transfer payments). The King-Leven study for 1919 to 1921 [55] combines transfer payments with wages and salaries, publishing only the total of the two items. Transfer payments were small during 1919 to 1921, and the combination probably could be treated as wages and salaries without serious bias; however, they have been treated as a combination of two components in this study. Property income and proprietors' income for 1919 to 1921 appear conceptually consistent with these

[52] In computing state incomes from the time-factor index, the level of each state's per capita income was taken at approximately the geometric mean of its 1929–1950 annual incomes.

[53] Since 1950, per capita incomes have continued to rise, although the coefficient of variation has remained almost constant. Since the sensitivity and time-factor indexes are descriptive rather than predictive, they would have to be recomputed to take into account these additional data.

[54] The report of the results of the analysis on which this summary is based will be found in the *Review of Economics and Statistics*, November 1956.

[55] *Op. cit.*

items for the later period. Two series of adjustments were made: (1) the data were reduced to a per capita basis to adjust for population differences and population growth, and (2) each of the components were expressed as a percentage of total income payments, which renders them independent of population change. These data help to explain the observed decrease in the interstate dispersion of per capita incomes.

State per capita property incomes had the greatest dispersion for the 1939–1951 period as a whole of any of the four components (Table 7). Per capita proprietors' income had almost as much interstate dispersion as property incomes. These two components and wages and salaries were all more disperse than per capita income payments. Per capita transfer payments, the smallest component, was the least disperse of the components and less disperse than per capita income. With few exceptions, this pattern has persisted since 1919. The interstate dispersion of per capita proprietors' income for 1920–1921, 1929, 1933, and 1939–1940 was somewhat less than that for per capita income. The interstate dispersion of per capita transfer payments in 1929 was greater than either proprietors' income or wages and salaries. Because transfer payments were combined with wages and salaries for 1919–1921, precise information is not available for this period.

State per capita wages and salaries, property income, and transfer payments, like state per capita incomes, have shown a tendency to become less disperse over the period. State per capita proprietors' income, on the other hand, has tended to become increasingly disperse over much of the period. The reduction in relative interstate dispersion of per capita wages and salaries was more the result of selective wage-equalizing shifts among industries within states than of the industrial composition of the states becoming more alike.

State per capita incomes, the sum of the four components, were less disperse than all combinations of two or three components, except that of wages and salaries with proprietors' income and of these two with transfer payments for the period 1939–1951. With few exceptions, this pattern has persisted during the years for which data are available. Among the noteworthy exceptions is the combination of proprietors' and property incomes for 1919–1921, 1929, and 1940–1941, when this combination was less disperse than per capita income.

Since state per capita property incomes were both more disperse than other components and tended to be larger in the states with larger wages and salaries and transfer payments, combinations of property income with these components usually show more inter-

TABLE 7

Coefficients of Variation of State Per Capita Income Components and Combinations of Components, 1919–1951

(per cent)

						WAGES AND SALARIES AND			PROPRIETORS' AND			WAGES AND SALARIES AND			
YEAR	TOTAL PER CAPITA INCOME	WAGES AND SALARIES	TRANSFER PAYMENTS	PROPRIETORS' INCOME	PROPERTY INCOME	*Proprietors'*	*Property*	*Transfers*	*Property*	*Transfers*	PROPERTY AND TRANSFERS	*Proprietors' and Property*	*Proprietors' and Transfers*	*Property and Transfers*	PROPRIETORS', PROPERTY, AND TRANSFERS
1929	35.2	39.9	44.0	27.6	71.9	30.5	44.3	39.7	34.4	26.3	68.0	35.3	30.5	44.0	34.0
1933	38.5	38.7	30.8	19.8	79.4	32.3	45.7	37.4	41.5	17.7	64.9	39.2	31.7	44.2	40.8
1939	33.1	37.7	30.4	26.7	70.0	29.6	42.0	36.1	33.7	22.6	52.3	34.1	29.1	40.1	30.7
1940	33.9	39.4	29.0	29.8	64.7	31.0	42.9	37.5	32.6	25.3	49.3	34.9	30.2	40.9	30.1
1941	31.6	39.7	28.4	37.4	60.1	29.4	42.0	37.7	30.5	31.9	46.6	32.4	28.6	40.2	28.4
1942	29.6	38.9	26.9	47.6	51.3	28.7	39.3	37.6	34.9	42.0	41.7	29.8	28.2	38.2	32.5
1943	27.0	36.4	15.1	45.0	47.7	26.5	36.7	34.7	33.5	37.7	35.2	27.6	25.7	35.2	29.8
1944	23.7	34.4	11.7	43.5	43.7	24.4	34.5	31.6	31.7	33.0	27.2	25.4	22.8	32.0	26.0
1945	21.9	32.1	11.0	40.2	41.6	22.6	32.5	28.7	30.0	27.9	23.8	23.8	20.7	29.4	23.0
1946	22.8	32.2	16.3	39.7	40.2	22.9	32.6	29.6	30.2	29.4	26.5	24.0	21.5	30.2	24.6
1947	22.4	31.1	19.2	50.5	39.9	22.5	31.6	29.0	36.4	38.5	28.0	23.5	21.3	29.7	30.1
1948	21.1	29.1	20.0	52.2	38.2	21.2	29.5	27.4	36.9	41.2	28.2	22.0	20.2	28.1	31.3
1949	21.4	28.2	20.0	37.1	38.5	21.2	28.9	26.3	26.5	27.3	27.8	22.4	20.1	27.2	22.2
1950	22.7	29.6	18.7	43.3	41.4	22.1	30.5	27.4	30.8	31.2	28.6	23.8	21.1	28.6	25.2
1951	22.2	29.1	17.4	43.8	40.7	21.7	30.0	27.3	30.8	32.9	28.9	23.0	20.5	28.3	25.6
1939–1951	23.7	32.1	16.1	41.8	44.7	23.2	33.1	30.0	30.0	32.0	31.3	24.7	22.1	31.2	25.4
1919	26.7	...	...	35.3	52.9	...	...	38.5	26.5	...	...	...	24.5	39.7	...
1920	32.1	...	...	26.4	55.3	...	...	40.3	25.9	...	...	...	29.9	41.7	...
1921	35.8	...	...	29.8	59.0	...	...	38.3	35.3	...	...	...	32.5	41.6	...

... = not available.

Source: *1929, 1933, and 1939–1941: Survey of Current Business*, Dept. of Commerce, August 1945. *1942–1947: Ibid.*, August 1950. *1948–1949: Ibid.*, August 1952. *1950–1951: Ibid.*, August 1953. *1919–1921:* Maurice Leven, *Income in the Various States: Its Sources and Distribution, 1919, 1920, and 1921*, National Bureau of Economic Research, 1925. The 1919–1921 per capita incomes are the sum of the items for which data are shown and exclude certain in-kind and imputed items (see Leven, *op. cit.*, 236*n*). The District of Columbia is omitted.

state dispersion than the component or components with which property income is combined. Except for 1921, 1929, 1933, and 1939–1940, the combination of property income with proprietors' income or with proprietors' income and transfer payments shows less interstate dispersion than proprietors' income alone.

The percentage distribution among the four components (or composition of a state's income), although not adjusted for population size, is independent of it. The widest departure from the average state composition is found in the proprietors' incomes, the least in wages and salaries, with property income and transfer payments occupying intermediate positions (Table 8). The most marked

TABLE 8

Coefficients of Variation of State Income Components as Percentages of Total State Income, by Specified Years, 1919–1951

(per cent)

Year	*Wages and Salaries*	*Transfer Payments*	*Proprietors' Income*	*Property Income*
1929	10.7	27.1	41.3	38.8
1933	7.7	27.7	35.8	40.8
1939	9.8	22.2	38.6	38.8
1940	10.8	22.1	39.1	33.0
1941	14.2	27.1	44.5	31.5
1942	16.7	21.3	47.3	28.8
1943	15.7	24.7	45.5	27.5
1944	15.9	27.3	44.5	25.9
1945	15.2	25.3	40.4	24.3
1946	15.2	23.3	37.8	22.1
1947	16.0	24.4	43.8	22.8
1948	16.0	24.5	45.6	23.9
1949	11.6	24.8	38.8	22.3
1950	12.8	24.0	42.2	22.7
1951	12.8	25.4	43.1	22.7
1939–1951	14.3	22.5	42.7	25.1
1919	–19.7–		38.1	31.7
1920	–12.9–		35.0	29.8
1921	–9.0–		30.7	28.7

Source: Same as Table 7.

change in the composition of state income payments is the reduction in the relative importance of property incomes. For selected years 1919–1933, property incomes accounted for 16 to 19 per cent of state income payments; since 1939, they have averaged only 11 per cent. The decreasing importance of average state property incomes was accompanied by a decrease in its interstate dispersion.

Wages and salaries as a percentage of state income payments has varied within the range of from 61 to 68 per cent since 1929. Wages and salaries and transfer payments combined increased in relative importance from 55 to 61 per cent in 1919 to 1921 to 70 per cent or more in every year after 1942 except 1946. Wages and salaries tend to be a larger percentage component in the states having the higher per capita incomes. When wages and salaries and proprietors' incomes are combined and treated as a single component, the combination accounts for 76 to 86 per cent of the income payments in every state, and the interstate variation seems to be accounted for chiefly by variations in proprietors' income, which tends to be a smaller percentage component in states with higher per capita incomes. The combination is unrelated to the size of a state's per capita income.

Howard G. Schaller's intensive study of transfer payments [56] has extended these findings. Much of the observed decrease in the interstate dispersion of transfer payments, 1929–1951, resulted from payments made to veterans, although the amount of social security transfer payments increased more rapidly during the period. The public assistance portion of social security transfers tended to be slightly higher in the higher per capita income states in 1939, but was not related to state per capita incomes in 1949, and unemployment compensation and old-age and survivors' benefits both tended to be higher in the higher per capita income states. Transfer payments to veterans, although administered on a national basis under a uniform set of regulations, apparently have been more attractive to residents of the lower income states. In 1949 they constituted 7 per cent or more of the income in four southeastern states. The interstate dispersion of social security transfer payments was larger than that for veterans' transfer payments. Because of their distributions by state, the two types of payments combined during recent years in such a way that transfer payments had a lower relative interstate dispersion than the wages, proprietors', and property components reduced the relative interstate dispersion of these components in any combination. Since veterans' transfer payments are a temporary

[56] Howard G. Schaller, *The Effects of Transfer Payments on Differences in State Per Capita Incomes, 1929, 1939, and 1949*, a Ph.D. dissertation on file in the Duke University Library, is a monographic report of these investigations. A part of his findings are published in "Veterans Transfer Payments and State Per Capita Incomes, 1929, 1939, and 1949," November 1953, pp. 325–332, and "Social Security Transfer Payments and Differences in State Per Capita Incomes, 1929, 1939, and 1949," February 1955, pp. 83–89, both in *Review of Economics and Statistics*.

and declining portion of income, the observed effects of these payments on state per capita incomes in 1949 are likely to decline.[57]

DEMOGRAPHIC FACTORS

Studies have been conducted of three sets of demographic factors: state differences in the age composition of the population, state differences in labor force participation, and the relation of city size to income.[58]

Age Composition. In dividing total income by total population to obtain per capita income, it is implicitly assumed that the total population does not vary from one state to another in any important way. In this study, persons fifteen years or older, twenty years or older, or twenty to sixty-four years of age were substituted for the total population in the denominator of the per capita income calculation. It is at these ages that persons contribute, or contribute most effectively, to income production. The study relates to the three most recent decennial census years, when both age and income distributions by state are available.

Substitution of the population in the potentially productive ages for total population in the per capita adjustment reduces the interstate dispersion by one-ninth to one-fifth (Table 9). Moreover, since 1930 the age compositions of the states have become more alike. This reduction in the dispersion of the denominator, coupled with the reduction in the interstate dispersion of per capita incomes noted above, has had a multiplicative effect on the reduction of the interstate coefficient of variation. This follows from the fact that larger percentages of the total population are in the less productive ages in the lower income states, which have experienced larger percentage increases in income during the period.

Labor Force Participation. Two labor force variants of the population—employed labor force and total labor force—also were substituted for total population in making the per capita adjustment. Each variant provides direct data on the numbers in state populations who contributed directly to income payments. Since the census measures unemployment as of a single week, the employed labor

[57] The results of Schaller's investigations of the income effects of federal grants-in-aid relate more to disposable income than to state income payments before taxes. In these investigations, Schaller compares the income effects of the federal and local tax systems in financing the public works supported by the grants-in-aid system. Although the income effects are not great, they are in the direction of reducing the after-tax differences in state per capita incomes.

[58] This section summarizes Frank A. Hanna, "Age, Labor Force, and State Per Capita Incomes, 1930, 1940, and 1950," *Review of Economics and Statistics*, February 1955, pp. 63–69. In this volume, Mansfield provides an extensive discussion of the income effects of city size.

