OCCUPATIONAL CLASSIFICATION: CURRENT ISSUES AND AN INTERIM SOLUTION*

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Introduction

Of late, there has been a ground swell of interest in and criticism of the occupational classification currently used by the U.S. Bureau of the Census.[1] What has distinguished this recent