TABLE 9

Coefficients of Variation of State Per Capita Incomes Computed from Population Variants, 1930, 1940, and 1950

(*per cent*)

POPULATION VARIANT	COEFFICIENT OF VARIATION *1930*	*1940*	*1950*	PERCENTAGE DIFFERENCE FROM TOTAL POPULATION VARIANT *1930*	*1940*	*1950*
Total population	40.7	36.3	22.9	n.a.	n.a.	n.a.
15 years and older	35.9	31.4	19.4	11.7	13.5	15.1
20 years and older	33.9	29.6	17.9	16.7	18.5	21.7
20 to 64 years old	33.9	29.5	17.9	16.6	18.6	21.9
Total labor force	33.8 [a]	28.1	17.0	17.0	22.5	25.5
Employed labor force	...	28.3	17.6	...	21.9	23.2

n.a. = not applicable.
... = not available.
[a] Based on gainful workers.
Source: Income payments: *Survey of Current Business*, Dept. of Commerce, August 1951. Population and labor force: decennial censuses of population.

force variant contains an erratic element by state. These variants are highly correlated with the population variants based on age. The use of the total labor force, rather than the total population as the denominator in the per capita calculation, reduces relative interstate dispersion by 17 to 25 per cent (Table 9).[59]

INDUSTRY

A series of four studies based on industry have been undertaken for the light they throw on interstate differences in wages and salaries.[60] Three of these examine the interstate differences of detailed industries within a major industry segment. One, based on the 1950 census of population, covers all industries, although the amount of industrial detail is limited. Unfortunately, suitable data for manufacturing are available only for 1947, for wholesale trade only for 1948, for government only for 1952, 1939, and to a lesser extent for 1929, and the census income data only for 1949.

[59] In these studies, it is the variation in composition rather than in income which has been removed. Apparently, the same number of categories has been employed for each variant, and certainly for a single variant for the three years studied, so that sensitivity of the coefficient of variation to the number of categories used in the standardization is the same for each measure.

[60] See Frank A. Hanna, "Contribution of Manufacturing Wages to Regional Differences in Per Capita Income"; and "State Wholesale Trade Earnings, 1948," *Southern Economic Journal*, October 1955, p. 212, and "State Earnings by Industry, 1949" (unpublished preliminary results). Schaller is now conducting a study of the effects of government payrolls on differences in state per capita incomes for 1952, 1939, and 1929, for which a few preliminary results are available.

All Industries, 1949. The most comprehensive data are those available for 1949 from the population census. For each state, data are provided on the number of persons attached to, or employed in, each of 146 industries and on the distribution of the earnings of all wage and salary workers during 1949. These data, together with a special tabulation of wage and salary earnings by industry, permit the computation of state rate-constant average annual industrial earnings (Table 10).[61]

TABLE 10

Reported and Rate-Constant Industrial Earnings, by State, 1949

(dollars)

State	*Reported*	*Rate-Constant*	*State*	*Reported*	*Rate-Constant*
New England:			South Atlantic:		
Maine	2,065	2,258	West Virginia	2,412	2,382
New Hampshire	2,193	2,301	North Carolina	1,841	2,011
Vermont	1,997	2,203	South Carolina	1,740	1,972
Massachusetts	2,610	2,486	Georgia	1,801	2,066
Rhode Island	2,359	2,467	Florida	2,064	2,199
Connecticut	2,795	2,557	East South Central:		
Middle Atlantic:			Kentucky	2,024	2,127
New York	2,921	2,481	Tennessee	1,956	2,140
New Jersey	2,959	2,557	Alabama	1,832	2,079
Pennsylvania	2,630	2,502	Mississippi	1,408	1,800
East North Central:			West South Central:		
Ohio	2,797	2,531	Arkansas	1,594	1,940
Indiana	2,652	2,453	Louisiana	2,114	2,234
Illinois	2,936	2,503	Oklahoma	2,238	2,275
Michigan	2,974	2,587	Texas	2,277	2,301
Wisconsin	2,586	2,300	Mountain:		
West North Central:			Montana	2,461	2,176
Minnesota	2,472	2,226	Idaho	2,300	2,104
Iowa	2,312	2,126	Wyoming	2,557	2,308
Missouri	2,422	2,273	Colorado	2,412	2,311
North Dakota	2,007	1,892	New Mexico	2,364	2,249
South Dakota	2,028	1,928	Arizona	2,397	2,252
Nebraska	2,262	2,106	Utah	2,610	2,425
Kansas	2,372	2,249	Nevada	2,839	2,308
South Atlantic:			Pacific:		
Delaware	2,752	2,439	Washington	2,774	2,364
Maryland	2,652	2,461	Oregon	2,668	2,241
Virginia	2,277	2,265	California	2,870	2,431

Note: Earnings are average annual earnings per worker.
Source: For sources and method of computation, see note 61 in the text.

[61] The unpublished tabulation, identified as D-9, is based on a 3.3 per cent sample of returns and provides a distribution of the wage and salary income of class 1 and 2 (wage and salary) workers from which average annual earnings can be computed for each industry. The methods used for estimating industrial earnings from the D-9 tabulation are identical with those used in estimating occupational earnings (see

When industrial earnings are held constant, variations in industrial composition (in terms of the 146 population census industries) explain about 76 per cent of observed differences in state earnings of wage and salary workers.[62] The unexplained 24 per cent is attributable to the portion of the forces giving rise to dispersion of earnings within each industry that is not associated with state earnings rates. One of these factors apparently is differential occupational composition, which accounted for 80 per cent of the interstate differences in wage and salary earnings. If it is correct to assume that occupation is the basic determinant of differential earnings and that industry earnings are but a reflection of a particular occupational composition, these figures show that in 1949 about one-sixth of the interstate dispersion unexplained by industry composition was accounted for by differences among states in the composition of skills employed by specific industries.[63]

The use of fairly broad industry categories in the census leads to some dispersion within the industries. The 1950 census of population classifies manufacturing employees into 59 categories and wholesale trade into 10 categories. These may be compared with some 430 categories used in the 1947 census of manufactures, and with the 244 wholesale trade categories used in the 1948 census of business. Attention is now directed toward these more detailed bodies of data.

Manufacturing, 1947. The hourly earnings data by industry and by state, made available in the 1947 census of manufactures, provide the basis for computing the state hourly earnings of manufacturing production workers on the assumption that earnings rates were constant and only industry composition varied.[64] When the

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note 16). The experienced labor force attached to each industry, as given in the census (State Tables 79), was used to weight the industrial earnings in computing state average earnings standardized for industrial earnings by methods similar to those outlined in note 18.

The inclusion of the large numbers of self-employed and unpaid workers in 01, farming, in the computation of the rate-constant earnings yields a national average of $2,357, about $200 lower than the observed average earnings of $2,556 estimated by the census (State Tables 94).

[62] This measure is based on the coefficient of determination ($r^2 = 0.76$) between state average earnings reported and standardized for industry composition. In line with Borts' comment, this 76 per cent may be partitioned as follows: 25 per cent to the independent influence of variation in industrial composition and 51 per cent to the joint influence of the simultaneous variation of rates and composition. A weighted regression yields a coefficient of determination of 0.84, with 21 per cent attributable to the "independent" effects.

[63] Of the 24 per cent unexplained by industrial composition, 4 per cent or about one-sixth is explained by occupational composition.

[64] Average hourly earnings for an entire industry were weighted by the reported production worker man-hours in a state to obtain the state rate-constant hourly

effects of industry earnings are held constant, the interstate variation in industry composition is found to explain 54 per cent of the reported interstate differences in hourly earnings.[65]

The use of hourly, rather than annual, earnings as the basis of the investigation tends to limit the sources of unexplained variation among states, for example, by excluding interstate differences in the length of the work year. It still reflects the effect of the differences in the composition of skills among firms within a specific industry; these differences, in turn, may be reflected as differences in state earnings. The unexplained state differences appear to stem chiefly from differences in pay rates for similar skills. Eight of the Mountain and Pacific states (Oregon, Washington, California, Idaho, Arizona, Montana, Nevada, and Wyoming) and New York, New Jersey, Illinois, and Michigan report higher hourly earnings than would be indicated by their industrial composition. Most of the southern states, on the other hand, report even lower earnings than would be indicated by their low-hourly-earning industrial compositions.

Wholesale Trade, 1948. When the differences in annual earnings by kind of business are taken into account, variations in the kind-of-business composition explain about 50 per cent of the reported interstate differences in the average annual earnings of wholesale trade employees in 1948.[66] The interstate differences in rate-constant wholesale trade earnings are not great. Except for Idaho

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earnings. The computations were made mechanically by the Bureau of the Census as a special tabulation. State data for all 430 industries were used in these computations; however, to avoid disclosing the operations of individual concerns, the results were made available only at the major group level.

[65] Based on the coefficient of determination ($r^2 = 0.54$) between reported and rate-constant state average hourly earnings. According to Borts' comment, the 54 per cent consists of 28 per cent attributable to the independent effect of variations in industry composition and 26 per cent attributable to the joint effect of simultaneous changes in composition and rates. A weighted regression yields an $r^2 = 0.72$, with 32 per cent attributable to the "independent" effects, and 40 per cent to correlated effects.

[66] Frank A. Hanna, "State Wholesale Trade Earnings, 1948." This measure is based on the coefficient of determination ($r^2 = 0.50$) between reported and standardized state average annual earnings. Of this 50 per cent explained, 28 per cent may be attributed to the independent effects of kind-of-business composition and 22 per cent to the simultaneous changes in composition and rates. Manufacturers' sales offices without stocks and agents and brokers are omitted. Since data for every detailed kind of business could not be published for every state, the actual computations of the standardized earnings were made by the Bureau of the Census as a special tabulation. While all 244 kinds of business were used in the computations, the results were made available only in the form of group totals that can be published without disclosing data for individual establishments. A weighted regression yields an $r^2 = 0.73$, with 27 per cent attributable to "independent" effects and 46 per cent to correlated effects.

($2,711) and New York ($3,764), the range is about $650, from $2,972 to $3,625. More interstate dispersion is found in reported earnings, which range from $2,602 to $3,651, except for Mississippi ($2,456) and New York ($4,076). After the differences in kind-of-business composition are taken into account, about half of the interstate differences remain unexplained.

Consistency of Results. Are the results obtained for 1949 for all industries consistent with those for 1947 manufacturing and 1948 wholesale trade industries? Should not the state composition of manufacturing industries be expected to explain as much or more of the interstate differences in manufacturing wages as the less detailed classification of all industries does of all annual wage and salary earnings? Indeed, the use of hourly rather than annual earnings and of detailed classifications make this seem likely.

But several factors curtail the explanatory effect of standardization here. First, much of the interstate difference in composition is accounted for by differences in the major groups rather than in the individual industries composing them, so the added detail is of little help. Also, all the industries within a state tend to have either higher or lower than average hourly earnings. Secondly, the contribution to co-variation of three states (Oregon, Washington, and Idaho) which have low-pay industries and higher-than-average earnings, is great enough to account for the difference between the two sets of data.[67] If all industries rather than manufacturing industries alone are used, these states show neither their extremely unfavorable industrial composition nor the extreme departure from the average compensation for the industries they have. This comparison illustrates the difficulty of trying to combine different bodies of data.

One advantage in the use of hourly earnings, the exclusion of unemployment as a source of within-industry variation, is offset by the exclusion of the income-leveling effects of the movement of workers during a year from one industry or industrial segment to another. The latter can be important, since there is less geographic concentration in the major industrial segments than in the detailed industries.[68] Were it not for the fact that the content of these major

[67] When these three states are excluded, the coefficient of determination for the remaining forty-five states is 0.80. The ranks of these states, ranked from the lowest rate-constant hourly earnings, are: Idaho, 6; Oregon, 8; and Washington, 19. From the highest reported earnings, the state's ranks are: Idaho, 17; Oregon, 3; and Washington, 2.

[68] Among the 430 manufacturing industries, there were 108 in which more than 50 per cent of the man-hours were expended in one census division, *Census of Manufactures, 1947,* Bureau of the Census; among the 51 merchant wholesaler kinds of business, there were 8 similarly concentrated, all in the Middle Atlantic division, *Census of Wholesale Trade, 1948,* Bureau of the Census. Among the 14

segments changes from one area to another, the apparent similarity of the major segment composition of the states and divisions would lend support to the hypothesis that the national economy could be viewed as a series of overlapping and more-or-less self-sufficient regional economies.[69]

The tendency noted for a state with a high (low) level of earnings to pay higher (lower) than average rates creates difficulties in analysis, but is reasonable enough. In an area in which low-paying industries are concentrated, there are few openings in high-paying industries, so a worker is likely to accept a job that pays less than it would elsewhere but more than he is currently making. Likewise, in an area in which high-paying industries are concentrated, low-paying industries may be forced to offer above-average rates to attract a labor force; especially during periods of full employment. To the extent that this phenomenon exists, it may affect comparisons between measures based on different levels of classificatory detail. With finer detail, the tendency toward geographic concentration may be accompanied by some substitution of location for skill as the basic determinant of average earnings for the industry. The net result of geographic concentration presumably would be in the direction of explaining more of the observed state differences through standardization. Conversely, the average earnings of broad categories will be a compound of the averages associated with their component (detailed) industries, some of which are determined by location and some by the basic skills required. This makes possible two types of departure from the broad category average: (1) a state may have a different composition of detailed industries within the broad category, or (2) a state's compensation rates for particular detailed industries may differ from the national average. In either case, these departures should be included among the unexplained differences. But they may offset one another, yielding a state average close to the national average and thus be counted as an explained difference.[70]

The fact that each of the three bodies of data relate to different years also add elements of noncomparability. The data presented above, particularly in Tables 3 and 6, indicate that interstate dis-

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major industrial segments, no such geographic concentration is found, *Statistical Abstract, 1954*, Table 241.

[69] Cf. Vining papers cited in note 3.

[70] A planned analysis of the census of population income data for the fifty-nine manufacturing and ten wholesale trade groups, in which these industrial segments are treated as separate entities, will provide some additional information for 1949 on the extent to which these two types of departures are offsetting or are cumulative.

persion is sensitive to cyclical changes. Although the differences in levels of income and its relative interstate dispersion for 1947 to 1949 were small, the income increase from 1947 to 1948 gave way to a mild decrease from 1948 to 1949. It is possible that the effects of this change of direction were more pronounced in one industrial segment than another.

The Use of States for Economic Analysis

CROSS SECTIONS AND TIME SERIES

The changes associated with time have long plagued empirical efforts to ascertain from time series the relationships between economic variables, e.g. demand functions. The effects of changes in taste, of the introduction of new and substitute products, of changes in the quality or serviceability of existing products, and of cyclical and secular changes in the relative price of specific goods are difficult to remove. Often, neither the adjustment of the original series to remove cyclical and secular components nor the introduction of a time factor in a multiple regression system is wholly satisfactory. Moreover, these changes often limit severely the period for which comparable data are available and thus reduce the degrees of freedom available for a specific analysis.

Since cross-sectional data refer to a point in time or a short period, they are relatively free from many of these difficulties. Of great importance is the opportunity offered by cross-sectional techniques to obtain data with sufficient degrees of freedom to permit analysis without having to wait until such data can be accumulated over a span of years. It is the hope of making many existing bodies of data tractable for use in cross-sectional analyses that makes worthwhile an investigation of state boundaries as a cross-sectioning device.

Cross sections provide better analytical tools when the relationships under study are stable. Only to the extent that the relationship between, for example, butter purchases and income is stable, do budget studies designed to ascertain this relationship prove of lasting significance; otherwise, the relationship itself becomes dated and a datum in a time series. Many of the time-associated changes lead to some instability of relationships derived from cross sections. The introduction and widespread use of television undoubtedly affected pretelevision relationships in which radios were a variable. Too, many relationships are cyclically sensitive, and it is necessary to repeat cross-sectional analyses for various phases of the cycle, if these differences are to be taken into account. These arguments point either to the need for time-series data covering much longer time periods than are ordinarily available, or to the fact that useful relationships are short-lived and should be reestablished periodically.

Cross-sectional data typically are the product of special purpose surveys and are expensive to obtain. Budget studies, for example, are specifically designed to find the relationships between family incomes and expenditures, although the need for suitable weights for consumer-price studies may have helped obtain financial support. The expensiveness of the data together with the sustained effort required to see a special purpose survey carried through from the planning stage to completion has limited their availability.

When two variables, e.g. income and expenditures, whose relationship is the subject of study are collected on a single report, it is possible to take advantage of the opportunity to stratify the returns by income, by expenditure, or by both characteristics. For each stratum the mean values of each variable can be computed. Since they can be chosen deliberately, the dispersion of the strata means can be statistically controlled. This provides an opportunity to devise a highly efficient design for the estimation of regression parameters. Such a design almost certainly will be superior to one based on time periods in which the differences between means depend upon a combination of cyclical, secular, and transient forces subject to only limited statistical control.

STATE BOUNDARIES AND CROSS SECTIONS

The use of interstate comparisons in economic analysis is not new. Many studies initially conducted for a single state have been extended to several states. Often the purpose of this extension is to obtain comparative data with which to validate the findings on the original state, just as international comparisons are used to help substantiate findings essentially national in their orientation. But can the states be used systematically to produce analytical series superior to time series and with many of the advantages of cross sections for the study of national economic problems? If data for the variables, whether collected in the same survey or in different ones, are distributed by state, the nature of the expected state distribution of the means is the issue. Two questions are relevant: How closely do the interstate differences approximate a useful stratification of the data? Are the strata relatively stable and free from bias?

Stratification. To the extent that the effects of the geographic distribution of income-generating forces have a pattern whose major outlines can be delineated, this pattern can be viewed as defining a set of strata. Thus, if the incomes of state A are wholly from farming and those of state B wholly from manufacturing, state incomes will reflect these farming-manufacturing strata. Observed data do not provide such clean-cut classifications. But the behavior of state differences suggests that the existing industrial composition of the states changes slowly and is as much affected by cyclical as by secular forces. While both low-income and high-income industries are found in every state, there is enough variety among state industrial compositions to provide a sufficient range of state incomes to permit cross-sectional analyses. The difference between the extreme state per capita incomes in 1953 (Mississippi, $834, and Delaware, $2,304) exceeds by more than $100 the difference between the lowest and highest annual per capita incomes for the nation observed since 1919 (1933, $368, and 1953, $1,709).

If all of the observed differences were accounted for by differences in occupational composition, it could be said that cross-sectional data by state provided a good stratification by occupational composition. The differences between strata would be smaller than those found between detailed occupations, since a wide range of occupations enters into each state's composition. Also, the association of other types of income with occupational earnings is not exact and would probably operate to decrease state differences.[71] But the remaining stratification apparently would provide more dispersion for use in determining relationships between variables than would time series.

There are classificatory systems other than occupation, e.g. industry, that also can explain part of the observed interstate differences. The systems are, of course, interrelated. The presence of an industry determines to some extent the occupational opportunities available, and the existence of a labor force with a given range of skills and aptitudes affects industrial plant location. This interrelationship limits the confidence with which the observed differences can be interpreted as reflecting a given set of strata. However, as time-series analyses have shown, interpretation of the sources of stratification is not essential to the use of observed dispersion in regression analysis.

Stability. The observed differences in per capita income and its components tended to become smaller during the period 1929–1953.

[71] See Table 8, above. When 1949 occupational earnings are put on a per capita, rather than a per worker, basis and regressed on per capita income from all sources, $r^2 = 0.74$, indicating that occupational composition is less effective in explaining total income differences than in explaining wage and salary differences. This is only an approximate measure, since there are state differences between the 1949 Department of Commerce wage and salary estimates and those reported in the census.

In part, this decrease was associated with the increasing level of national income; in part, with a secular trend. The change disturbed the rank position of the states only slightly; the basic sources of the observed differences between states thus appear to be firmly established geographically and to persist in their operations. In this sense, at least, the state distributions can be said to be stable.

While the investigations so far conducted leave much to be desired, they indicate, on balance, that experimentation with the use of state boundaries as a cross-sectioning device is worthwhile. Final judgment will depend on the usefulness of the resulting analyses.

AN EXPERIMENT

Only one study in which the state boundaries were used to cross-section data has been undertaken, and the results are incomplete and preliminary.[72] Its problem is the relationship between various categories of expenditures on personal transportation by automobile and between these categories and per capita incomes.

A first glance at the data is enough to reveal marked differences between highly populated states with mass transportation systems and other states in the relationship of automobile expenditure to per capita income. New York, probably because of the dominance of New York City, appears to be a class by itself. Massachusetts, Pennsylvania, Illinois, Connecticut, Rhode Island, New Jersey, Delaware, Maryland, and the District of Columbia form a group apart from the remaining thirty-nine states and usually show a distinct pattern among themselves. Each one either has a large central metropolitan area or borders on such a metropolitan area. Missouri, Michigan, Ohio, and California, the other states with metropolitan areas of more than one million persons, however, do not display characteristics sufficiently different to be treated as a separate group and are treated in the group of thirty-nine states.[73] Other differences in behavior are also present, although their effects are not so pronounced. States with low population density appear to make more intensive use of automotive transportation than do the more densely populated states.

[72] Robert A. Bandeen is now studying the relationship of state automobile expenditures to state per capita incomes for 1930, 1940, and 1950. His results, when available, should do much to dispel the indefiniteness of this section.

[73] Some notion of the magnitude of the differences may be gained from the coefficients of determination between total automotive expenditures and per capita incomes for the various groups of states. New York has been excluded from these computations. The coefficients of determination for 1950 are: based on 47 states and the District of Columbia, 0.54; for the 39-state group, 0.82; and for the 9-state group, 0.96. The corresponding coefficients for 1940 are: 47 states and District of Columbia, 0.65; for the 39 states, 0.90; and for the 9-state group, 0.95.

A type of difficulty that is likely to be encountered frequently in state data is illustrated by motor fuel. State fuel consumption shows little relationship to per capita income or to the number of automobiles in a state. State boundaries may not pair the variables adequately. Although automobiles are used chiefly in the states in which they are registered, they are often used for interstate trips with fuel purchases being made along the highways traveled. To some extent this will cancel out, since cars registered in state A will be fueled in state B, while state B cars will be fueled in state A, but apparently the offsetting is not complete.

These difficulties do not appear insurmountable, although tested solutions are not yet available.

When per capita income is dropped as one of the variables and the analysis is confined to variables based entirely upon the automotive series, some of the difficulties noted above tend to disappear. For example, when one calculates the regression of the 1950 per capita depreciation of former-year models on the per capita depreciation of current year models, the state observations appear adequately described by a straight line with a positive intercept.[74] A similar regression for 1940 appears to be better described by a curve which is somewhat lower at each end.

Many questions need further investigation. For example, with changes in the level and dispersion of state incomes over the period, under what circumstances should similar regression coefficients be expected? Which of the many relationships subject to investigation should be treated as logarithmic? To what extent are differences from one year to another explained by differences in income sensitivity of the various categories of automotive expenditures?[75] And how consistent are these results with the findings of other investigators? It is only after these and similar questions have been answered that an appraisal can be made of the state automotive data or that a reasonably reliable outline can be formulated of the conditions to be met if the use of the states for cross-sectioning is to be valuable.

[74] The regression formula is $X_{12} = 4 + 0.65X_2$, where X_{12} is depreciation on former year models computed from X_2, the per capita depreciation on current year models. Were the intercept 0, the national averages would provide an adequate description of the relationship. In these preliminary calculations; population rather than car registrations was used to adjust for differences in the size of states. Whether this introduces some bias due to state differences in number of cars per capita has not yet been ascertained.

[75] Mabel A. Smith and Clement Winston, "Income Sensitivity of Consumption Expenditures" (*Survey of Current Business*, Dept. of Commerce, January 1950), give the coefficients of the sensitivity to changes in 1929–1940 disposable income of many of the expenditure categories included in Table 30, *Survey of Current Business*, Dept. of Commerce, National Income Supplement, 1954.

Some Unanswered Questions

Some attention has been accorded problems of measurement and interpretation. It has been mentioned that data are not readily available for a series of years covering all phases of the cycle; that the data on manufacturing are for a different year from those covering wholesale trade, and that neither of these detailed bodies of data are for 1949, which is covered by the census of population; and that independent data capable of testing the trend in dispersion found in the state income payments series are lacking. Only a statistical interpretation of the empirical results has been possible. In this section, a more general problem of interpretation is raised.

The fact that in 1949 industrial and occupational composition accounts for a large part of the observed differences in wage and salary earnings is impressive, but it does not indicate whether the unexplained differences are associated with persistent geographic factors. To what extent are demographic factors basically of geographic, rather than of economic, origin? What about the observed association between the prevalence in a given area of low-pay occupations and lower-than-average pay for these occupations?

If these and other factors taken together are capable of explaining all of the differences among state per capita incomes, we are left with two sets of questions. The first set has to do with the technical problem of simultaneously taking account of several classificatory systems. How does one proceed to integrate the results of independent investigations of the occupational composition, the age composition of the population, the resource distribution, and the city-size composition of the various states? This would require more than measuring the secondary, tertiary, and the more remote effects of a particular classificatory system. Answers apparently are to be found in the detailed relationships of the determinants of population composition to industrial structure and to the process of urbanization, of the relationship of industrial structure to urbanization and to wage determination, and the effect on these relationships of population and industrial growth, increasing urbanization, and cyclical influences.

The second set of questions relates more to the identification of factors connected in some causal sense with location or geographic boundaries. In many respects, answering this set of questions is more difficult than answering the first set. Consider the extreme (and unlikely) possibility that all of the differences in state per capita incomes could be accounted for by some combination of classificatory systems, say occupation and urbanization. Observed differences among states would be "explained" in a statistical sense, but one still could not say that the spatial distribution of either occupations or cities was not affected in some fundamental sense by the existence of the state boundaries. In such a case, however, state differences could be transformed into occupational and city-size differences without serious biases being introduced into analyses based on state data. More vexing questions arise when some part of the observed differences among states remain unexplained. Are the unexplained differences to be attributed to some set of geographic differences among the states? The fact that occupational or industrial composition does not explain all of the observed differences in earnings indicates that they are something more than mere reflections of varying industrial or occupational compositions. To what extent are we justified in bringing to bear additional classifications? Certainly, if enough classification systems were used and the categories were fine enough, practically all state differences could be explained statistically.[76] If, however, state data are to be used to study national or general economic problems, how should residual state differences be treated? Does the existence of state (geographic) differences bias the results of such economic investigations? Investigations now under way may provide partial answers.

COMMENT

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Frank A. Hanna's paper encompasses (1) the expression of a point of view on the significance of interstate income differentials and an examination of their potential use in general economic analysis, and (2) a number of sections which together comprise a progress report on the statistical investigations conducted in the "Study of Differences in State per Capita Incomes," which he heads. Though the work underlying each of these sections is so large as to merit our careful consideration, I must confine my remarks to a few points that seem to me of central importance and with which I find myself in at least partial disagreement.

The General Hypothesis

A summary statement of Hanna's point of view (perhaps it should be called a hypothesis) might be somewhat as follows.

[76] The extreme case would be one in which there were as many categories as there were individuals in the United States.

The United States is, geographically speaking, a single economy, operating within a single set of institutions, and consisting of 165 million Americans of different ages, sexes, races, skills, and propensities to work, many of them engaged in a variety of occupations and industries. From an economic standpoint, the forty-eight states making up the nation have no significance in and of themselves, but merely represent different groupings of the types of individuals in the total population and of resources. Fortunately from the standpoint of making state data useful as an analytical tool, the composition of their populations varies rather widely among the states, and, as a result, there are substantial interstate differences in income per capita. Incomes of persons with the same attributes do not differ among the states in any systematic way. Since the residents of each state can be viewed as a sample of all the residents of the United States, distributions of state averages can be used to develop relationships between economic variables that are valid for the measurement of income elasticities or other economic relationships for the country as a whole. Left open is the question whether such demand and similar relationships may not be useful even though differences in the per capita incomes of the states are not wholly ascribable to differences in the composition of other populations.

My summary omits such qualifications as Hanna makes; it is in my words, not his; and I would stress again that even with these qualifications it *is* a hypothesis, and he does not say that its accuracy is fully established. However, the reader of the paper is likely to come away with the impression that Hanna believes not only that it is substantially correct but also that his statistical investigations support his view that the bulk of the interstate differences in per capita income arise solely from differences among the states in the composition of their populations.

I find puzzling the connection between the question of whether interstate income differentials are due to differences in population composition or to "genuine" regional differences and the question of whether state data can be used for demand analysis. Indeed, I am not even sure that, if there is a connection, it is in the direction Hanna suggests. Suppose that, in direct contrast to Hanna's hypothesis, each of the states were an exact miniature of the nation with respect to its industrial, occupational, racial, age, etc., composition, but average earnings within each of these groups, and therefore per capita incomes, differed among the states because of immobility, variations in efficiency, or other reasons. It would seem that the relationship among the states between per capita expenditures for a product and per capita income would be more likely to indicate the effect upon national expenditures for the commodity of a change in national per capita income under these circumstances than if interstate differences in per capita incomes reflected variations in the proportions of farmers, white collar and industrial workers, and other groups in the population—each of which may have its own buying pattern.

Also, regional differences in consumption patterns arising from differences in tastes or in requirements imposed by climate, population density, or other geographical factors may more seriously restrict such uses of state data than do the sources of income differentials, whatever they may be. Hanna does not, of course, fail to stress these and notes that when indicated one may use data only for states believed to be similar—just as one can use only selected years in time series analysis.

Before turning to the evidence Hanna adduces to support the position that interstate income differentials are due to differences in characteristics of the population, one distinction must be made. To test whether similar workers receive the same income in different parts of the country, the economist must be clear how he intends to treat differentials in productivity (arising either from differences in skill or in the amount of nonlabor resources with which labor input is combined). Hanna's thought on this, in the context of his statistical investigations, is not clear to me.

If equal productivity (or skill alone) is one of the criteria of similarity, the position that incomes of like individuals are similar throughout the country cannot be tested in any rigid sense from information of the type used by Hanna, or by any other information likely to become available on other than a case-study basis. Competition and mobility in labor markets may be sufficient to ensure that earnings for the same work are the same throughout the country, so that all regional differences in earnings of otherwise similar workers are due to differences in their marginal value product arising from differences in skill. In the absence of direct data on relative marginal value products, this cannot be determined from statistical evidence.

The most that one can hope in principle to establish by standardization procedures, upon which Hanna mainly relies, is the extent to which regional income variations reflect differences in the incomes of persons of a given age, race, and sex (and whatever other observable characteristics one may wish to specify), working in a stated occupation and in a particular industry,[1] and the extent to which they reflect differences in the population mix with respect to the characteristics specified. Whether interstate differences in the earnings of persons similar with respect to the specified characteristics reflect differences in productivity remains unknown.

If, however, nearly all of the observed interstate differences in average earnings can be explained in terms of differences in the composition of the population with respect to readily observable characteristics, the question of whether the small remaining differences are due to differences in the productivity of nominally comparable persons or to true regional differentials may not be crucial.[2] Hanna's discussion may readily lead the reader to suppose that this is what the data indicate, for Hanna finds, for example, that "variation in occupational composition explains 80 per cent of the variation in reported state earnings."

Standardization and Use of the Coefficient of Determination

My own conclusion from Hanna's data, however, is that the proportion of interstate differentials in average earnings due to occupational composition is probably less than one-third, while more than two-thirds is due to differences in the earnings of persons in the same occupations. The calculations are simple, but it is worthwhile to show them in detail in view of the need for precision in interpretation. The necessary information is given in Table 1. For a comparison of a state with the nation in order to isolate sources of earnings differentials, four averages are relevant:

$N =$ actual United States average earnings (national average earnings in each occupation weighted by the national occupational composition; given by Hanna as $2,556)

$S =$ actual average earnings in the state (state's average earnings in each occupation weighted by the state's occupational composition; for Maine, $2,065)

$R =$ "rate-constant" average earnings (national average earnings in each occupation weighted by the state's occupational composition; for Maine, $2,346)

$O =$ "Occupational-composition-constant" average earnings (state's average earnings in each occupation weighted by

[1] Given the actual data, one cannot hold all these characteristics constant simultaneously. The best Hanna has been able to do is to deal simultaneously with occupation and sex and treat industry, age, and certain other variables separately.

[2] Such a result suggests that skill differentials among the states are small for otherwise comparable persons, which would be in itself an interesting conclusion.

the national occupational composition; for Maine, estimated at $2,251)

Hanna omits the last figure because data are not available for average earnings in each occupation in each state. I do not think the analysis can proceed satisfactorily, by any approach, without such data, however. In order to illustrate the methodology which seems to me correct when actual data are available—and to secure results for the present problem which are at least consistent with the available facts and likely to approximate those which would be obtained if all requisite information were at hand—I have used estimates for O. These estimates, which Hanna has provided me, were obtained by the formula $O = NS/R$, which is the same formula that Hanna, using different symbols, describes in his note 18.[3]

One can compute the amount by which Maine average earnings would differ from United States average earnings if both had the same average earnings in each occupation (so that only occupational composition varied), either as $S - O$ (—$186) if state weights are used for average occupational earnings, or as $R - N$ (—$210) if national weights are used.

Since, in general, there is no apparent reason to prefer one set of weights to the other, it seems appropriate to average the results and to take —$198 as the amount by which Maine average earnings would differ from the national average earnings if only their occupational composition varied. Similar results are given for all states in column 6 of Table 1.

One can similarly compute the amount by which Maine average earnings would differ from national average earnings if they had the same occupational composition (so that only earnings within occupations varied geographically), either as $S - R$ (—$281) if state weights are used for occupational composition, or as $O - N$ (—$305) if national weights are used. The difference due to weighting, $24, is necessarily the same as in the measurement of the difference due to occupational composition.[4] Again, there is no reason

[3] It can be shown that this approximation approaches the desired nationally weighted figure when differences between state and national earnings in each occupation tend to proportionality, and is exact when percentage differences between state and national average earnings are the same in all occupations.

It is of interest to note that published census of manufactures data would permit the direct calculation of the figures corresponding to O for Hanna's analysis of 1947 hourly earnings in manufacturing. Calculation of such standardized data would introduce greater precision in that analysis, and also be suggestive of the extent of any error likely to be introduced by the type of approximation used here.

[4] In principle, *i.e.* if O is directly measured rather than approximated as was necessary here, it is also the amount sometimes referred to as the "interaction" factor—the amount by which the sum of the differences ascribed to occupational

to prefer one set of weights to the other. An average of the two results gives —$293 as the amount by which Maine average earnings would differ from the national average earnings if their occupational composition were the same (the results for all the states are given in column 7).

Thus, of the actual amount of $491 (column 5) by which average earnings in Maine fall short of the national average, $198 would disappear if their occupational composition were the same and $293 would disappear if earnings in each occupation were the same.[5] For thirty-seven states the two factors operate, as they do in the case of Maine, to create differences from the national average in the same direction, and there is no difficulty in cumulating the amounts of the deviations of the state averages from the national average which may be ascribed to each of the two factors.

In nine states, however, the influence of occupational composition is toward pushing the state's average earnings away from the national average in the direction opposite to that in which the actual deviation exists. For example, average earnings in Pennsylvania are $74 above the national average, but this is the result of an unfavorable influence of occupational composition, computed at $15, and a favorable influence of average earnings in individual occupations, computed at $89. Differences in occupational composition obviously do not provide a partial explanation of the reason that Pennsylvania average earnings are above the nation's, but instead add to the amount to be explained by occupational earnings differences. Hence, in cumulating for all the states the amount of the actual deviation that is explained by differences in occupational composition, in the case of Pennsylvania $15 should be deducted; while in cumulating the amount explained by differences in occupational earnings $89 should be counted.

There are also two states in which differences in occupational earnings are in the wrong direction to explain the actual difference in state and national earnings, and in which the opposite procedure is indicated.

By following the procedures described, it appears that, of the sum

composition and to occupational earnings differences will fail to equal the actual difference between state and nation if only national (or state) weighting is used. However, in the present case the error involved in estimating O, even if it is small relative to the amount of the difference between state and national earnings, may be significant relative to the amount of the "interaction."

[5] The parts necessarily add to the total, since the amount ascribed to industrial composition differences, $\frac{1}{2}[(S-O)+(R-N)]$, plus the amount ascribed to occupational composition differences, $\frac{1}{2}[(S-R)+(O-N)]$, reduces to $S-N$, the actual difference.

TABLE 1

Analysis of Sources of Variation in Average Annual Earnings in 1949, by State

(dollars)

STATE	AVERAGE EARNINGS [a]				DIFFERENCE BETWEEN STATE AND NATIONAL AVERAGE EARNINGS		
						Due to differences in:	
	U.S Actual (N)	*State Actual (S)*	*Rate Constant (R)*	*Occupational-Composition-Constant* [b] *(O)*	*Total* [c]	*Occupational Composition* [d]	*Occupational Earnings* [e]
New England:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Maine	2,556	2,065	2,346	2,251	− 491	−198	−293
New Hampshire	2,556	2,193	2,392	2,344	− 363	−157.5	−205.5
Vermont	2,556	1,997	2,363	2,161	− 559	−178.5	−380.5
Massachusetts	2,556	2,610	2,570	2,596	+ 54	+ 14	+ 40
Rhode Island	2,556	2,359	2,508	2,404	− 197	− 46.5	−150.5
Connecticut	2,556	2,795	2,636	2,710	+ 239	+ 82.5	+156.5
Middle Atlantic:							
New York	2,556	2,921	2,588	2,885	+ 365	+ 34	+331
New Jersey	2,556	2,959	2,646	2,858	+ 403	+ 95.5	+307.5
Pennsylvania	2,556	2,630	2,542	2,646	+ 74	− 15	+ 89
East North Central:							
Ohio	2,556	2,797	2,644	2,704	+ 241	+ 90.5	+150.5
Indiana	2,556	2,652	2,586	2,621	+ 96	+ 30.5	+ 65.5
Illinois	2,556	2,936	2,629	2,854	+ 380	+ 77.5	+302.5
Michigan	2,556	2,974	2,660	2,858	+ 418	+110	+308
Wisconsin	2,556	2,586	2,562	2,580	+ 30	+ 6	+ 24
West North Central:							
Minnesota	2,556	2,472	2,546	2,482	− 84	− 10	− 74
Iowa	2,556	2,312	2,482	2,381	− 244	− 71.5	−172.5
Missouri	2,556	2,422	2,512	2,466	− 134	− 44	− 90

(continued on next page)

TABLE 1 (continued)
(*dollars*)

STATE	AVERAGE EARNINGS [a]				DIFFERENCE BETWEEN STATE AND NATIONAL AVERAGE EARNINGS		
	U.S Actual (N)	*State Actual (S)*	*Rate Constant (R)*	*Occupational-Composition-Constant* [b] *(O)*	*Total* [c]	*Due to differences in:* *Occupational Composition* [d]	*Due to differences in:* *Occupational Earnings* [e]
West North Central:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
North Dakota	2,556	2,007	2,400	2,137	− 549	−143	−406
South Dakota	2,556	2,028	2,397	2,162	− 528	−146.5	−381.5
Nebraska	2,556	2,262	2,490	2,323	− 294	− 63.5	−230.5
Kansas	2,556	2,372	2,564	2,365	− 184	+ 7.5	−191.5
South Atlantic:							
Delaware	2,556	2,752	2,554	2,755	+ 196	− 2.5	+198.5
Maryland	2,556	2,652	2,552	2,657	+ 96	− 4.5	+100.5
Virginia	2,556	2,277	2,401	2,425	− 279	−151.5	−127.5
West Virginia	2,556	2,412	2,490	2,477	− 144	− 65.5	− 78.5
North Carolina	2,556	1,841	2,235	2,106	− 715	−293	−422
South Carolina	2,556	1,740	2,169	2,050	− 816	−348.5	−467.5
Georgia	2,556	1,801	2,241	2,055	− 755	−284.5	−470.5
Florida	2,556	2,064	2,303	2,291	− 492	−240	−252
East South Central:							
Kentucky	2,556	2,024	2,399	2,156	− 532	−144.5	−387.5
Tennessee	2,556	1,956	2,369	2,111	− 600	−171	−429
Alabama	2,556	1,832	2,292	2,043	− 724	−237.5	−486.5
Mississippi	2,556	1,408	2,180	1,650	−1,148	−309	−839
West South Central:							
Arkansas	2,556	1,594	2,244	1,816	− 962	−267	−695
Louisiana	2,556	2,114	2,383	2,268	− 442	−163.5	−278.5
Oklahoma	2,556	2,238	2,527	2,263	− 318	− 27	−291
Texas	2,556	2,277	2,445	2,379	− 279	−106.5	−172.5

(continued on next page)

TABLE 1 (continued)
(dollars)

STATE	AVERAGE EARNINGS [a] U.S. Actual (N)	State Actual (S)	Rate Constant (R)	Occupational-Composition-Constant [b] (O)	DIFFERENCE BETWEEN STATE AND NATIONAL AVERAGE EARNINGS Total [c]	Due to differences in: Occupational Composition [d]	Occupational Earnings [e]
Mountain:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Montana	2,556	2,461	2,443	2,574	− 95	−113	+ 18
Idaho	2,556	2,300	2,397	2,452	− 256	−155.5	−100.5
Wyoming	2,556	2,557	2,498	2,616	+ 1	− 58.5	+ 59.5
Colorado	2,556	2,412	2,526	2,441	− 144	− 29.5	−114.5
New Mexico	2,556	2,364	2,422	2,494	− 192	−132	− 60
Arizona	2,556	2,397	2,382	2,572	− 159	−174.5	+ 15.5
Utah	2,556	2,610	2,594	2,572	+ 54	+ 38	+ 16
Nevada	2,556	2,839	2,420	2,998	+ 283	−147.5	+430.5
Pacific:							
Washington	2,556	2,774	2,526	2,807	+ 218	− 31.5	+249.5
Oregon	2,556	2,668	2,430	2,807	+ 112	−132.5	+244.5
California	2,556	2,870	2,551	2,876	+ 314	− 5.5	+319.5

[a] Actual national average earnings (N) equals $2,556.
[b] Estimated from approximate formula, $O = NS/R$.
[c] Equals $N - S$.
Source: Hanna's Table 1 and his notes 17 and 18.
[d] Equals ½ $[(S - O) + (R - N)]$.
[e] Equals ½ $[(S - R) + (O - N)]$.

of the actual differences (sign disregarded) between average earnings in the individual states and the nation of $16,253, the amount due to differences in occupational composition is $4,646; and the amount due to differences in earnings in individual occupations is $11,607. Hence, it seems appropriate to ascribe only 29 per cent of interstate variation in average earnings to differences in occupational composition and 71 per cent to differences in occupational earnings.[6]

Moreover, the amount of the difference in earnings between the national average and the state average ascribable to occupational earnings differences exceeds that ascribable to occupational composition in forty-two of the individual states; and, as noted, in nine of the eleven states where the two factors work in opposite directions, the actual deviation from the national average is in the direction indicated by earnings differentials.

Given the occupational classification Hanna uses, differences in earnings in particular occupations are clearly the main factor making for interstate income differentials.

Hanna has used procedures roughly similar to this (though without the averaging of weights and described treatment of deviation in the "wrong" direction) on other occasions, and Mansfield apparently does so in his present paper on city size. The results seem to me clearly preferable to those obtainable by use of the coefficient of variation or of correlation techniques, both of which are more difficult to interpret, and also involve squaring deviations from the national average and thus give undue emphasis to the few states that deviate from it mostly widely. The coefficient of variation has also the unhappy characteristic (for this purpose) that it treats deviations in the standardized data alike whether they are in the same direction as, or the opposite direction from, deviations in the actual data. (In the series under consideration, the latter are not large, however.) Nevertheless, in the present problem conclusions that may be drawn from the slope of a regression line or from use of the coefficient of variation are not very different from those already obtained.

That only the smaller portion of the difference between state earnings and national earnings is eliminated by adjusting for differences in occupational composition is indicated by the slope of the regression line in Hanna's Chart 1. The slope reflects the relative disper-

[6] I have followed Hanna in not weighting the state results. A strong case can be made for weighting by employment.

It may be repeated that the exact figures given above are conditioned by the accuracy to be ascribed to the estimates of column 4 in Table 1. It is difficult to suppose, however, that if actual data were available, they would be changed by any appreciable amount.

sions of the actual and rate-constant standardized variables. On the average, according to the line plotted, actual earnings rise $100 with each $37 rise in figures standardized to reflect only differences in occupational composition, suggesting that on the average around 37 per cent of the actual variation is ascribable to differences in occupational composition.[7]

Use of the coefficient of variation gives a result quite similar to mine. Hanna gives the coefficient of variation for the actual data as 16 per cent. For the rate-constant standardized data (which reflect only differences in occupational composition), it is 5.1 per cent. For occupational-composition-constant standardized data (which reflect only differences in earnings in the same occupation), the coefficient of variation is estimated at 12.0 per cent.[8] The sum of these two—17.1 per cent—slightly exceeds the actual figure of 16 per cent, partly because, in some states, standardization one way or the other moves the state figure away from, rather than toward, the national average. If the coefficients of variation are compared to see how much of the actual difference in earnings is due to occupational structure and how much to occupational earnings differences, the answer resulting is that 30 per cent (5.1 ÷ 17.1) is due to differences in occupational structure and 70 per cent to interstate earnings differences within occupations.

It thus appears from any of the three methods that on the basis of the occupational classification used by Hanna, roughly one-third or less of observed interstate earnings differentials results from differences in occupational composition and two-thirds or more from differences in earnings in the same occupation. When Hanna says that 80 per cent of the interstate variation is explained by occupational composition, he relies upon the coefficient of determination, r^2, between the actual state earnings and his state series of earnings standardized to reflect only occupational composition differences. As such, it is simply a measure of the goodness of fit of the regression line shown on his Chart 1.

Now if that is the only use to which it is to be put, it is, of course, unobjectionable. And Hanna states that this is the case, and that it is in this statistical sense only that the words "explained" and "accounted for" are used throughout the paper. But if this is all he means when he says that 80 per cent of interstate differences in earn-

[7] The line does not pass exactly through the point at which the national figure would be plotted, which raises some question of precise interpretation here and prevents any exact use of the 37 per cent figure, but the departure is small enough not to affect the main point.

[8] This figure was provided by Hanna; it is computed from the estimated data shown in column 4 of Table 1 of this comment.

ings are accounted for by occupational composition, the finding is not very enlightening, nor does his discussion seem at all complete. In particular, it must be stressed that it lends no support to the general hypothesis discussed at the beginning of his paper and of this comment.

Particularly is this so when one finds—as is to be expected from the earlier conclusion as to the relative importance of the two determinants—that the coefficient of determination between actual earnings and occupational-composition-constant earnings, which measure only interstate earnings differences within occupations, is still higher—96 per cent.[9] That both correlations are fairly high is, of course, a result of the fact that thirty-seven of the states with favorable (unfavorable) occupational compositions have also high (low) earnings in individual occupations. Hence, the two standardized series are highly intercorrelated.

To give the 80 per cent figure a more substantive meaning would require a demonstration that interstate differences in occupational composition are the *cause* of interstate differences in earnings in comparable occupations and hence should be credited in a causal economic sense with being the source of all the intercorrelation between the two standardized series. This position would need a great deal of demonstration, the basis for which is not evident. (In addition, a comparable demonstration would be required for each of the other types of data to which the coefficient of determination is applied.)

Hanna does not attempt such a demonstration, except perhaps on page 154, where he suggests that limited employment opportunities in more skilled jobs in places where occupational composition is unfavorable may hold earnings in such occupations below rates elsewhere. But it would be necessary to show a differential among states in the difference between the distribution of job opportunities and the occupational distribution of the labor supply to make this case.

In the revision of his paper, Hanna has accepted (in note 21, and similar notes in other sections) the interpretation Borts places upon his calculations. According to this interpretation, 11 per cent of the variation in observed state average earnings may be attributed to the "independent" influence of occupational composition, 69 per cent to the "joint influence of occupation mix and earnings levels changing simultaneously,"[10] and the remaining 20 per cent, rather

[9] Not in the paper; provided by Hanna on the basis of calculations from the estimates shown in column 4 of my Table 1.

[10] This "joint influence" has nothing to do with what has usually been called "interaction" in allocation problems, and to which I refer in note 4, above.

ambiguously, "to that portion of earnings levels which are independent of both state income and occupation mix." This 20 per cent is simply the difference between 100 per cent and Hanna's original 80 per cent coefficient of determination. Borts' only addition to Hanna's breakdown, then, is to provide a measure of the "joint influence" so as to subdivide Hanna's 80 per cent. Borts' results, like the others examined, give no support to the thesis that interstate income differences arise largely from interstate differences in occupational composition.

However, the procedure is not acceptable. Basically, the difficulty stems from the fact that the allocation problem is not amenable to solution by correlation techniques, at least as applied by Hanna and Borts. The most obvious defect in the procedure is that it does not give the same result in a correlation of actual with rate-constant standardized data as in a correlation of actual with occupational-composition-constant standardized data. The results can differ radically and, in fact, do so in the present case.

I have already noted that the coefficient of determination between the actual and occupational-composition-constant standardized data is 96 per cent. Applying Borts' technique gives the following fuller breakdown: independent influence of occupational earnings, 61 per cent (instead of 20 per cent arrived at from the rate-constant data as "independent of both state income and occupation mix"); "joint influence of occupation mix and earnings levels changing simultaneously," 35 per cent (instead of 69 per cent); and the portion independent of both state income and occupational earnings, 4 per cent (instead of 11 per cent as the "independent influence of occupation mix").

Since there is no theoretical reason, in general, to prefer one set of results to the other, any acceptable procedure must be independent of the standardized series used.[11] The differences here are so great that I do not see how the results can be utilized. Borts' reference to their use for prediction is irrelevant, since no prediction problem is involved.

Before leaving the discussion of standardization procedures, I should make two points very clear. First, Hanna has performed a distinct service by computing the standardized earnings and other standardized income figures upon which he reports in this paper. Much of this material cannot be duplicated from published sources. My disagreement with Hanna over interpretation does not concern

[11] The occupational-composition-constant data I have used are, as noted above, estimates, but they are *possible* estimates consistent with the known facts. In general, there is no reason for Borts' technique to give even roughly consistent results, as can easily be verified from examples where all the necessary data are given.

the value of the standardized data themselves. Moreover, much of the textual discussion of standardization procedures is excellent and I believe would make a valuable contribution if it were not related to the use of the coefficient of determination. Second, my questioning of his statistical results in no way constitutes a denial of his theoretical position that if one could simultaneously standardize for a large number of population characteristics, a high proportion of observed interstate income differences would in fact be explained. For lack of data this cannot be done by cross classification. The major problem to be resolved before much more progress can be achieved in testing this hypothesis is how the results of separate standardization computations for individual characteristics, such as city size and occupation, can be combined. Hanna discusses this problem briefly. Perhaps he will find some method for coping with it comprehensively before the study that he heads is completed.

Use of Intertemporal Regression Lines

I shall comment less extensively on two aspects of Hanna's time series analysis of the state per capita income data. Let us consider first the section starting on page 130, which reports on a rather formidable statistical undertaking. For each possible pair of years for which state data are available, there was constructed a scatter diagram of the states that related per capita income for the later year, taken as the dependent variable, to per capita income in the earlier year, taken as the independent variable, and a linear regression line was computed. For each scatter, this line, of course, reflects any systematic tendency for per capita income in low income states to rise more or less than in high income states. As is well known, and as Hanna confirms, over the period covered per capita income has generally risen more percentagewise in the low income than in the high income states, and presumably this is reflected in the slope of a majority, though not all, of the 210 separate regressions.

What substantive meaning, though, is to be attached to the fact that a particular state falls above or below the linear regression line on a particular diagram? Evidently, if a state is above the line, it could mean that, in the period covered by that diagram, its per capita income increased relatively more than the average, not of all states, but of states with a similar level of income.[12] But this interpretation

[12] This is, of course, an idealized statement. It assumes that, at each income point, the number of states is large and it would be literally true only if, at each income point, the mean of the states fell on the regression line.

would require that the relationship be truly linear. Otherwise, most or even all of the low-income states, for example, might fall below the regression line, but obviously per capita income in all the low-income states cannot rise less than the average for low-income states.

Hanna clearly recognizes the crucial character of the existence or nonexistence of linearity and has undertaken extensive tests for it. These tests he finds inconclusive, though considerable doubt is cast upon the existence of linearity and in general it appears that a curvilinear line would better describe the data.

From the 210 charts covering the 1929–1949 period, Hanna has tabulated the number of times each state lies above, on, and below the regression line. The results seem to me pretty much to destroy any hope of deriving meaningful results from this part of the study. For he reports that "the states most frequently below the regression lines are concentrated in the lowest quartile, and those most frequently above, in the third quartile." Indeed, all of the last thirteen states in the ranking by per capita income level (which are also the southern states) are in the lower half of the ranking from Hanna's Table 4. Hence, it is obvious that (presumably, as Hanna himself notes, because the regressions are not linear) a position above or below the regression line does not mean that a state has advanced more or less than other states at a similar income level. Hanna tells us that the regression line "provides a better set of expectations against which to gauge the behavior of a particular state than does the percentage change in national per capita income." But is a set of expectations that exceed the performance of *all* the low-income states, despite the fact that they bettered the national average percentage change, reasonable or meaningful? [13] Under the circumstances described, position above or below the regression line has, insofar as I can see, no substantive meaning.

However regrettable this may be in view of the effort incurred, I think that this portion of the study ought to be written off as having failed to produce significant results.[14] One may also ask why such

[13] Because of the positive intercept, the percentage increase in income required for a state to reach the regression line approaches infinity as the income level approaches zero. It is understandable, therefore, that Mississippi, with an income level well below the range of the other states, was rarely able to achieve the required increase and ranks last by this criterion in the listing in Hanna's Table 4. It is also true, however, that since 1929 per capita income has risen less, percentagewise, in Mississippi than in other very-low-income states.

[14] The heterogeneity of the period covered and the absence of a distinction between large and small deviations from the regression line would raise serious doubts about the procedure followed even if the regressions were linear. I shall surmise that failure to quantify the deviations is part of the reason why South Carolina, which has had by far the largest percentage increase in per capita income since 1929 of any state, is ranked thirty-sixth in Hanna's Table 4.

an elaborate structure was necessary. Why not simply compare directly percentage changes in per capita income from the beginning to the end of the period, provided that cyclically they represent roughly similar years, and relate these changes to level of per capita income?

Cyclical and Secular Changes

In the section on cyclical and secular changes, which starts on page 137, Hanna computes for each state a logarithmic regression between United States per capita income and (where it proves statistically significant) time, taken as the independent variables, and the per capita income of the state. The purpose is to focus attention on "two groups of . . . forces: the changes in the state distributions associated with the level of national income [payments] and those that appear to have a persistent and differential influence on the development of a state's income."

But can one deal with the level of income nationally as a single determinate? Will there be a similar change in the state distribution if per capita income nationally changes because of a cyclical movement, a temporary or a durable change in the general price level, a war mobilization, or a long-term increase in the level of real income? I do not think so. Since Hanna's results combine the influence of all these forces, it seems to me that the results cannot be interpreted in any very usable fashion. If his sensitivity index shows that a 10 per cent increase or decrease in national per capita income was associated with a 13 per cent increase or decrease in the per capita income of Idaho, I would want to know what kind of a change in national per capita income he has in mind before I would find the statement very helpful. Since it is based on such a heterogeneous period, I doubt that this is the best description of the effect of any of these types of change upon Idaho income.

This doubt could in large degree be set at rest if it could be shown that for each state a single sensitivity index satisfactorily describes changes in the state's per capita income (relative to the United States per capita income) in the prewar, war, and postwar periods separately. This would imply the same reaction in each state to any type of change in national per capita income—which would be most surprising and has not been established.

It is interesting to observe, however, that the greater the degree to which the sensitivity indexes actually do describe the relationship between a state's and the United States per capita income throughout the whole period, the less is it possible to interpret the time-factor indexes as in any sense measures of trend.

These indexes have a peculiarity illustrated by the following example: Suppose that over a long period of years per capita income rose 2 per cent a year in the United States and 4 per cent a year in a particular state. I presume that one would want to say that this state had a strong upward trend relative to the nation. But, since the national and state series would be perfectly correlated, Hanna's formula for the state would necessarily show a sensitivity index of 2 and a time-factor index of 0. If, in addition, the period covered a business cycle in which the state's income went down and up twice as much as the nation's, the result would remain the same—a sensitivity index of 2 and a time-factor index of 0.

Now there was a general upswing of income over the period covered by the author's computations, and there was also a strong tendency for per capita income systematically to increase relatively more over the period in the low-income states than in the high-income states. Apparently, this tendency must be reflected predominantly in the sensitivity index—tending to result in a high sensitivity index for states with an upward trend (relative to the nation) in per capita income (and hence in general in the low-income-level states) and a low index in the states with a downward relative trend in per capita income (generally high-income-level states)—rather than in the time factor index, which to a large extent abstracts from it.

Is this the reason that Rhode Island and the District of Columbia appear in Table 5 with no significant time-factor index, although they are among the three jurisdictions with the smallest percentage increase in per capita income from 1929 to 1953? The suspicion is strengthened by the fact that both have very low sensitivity indexes, although the absence of farm income is an additional explanation of this.

In the case of Rhode Island (like most other New England states) it appears that per capita income truly has low cyclical sensitivity and also has a downward trend relative to the nation. Both forces lead, for most years of the period, to a rise in Rhode Island income less than proportional to that in United States income and hence may yield a good fit between the two series throughout the period. Under these circumstances, a simple regression between the two series may describe the observed relationship throughout the period, but to classify it as exclusively a cyclical relationship would be incorrect; it would be both cyclical and trend.

Much of what needs to be said in the way of qualification to this section is, in fact, summarized by Hanna in his note 51 and to some extent in his comparison of the merits of cross-sectional and time series analysis on pages 155–156. The difficulty is that, with the necessary qualifications, not much of interest can be said about the results. Trend and cyclical (and other) factors are too mixed up in the calculations as they stand for either the formulas taken as a whole or the sensitivity and time-factor indexes taken separately to be very instructive.

I believe these difficulties can be lessened by careful selection of periods, designed to separate trend, cyclical, and other movements. In addition, a thoroughgoing analysis requires some attention to components. In view of the way agricultural income dominates short-term changes in the state income distribution, at least a farm-nonfarm income breakdown appears essential in order to derive valuable analytical results on the relation of state income to national data. More fruitful results can be achieved by dealing with total income and population rather than with per capita income alone.

The doubts raised about the value of the sensitivity and time-factor indexes do not, of course, impugn all of the analysis in this section. The coefficients of variation shown in the third column of Table 6, for example, confirm the reduction in the geographic income spread from 1929 to 1941, and again from 1941 to the postwar years—to deal only with periods as nearly representative of peacetime prosperity as are available—which have been arrived at by other methods. The absence of a trend in the dispersion of per capita incomes within the postwar period suggests that the continuation in this period of differential regional trends in total income is associated with similar population trends.

Taken as a whole, my comments on Hanna's paper may appear rather negative. But they are qualifications rather than fundamental criticisms of the project as a whole. The basic conception of the United States as a unified economy I believe to be essentially correct; national economic developments *are* the most important influences affecting changes in income in the various states. Hanna may or not be—I rather think he is—somewhat overenthusiastic in the extent to which he pushes the concept in relation to cross-sectional analysis. Use of standardization techniques and of detailed analyses of components, which I have not discussed, has contributed and will contribute increasingly to an understanding of state differentials. The use in that connection of the coefficient of determination must be settled, however, and some way must be found to consolidate results of separate standardization studies, and of analyses of components of total income. The analysis of state income movements in relation to those of the country as a whole is a promising field for investigation. I hope that members of the

"Study of Differences in State per Capita Incomes," as well as other investigators, will continue to work on these and related problems, because they are both interesting and important.

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Frank A. Hanna's detailed study contributes much to our knowledge of the causes of interstate per capita income differentials. Nevertheless, he concludes his paper by posing some questions. My comments will deal mainly with two problems: (1) the suitability of the state unit, unweighted by population, for regional income analysis, and (2) the meaning of standardized earnings and the extent to which interstate earnings differentials are explained by occupational composition. I shall also suggest a simple method of explaining earnings differentials by industrial composition, wage levels, and the number of hours worked.

Hanna discusses the theoretical and practical advantages and disadvantages of basing regional income analysis on the forty-eight states—frequently, the District of Columbia is added. He suggests they can be viewed as a randomly selected set of subareas, with the advantage that "such a conception provides us with a framework for analyzing any observed changes in terms of economic factors other than location" (page 118). Hanna also considers the United States a single economy, since, although state per capita incomes are not distributed normally, the observed differences among states can be explained by differences in industrial composition, birth rates, age composition, educational achievements, racial composition, participation of women in the labor force, and a host of other income-connected factors (page 119). I agree that the differences cannot be attributed to chance forces. But once the existence of regional differences in income-connected factors are recognized, their systematic analysis would seem to require that the subareas to be compared be logically, not randomly, selected.

Because of the complex nature of the factors determining income, no single set of subareas is completely satisfactory for the analysis of regional income differentials. Ideally, a different set of subareas would be required to study the relationship between per capita income and each determining factor. Since, as a practical matter, one set must be used, what can be said for the practice of using the forty-eight states as national subdivisions?

State land areas vary widely, of course, from 61 square miles for the District of Columbia and 1,058 for Rhode Island to 263,644 for

Texas. Consequently, size differences must be taken into account in some aspects of regional income analysis. However, area alone is a poor criterion of economic importance.

State populations also vary, ranging from 160,083 for Nevada to 14,830,192 for New York in 1950. Thirty-four states—more than two-thirds—had a population below the mean value of 3.08 million. Table 1 shows the distributions of states and state popula-

TABLE 1

Effect of Population Weights on Distribution of States and the District of Columbia by Per Capita Income, 1950

1950 per Capita Income (dollars)	*Number of States*	*Population (millions)*	*Percentage of Total: States*	*Percentage of Total: Population*	*Difference in Percentages*
650– 849	4	9.3	8.2	6.2	+2.0
850–1049	4	13.7	8.2	9.1	– .9
1050–1249	9	15.7	18.4	10.4	+8.0
1250–1449	12	27.0	24.4	17.9	+6.5
1450–1649	12	42.8	24.4	28.4	–4.0
1650–1849	4	26.1	8.2	17.3	–9.1
1850–2049	4	16.1	8.2	10.7	–2.5
Total	49	150.7	100.0	100.0	

Source: Bureau of the Census and *Survey of Current Business*, Dept. of Commerce, August 1954.

tions, classified by per capita income. The distribution of population by state per capita income is more symmetrical than the state distribution and has a higher mean value (equal to United States per capita income) because many larger (smaller) states have above (below) average per capita income, as reflected in the last column.

Hanna does not ignore the question, but his reasons for giving each state one "vote" regardless of the number of "constituents" are not entirely convincing. One illustration will demonstrate the influence of population size in state income analysis. In his Table 3, Hanna presents three measures of the distribution of states by per capita incomes for each year from 1919 to 1921 and 1929 to 1953: mean, standard deviation, and coefficient of variation. My Table 2 compares Hanna's unweighted measures with those obtained using population weights for the three census years 1930, 1940, and 1950.

While his standardization process is an ingenious and invaluable method of isolating the contribution of occupational differences to state earnings differentials, the correlation technique employed does not properly measure the extent to which occupational composition explains (in the statistical sense) earnings differences.

Although the observed and standardized earnings are highly correlated, with a coefficient of determination (r^2) of 0.80 (using the detailed occupational breakdown), this coefficient reflects only the scatter of points about the regression line (see Hanna's Chart 1).

The regression equation obtained can be used to predict observed from standardized earnings with great precision, but this is not "explanation." For example, points for Georgia and Michigan lie on or very close to the regression line, but, for Georgia, the observed value is some $450 or 20 per cent below the standardized value and, for Michigan, the observed value exceeds the standardized value by $320 or 12 per cent. These differences are caused largely by state deviations from the national wage levels used in computing standardized earnings.

TABLE 2

Effect of Population Weights on Measures of State Per Capita Income Distributions, 1930, 1940, and 1950

Measure [a]	*1930*	*1940*	*1950*
Mean		(*dollars*)	
Unweighted	518	520	1343
Weighted	596	575	1439
Standard deviation			
Unweighted	197	176	305
Weighted	242	203	321
Percentage coefficient of variation		(*per cent*)	
Unweighted	38.0	33.9	22.7
Weighted	40.6	35.3	22.3

[a] The unweighted measures exclude the District of Columbia.
Source: Bureau of the Census, and Hanna's Tables 1 and 2.

The degree to which occupational differences alone explain earnings differentials can be illustrated by comparing the deviations of observed from standardized earnings with the deviations of observed earnings from their mean. In terms of the data on Chart 1, the total variation to be explained is the scatter of the items in the vertical direction. The explained variation is not properly represented by the regression line shown but rather by a straight line with a slope of unity, drawn from the $2,000 value on the y axis and passing through the mean values of both variables (approximately $2,500). The variation in observed state earnings not explained by occupational differences is, then, the scatter of points about this line of unit slope.

Although the amount of total variation explained by standardization can be represented in a measure analogous to the coefficient of determination, inspection of Chart 1 suggests that occupational differences explain somewhat less than half of total variation in state earnings. If the above is a valid criticism of the correlation technique in this type of analysis, occupational differences between states are apparently much less important than Hanna thinks in accounting for interstate differentials. Of more concern, however, is the apparent difficulty of measuring directly the contribution of occupational or industrial composition.

I suggest a simple method to explain the relationship between average state earnings and (1) industrial composition, and (2) wage levels and average number of hours worked.[1] An illustration of this approach is presented in my Table 3, based on the reported and standardized earnings data shown in Table 10 of Hanna's paper.[2] The ratio of reported state earnings per worker to the unweighted mean for forty-eight states (column 3) will be shown to be the product of two factors: one reflecting differences in industrial composition (column 1) and the other the combined differences in wage levels and hours worked per year (column 2). These can be represented as follows:

(col. 1) Standardized earnings/mean earnings $= \Sigma(W_n E_s)/\Sigma(W_n E_n)$

(col. 2) Reported earnings/standardized earnings $= \Sigma(W_s E_s)/\Sigma(W_n E_s)$

(col. 3) Reported earnings/mean earnings $= \Sigma(W_s E_s)/\Sigma(W_n E_n)$

Where, for each industry,

W_s = state average wage-hour production
W_n = national average wage-hour product
E_s = state employment
E_n = national employment

Because wages are held constant, the industrial factor measures the contribution of industrial composition to interstate earnings differentials. It ranges from 1.10 for Michigan, where high-wage industries are concentrated, to 0.78 for Mississippi, which has few such industries. The wage-hour factor is an index of state wages and

[1] This method is similar to that used by Frank A. Hanna in his "Contribution of Manufacturing Wages to Regional Differences in Per Capita Income," *Review of Economics and Statistics*, February 1951.

[2] The data in his Table 10 are based on 146 census of population industries, whereas the data shown on his Chart 1 are based on 442 occupations. It is interesting to note that the degree of correlation between reported and standardized earnings is nearly the same for the two sets of data (the coefficient of determination is 0.80 using the finer occupational breakdown, and 0.76 for the 146-industry breakdown). However, the standardized values based on the 146-industry breakdown appear to be much closer to reported earnings. The implications of this difference are not entirely clear.

TABLE 3

Ratio of Reported to Mean Earnings Explained in Terms of Industrial and Wage-Hour Differentials, 1949

State	*Industrial Factor* [a]	*Wage-Hour Factor* [b]	*Ratio of Reported to Mean Earnings*	*State*	*Industrial Factor* [a]	*Wage-Hour Factor* [b]	*Ratio of Reported to Mean Earnings*
	(1)	(2)	(3)		(1)	(2)	(3)
Maine	0.96	0.91	0.87	W. Virginia	1.01	1.01	1.02
New Hampshire	0.98	0.95	0.93	N. Carolina	0.85	0.92	0.78
Vermont	0.92	0.91	0.84	S. Carolina	0.84	0.88	0.74
Massachusetts	1.05	1.05	1.10	Georgia	0.87	0.87	0.76
Rhode Island	1.04	0.96	1.00	Florida	0.93	0.94	0.87
Connecticut	1.08	1.09	1.18	Kentucky	0.91	0.95	0.86
New York	1.04	1.18	1.23	Tennessee	0.91	0.91	0.83
New Jersey	1.08	1.16	1.25	Alabama	0.88	0.88	0.77
Pennsylvania	1.06	1.05	1.11	Mississippi	0.77	0.78	0.60
Ohio	1.07	1.10	1.18	Arkansas	0.82	0.82	0.67
Indiana	1.04	1.08	1.12	Louisiana	0.94	0.95	0.89
Illinois	1.06	1.17	1.24	Oklahoma	0.97	0.98	0.95
Michigan	1.10	1.15	1.26	Texas	0.97	0.99	0.96
Wisconsin	0.97	1.12	1.09	Montana	0.92	1.13	1.04
Minnesota	0.94	1.11	1.04	Idaho	0.89	1.09	0.97
Iowa	0.90	1.09	0.98	Wyoming	0.97	1.11	1.08
Missouri	0.95	1.07	1.02	Colorado	0.98	1.04	1.02
North Dakota	0.80	1.06	0.85	New Mexico	0.95	1.05	1.00
South Dakota	0.82	1.05	0.86	Arizona	0.95	1.06	1.01
Nebraska	0.90	1.07	0.96	Utah	1.02	1.08	1.10
Kansas	0.95	1.05	1.00	Nevada	0.98	1.23	1.20
Delaware	1.03	1.13	1.16	Washington	1.00	1.17	1.17
Maryland	1.04	1.08	1.12	Oregon	0.95	1.19	1.13
Virginia	0.95	1.01	0.96	California	1.03	1.18	1.21

[a] An estimate of the effect of differences between state and nation in industrial composition computed by dividing standardized state earnings by mean earnings for forty-eight states.
[b] Ratio of reported to standardized state earnings.
Source: Based on reported and standardized earnings in Table 10 of Hanna's paper.

hours (the base is the national average) weighted by state employment by industry, it ranges from 1.23 for Nevada to 0.78 for Mississippi.

Although the data shown in Table 3 are imperfect (due in part to substituting the unweighted mean of reported state earnings for national average earnings), they can be used to compute a rough measure of the relative contribution of industrial composition and the wage-hour factor to interstate earnings differentials. The values in columns 1 and 2 were converted into percentage deviations from mean and standardized earnings, respectively, by subtracting 100 from the product of each ratio times 100. The mean of the absolute deviations was 7.2 per cent for the industrial factor and 9.6 per cent for the wage-hour factor, indicating the greater importance of the wage-hour factor in explaining interstate earnings differentials. This finding is consistent with the visual impression obtained from Hanna's Chart 1.

The standardization procedure provides a method for measuring the effect of occupational composition on earnings differentials. Occupation, however, appears to contribute much less than the 80 per cent assigned to it. Perhaps interstate differences in wage levels, seasonal unemployment, and other factors affecting total hours worked annually are of major importance. The guaranteed annual wage may increase average annual earnings in industries where it is adopted. Because this is likely to occur first in high-wage, unionized industries, its effect may be to increase regional earnings differentials.

Certainly, age composition explains much of the difference in per capita income between rural and urban areas and, hence, between such states as Mississippi and New York. This appears to be a persistent phenomenon, although a trend to greater equality in rural and urban birth rates has been evident in recent years.

Why have regional income inequalities persisted in this country despite the relative freedom of movement afforded labor and capital? It seems obvious that barriers do exist that minimize effects of mobility between regions and occupations. These barriers are reflected in the median incomes in 1949 of persons shown in the 1950 census of population by color, farm, and nonfarm, in dollars:

REGION	WHITE		NONWHITE	
	Urban and Rural nonfarm	*Rural farm*	*Urban and Rural nonfarm*	*Rural farm*
Northeast	$2,273	$1,528	$1,626	$1,057
North Central	2,242	1,553	1,681	573
South	1,866	958	862	433
West	2,162	1,594	1,523	833

These broad regional classifications reveal few income differences between areas outside the South, and even in the South, median income of urban and rural nonfarm whites was only some 15 per cent below that for other regions. Median incomes of southern nonwhites, however, were much lower than for nonwhites elsewhere, and less than half that of southern whites. Obviously, a complete explanation of interstate income differentials requires analysis of the skills possessed by and the earnings opportunities offered nonwhites in various regions of the nation.

Hanna asks whether the state is the best unit for regional income analysis, since city size is a major factor in per capita income differentials. Cities of approximately the same size are usually more homogeneous with respect to factors determining income than are the states in which the cities are located. A detailed study of per capita incomes in Kansas City and six other metropolitan areas (Atlanta, Chicago, Dallas–Fort Worth, Los Angeles, Minneapolis–St. Paul, and St. Louis) revealed surprisingly few differences in many important characteristics, such as percentages of population 15 to 64 years of age, total population in the labor force, labor force employed, and labor force employed thirty-five hours per week.[3]

The differences between these seven metropolitan areas in 1950 per capita income (which ranged from $1,994 in Chicago to $1,505 in Atlanta) could be explained largely by differences in wage rates and industrial composition (Chicago had more employment in high-wage manufacturing industries, while in Atlanta more workers were engaged in low-wage manufacturing and personal service industries). These income-determining characteristics of metropolitan areas suggest that regions other than states may be better for some regional income analyses. However, income estimation for counties or groups of counties is a costly and laborious process, so the state will continue to serve as the basic unit for much regional analysis.

Explanations of income behavior should take account of all available data on demographic, social, and economic factors that are related to income. This probably means that explanations of interstate income differentials that go much beyond our present understanding of the subject will require more description and less statistical analysis. The biggest obstacle to further analysis of regional income differentials continues to be the lack of data on wage levels by occupation and industry, on man-hours, and, especially, on the composition of transfer payments and entrepreneurial and property income.

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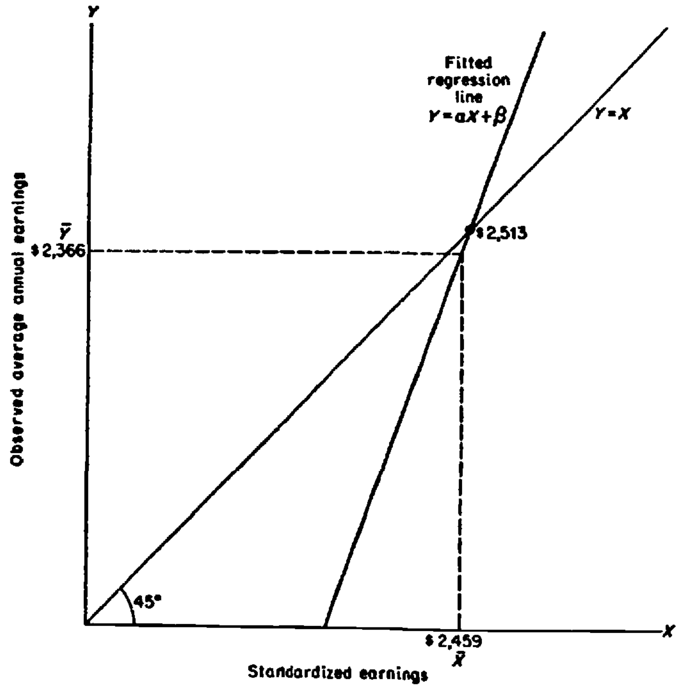
A number of important points are left unsettled by Frank A. Hanna and Edward F. Denison. In my opinion, both of them overestimate the independent influence of occupation mix on state income differentials. Hanna claims that 80 per cent of state income

[3] Philip Neff and Robert M. Williams, *The Industrial Development of Kansas City*, Federal Reserve Bank of Kansas City, 1954. Per capita income was computed for each of the seven metropolitan areas for 1929, 1933, 1939, 1948, and 1950.

variation is due to occupation mix. Denison claims that only 37 per cent is due to occupation mix. I shall indicate below a method of estimating precisely the proportion of variance attributable to different factors. With the information provided by Hanna it appears that:

1. 11 per cent of state income variation is due to the independent influence of occupation mix.
2. 69 per cent is due to the joint influence of occupation mix and earnings levels changing simultaneously.
3. The remaining 20 per cent is due to that portion of earnings levels which are independent of both state income and occupation mix.[1]

My method of partitioning the variance of state per capita income is given in the last section of this note. A number of prefatory remarks are in order which can best be illustrated by reproducing the chart from page 123 and some of the computations underlying Hanna's paper.



[1] When Hanna uses weighted regressions, the proportions are 10.2 per cent, 76.5 per cent and 13.3 per cent, respectively.

On the vertical axis appears the observed annual per capita earnings for forty-eight states in 1949. On the horizontal axis appears the per capita earnings which each state would have if each of 422 occupations yielded earnings rates equal to the national average for each category. This figure is called the standardized earning rate. The 45° line on the chart indicates a set of points for which the actual and standardized earnings are equal. The fitted regression line crosses the 45° line at $2,513. The mean actual earnings are $2,366; mean standardized earnings are $2,459. The slope of the line is +2.71 actual dollars per standardized dollar.

The positive slope of the regression line indicates that high-income states tend to concentrate on high-income occupations and therefore have high standardized earnings. The slope greater than unity indicates that high-income states tend to have higher than average earning rates in the occupations in which they concentrate. That is, the regression reveals a positive correlation (called joint influence by Hanna), between occupation mix and earnings rates.

It is clear that a negative correlation between occupation mix and earnings rates would produce a slope of the regression line less than unity; and zero correlation between occupation mix and earnings rates would produce a slope equal to unity, with the regression line coinciding with the 45° line (not all states can depart from average earnings rates in the same direction). However, if the regression line has slope equal to unity, it does not necessarily follow that all income variation is explained by occupation mix. For that to be true, there must also be perfect correlation between standardized and actual income. The absence of perfect correlation would mean that earnings differences still exist, though they are not systematically related to occupation mix.

Suppose the regression has a slope of +2.71 (as it appears), and suppose in addition there is perfect correlation between actual and standardized income. We would say that every dollar difference between actual and national average earnings is accompanied by $1/2.71 = \$0.37$ difference in standardized earnings, and that occupational mix by itself accounts for 37 per cent of observed state income differences. At this point, Denison compares this 37 per cent with Hanna's 80 per cent. However, it must be noted that the two figures are not comparable. Hanna's percentage deals with squared differences (variance), while Denison's does not. To be comparable, the 37 per cent figure must be squared, indicating that, with perfect correlation, 14 per cent of squared differences would be explained by occupation mix. However, the correlation is not perfect; the regression line reduces the variance of state income by

80 per cent. This literally reduces by 20 per cent the proportion of squared differences explained by occupation mix, i.e. from 14 per cent to 11 per cent.

At issue between Hanna and Denison is the definition of the term "variation" as it applies to state per capita incomes. Denison prefers the term to mean numerical differences between state and national per capita incomes. He regards the variation to be explained as the sum of the absolute values of these differences. Hanna uses the variance as the measure of variation, and rightly so in this context. The variance lends itself to formal partitioning according to the influence of different factors. The major objection to Denison's technique is that it requires an arbitrary allocation of the joint influence among the factors influencing state per capita incomes. The most reasonable treatment of this joint effect is to separate it from the independent effects of known influences. At the same time, it must be remembered that the joint effect will reinforce the predictive power of either variate when used alone to estimate state per capita incomes. One of the major contributions of Hanna's paper is the evidence indicating the predictive power of occupational mix in a regression equation.

These remarks will become clear below when it is seen how the variance in state incomes can be partitioned. In the regression analysis, the difference between state and national per capita earnings is partitioned into:

a = differences between the regression line predictions and the actual state incomes.

b = differences between regression line predictions and the national average. Under the least squares hypothesis, the two components are independent. We know from Hanna that the variance of the first term is 20 per cent and that of the second 80 per cent of the variance of state per capita incomes.

In addition, the second term can be partitioned to indicate the variance of state incomes explained by standardization. The second term can be split into:

b' = differences between the regression line predictions and the standardized incomes.

b'' = differences between standardized incomes and the national average.

When the mean of the standardized incomes is equal to the national average,[2] the variance of the second term is the variance of stand-

[2] This condition, which is essential to the interpretation of variance analysis, ordinarily is fulfilled when the weighted average of the states (the national average) is taken as the standard. For this reason, weighted rather than unweighted regres-

ardized incomes. The variance of the first term plus the co-variance factor between b' and b'' is equal to the variance explained by regression less that explained by standardization.[3] It is clear that this term reflects the joint influence of earnings levels and composition. For if earnings levels and composition were uncorrelated, the variance of the regression line would equal the variance of standardized incomes. These remarks may be summarized by the following variance table: note that a refers to the regression coefficient of y upon x.

	Variance Term	*Per cent of σ^2_y*
(1) Occupation mix acting independently (variance of standardized incomes)	σ^2_x	11
(2) Additional variation explained by regression above that explained by standardization (variance of regression line less variance of standardized incomes)	$a^2\sigma^2_x - \sigma^2_x$	69
(3) Residual from regression	$\sigma^2_y - a^2\sigma^2_x$	20

The Influence of Occupational Mix and Earnings Levels

From the preceding discussion it was clear that a large part of the predictive power of occupation mix came from its correlation with earnings levels. Indeed, if the two factors were independent,

sions should be used. The use of the total numbers in the experienced labor force, rather than the numbers with wage and salary earnings in the experienced labor force, to compute the state rate-constant earnings yields a 1.7 per cent discrepancy in the weighted averages (see Hanna's note 17).

[3] This can be proved quite simply. Let y indicate the state per capita income, x the standardized value. Let y_p be the predicted value from the regression, and $\bar{y}$ be the national average. Then (using σ^2 to denote variance):

$$y - \bar{y} = (y - y_p) + (y_p - x) + (x - \bar{y})$$

and

$$\Sigma(y - \bar{y})^2 = \underset{a}{\Sigma(y - y_p)^2} + \underset{b'}{\Sigma(y_p - x)^2} + \underset{b''}{\Sigma(x - \bar{y})^2} + 2\,\Sigma(y_p - x)(x - \bar{y})$$

We know the variance in term a is 20 per cent of the variance of y, and that term a is independent of the other terms. The variance in term b'' is simply the variance of standardized incomes, which is 11 per cent of the variance of y. The variance of b' and covariance $b'b''$ reduce as follows:

$$\Sigma(y_p - x)^2 = \sigma^2_{y_p} + \sigma^2_x - 2\sigma_{y_p x}$$

$$2\Sigma(y_p - x)(x - \bar{y}) = 2[\Sigma y_p x - \Sigma x^2 - \bar{y}\Sigma y_p + \bar{y}\Sigma x] = 2\sigma_{y_p x} - 2\sigma^2_x$$

Cancelling, we have: $\sigma^2_{y_p} - \sigma^2_x$ and this is the variance explained by the regression less that explained by standardization.

occupation mix would have explained only 11 per cent of the variance of state per capita incomes. This is what is meant by the independent influence of occupation mix.

The concept of independent influence is useful as a guide to the statistical investigator. It tells him whether it is worthwhile to use an additional independent variable in analyzing a particular problem. If the independent influence of a variate is not a significant portion of the variance of the dependent variate, it is not worthwhile introducing it into the analysis. In the case of occupational mix, the number of degrees of freedom and the size of the variance indicates that 11 per cent is a significant reduction in the variance of state incomes.[4]

The exact relationship between earnings levels and occupational mix becomes clear from the following definitions. Let p_{ij} denote the earnings level in the ith occupation and the jth state; q_{ij} denote the proportion of the jth state's labor force in the ith occupation. p_{io} and q_{io} will denote the same entities for the nation as a whole. From these definitions, it is clear that $\Sigma_i q_{ij} = 1$ for every state and $\Sigma_i q_{io} = 1$. The difference between the per capita earnings of a typical state and those of the nation may be written as:

$$(1)\quad \Sigma_i p_{ij}q_{ij} - \Sigma_i p_{io}q_{io} = \Sigma_i p_{io}(q_{ij} - q_{io}) + \Sigma_i q_{io}(p_{ij} - p_{io}) + \Sigma_i (p_{ij} - p_{io})\ (q_{ij} - q_{io})$$

The first term is called by Hanna the rate constant particle, the second term the composition constant particle, and the third term the joint particle. Due to the nature of the data, it is not possible to compute either the second or third term, since the state rates (p_{ij}) are not available. However, the second and third term may be combined to yield a state weighted composition particle. The expression is then written:

$$(1a)\quad \Sigma_i p_{ij}q_{ij} - \Sigma_i p_{io}q_{io} = \Sigma_i p_{io}(q_{ij} - q_{io}) + \Sigma_i q_{ij}(p_{ij} - p_{io})$$

or

$$\Sigma_i p_{ij}q_{ij} = \Sigma_i p_{io}q_{ij} + \Sigma_i q_{ij}(p_{ij} - p_{io})$$

The first term on the right-hand side is the rate constant standardized term computed by Hanna which was previously denoted as x, i.e. state composition weighted by national earnings. The second term on the right-hand side is a state composition weighted sum of differ-

[4] The use of 1 degree of freedom to reduce the variance of state incomes by 11 per cent is certainly significant at the 5 per cent level when tested against the residual variance from the regression, which has 46 degrees of freedom.

$$F = \frac{0.11\sigma_y^2/1}{0.20\sigma_y^2/46} = 25.3$$

ences between state and national earnings rates. It can be computed by taking differences for each state between the state income y and the standardized rate x. The variance of this term may be computed, and it gives some idea of the independent influence of earnings levels. Without weighting the terms, the variance is 61 per cent of the variance of state per capita income. When the state terms are weighted by population, the variance is 51 per cent of the state income variance. It is not surprising that the variance of rate constant earnings and the variance of the composition weighted term do not exhaust the variance of state incomes. The two terms are highly correlated. As we indicated previously, this is responsible for the high correlation between the observed state incomes and rate constant earnings. When the state terms are unweighted, the correlation between the rate-constant and composition-constant terms is +0.74; when they are weighted, the correlation is +0.86.

REPLY BY THE AUTHOR

A reply, presumably, should assist the reader in appraising divergent views. My paper and Edward F. Denison's comment should be sufficient to enable one to decide whether a regression line or a line of proportional change is the more "meaningful" in describing changes over time in state per capita incomes, and whether the 1919–1951 period is a suitable one for computing an index which describes the changes in a state's per capita income in terms of the changes in the national income level or for estimating trend factors by any method. Edwin Mansfield's paper (in this volume) contains information pertinent to the appraisal of Robert M. Williams' suggestion that regional analyses should be based on cities rather than on states.

The one question, raised by all discussants, which needs additional discussion concerns the appropriate way to measure the statistical effects of state variation in (occupational, industrial, etc.) composition. I am in agreement with George H. Borts' comments.

The question to which my paper is addressed concerns the extent to which state variation in occupational composition accounts for the variation in reported state earnings. As I view it, the question relates to the distribution of all of the forty-eight states around their weighted mean, reported national earnings. A meaningful answer must be based on all of the measurable effects of occupational variation, not just the net, direct, and first-order effects reflected by the isolated comparison of a single state's reported and rate-constant earnings.

As shown by Borts' formula 1a, such a single state comparison ignores even the net joint effects of state-nation composition and rate differences. When a common weighting system is used and several states are compared simultaneously, still other joint terms appear.[1] These joint terms contain the net interactions of rate on composition, and of composition on rate changes. Unless we are prepared to say that the rate-composition relationships in one state are independent of those in another, these interstate joint terms should be taken into consideration.

As Borts has clearly shown, the coefficient of determination, as a measure of the extent to which variation in state reported earnings is explained by the variation in state rate-constant earnings, reflects not only the first-order effects of composition differences but also all other factors which are associated with them. To the extent that they are correlated, the measure will reflect the correlated effects of rate differences. The joint particles both within and among states arise from just such correlation.

The alternative measures suggested by Williams and Denison are based on one or another average over the states of the relative size of the rate-constant and composition-constant particles (the terms on the right-hand side of Borts' formula 1a). To my mind this is a misuse of standardized earnings (a misuse of which I was guilty in my article on manufacturing wages, *op. cit.*, note 20). Standardized earnings, like constant weight index numbers, are valuable in that they permit comparisons between states or between a state and nation without the distorting influence of the variation in the factor (rates or composition) held constant. But index numbers have never provided economists with a satisfactory answer as to the relative importance of price and production changes on growth and cyclical fluctuations.

One obvious basis for objecting to the use of relative importance of the rate-constant and composition-constant particles as measures of their explanatory value is (as mentioned previously) the ubiquitous joint particles, which cannot be partitioned satisfactorily. A more serious, though perhaps less obvious, objection is that much of their influence is netted out and thus ignored. When our sole objective is to obtain comparable figures, this netting is desirable and entirely proper. But when we are trying to gauge the relative importance of the two particles as explanatory variables, it would seem desirable to include all changes, whatever their direction, and with-

[1] The difference in reported earnings between states 1 and 2 may be expressed, using national weights, as follows:

$$\Sigma p_{i1}q_{i1} - \Sigma p_{i2}q_{i2} = \Sigma p_{in}(q_{i1} - q_{i2}) + \Sigma q_{in}(p_{i1} - p_{i2}) + \Sigma(p_{i1} - p_{in})(q_{i1} - q_{in}) + \Sigma(p_{i2} - p_{in})(q_{in} - q_{i2})$$

out regard to whether opposing changes existed. Here, our concern is with total variability, not just the comparableness of average earnings for a pair of states.

For economic data, in which rate deviations are likely to be predominantly in one direction, the amount of netting will be larger in the rate-constant particle. This effect can be seen most clearly when relative composition is used. Since both $\Sigma q_1 = 1$ and $\Sigma q_2 = 1$, if some $(q_1 - q_2)$ are positive, others must necessarily be negative, and vice versa.[2] Yet all $(p_1 - p_2)$ may have the same sign. Since all p's and all q's entering the computations are positive, the sign (for a particular occupation) of the rate-constant and composition-constant particles will be determined by the sign of the parenthetical differences. In summing, these signs are taken into account. Consequently, the rate-constant particle necessarily will be a net figure derived from summing algebraically some positive and some negative figures. The composition-constant particle, however, may be cumulative in one (either positive or negative) direction. Although I have no definitive answer to this problem, it may be suggested that working directly with the variance between occupations (within a state) overcomes the tendency to net out opposing influences. The question may be formulated in terms of how much of the total variance in the difference between reported series is due to rates, how much to composition, and how much to the two changing simultaneously. The problem apparently then would become one of interpreting a $p \times q$ variance table.[3]

There is reason to think that the measurement of the relative importance of rate- and composition-changes as explanatory variables poses basically insoluble problems. Insistence on some symmetrical framework that would require allocation of the joint terms would strengthen these reasons. The methods suggested in my paper appear to provide a sufficient answer to the central problem without having to deal with these knotty problems.

[2] It has been pointed out to me by Maurice Liebenberg that the rate-constant particle may be derived as the sum of the products of positive figures. The method is based on a scheme of "shifting" frequencies in the q_2 distribution, from occupations (denoted by the subscript j) where $q_2 > q_1$, to occupations (denoted by the subscript i) where $q_2 < q_1$ until the q_1 distribution of frequencies among occupations is obtained. If the frequencies moved into the i'th occupation are designated by Δq_i, and those same frequencies in the j'th occupation, from which they were removed, by Δq_j, it may be shown that $\Delta q_i = -\Delta q_j$, and that the rate-constant particle may be derived as $\Sigma(p_i - p_j)\Delta q_i$. This method implies that only the "shifted" frequencies are of importance. Thus, the netting is accomplished by ignoring all of the frequencies that "stay put."

[3] Maurice G. Kendall, *The Advanced Theory of Statistics*, London, Charles Giffen and Co., 1948, Vol. II, Chap. 24.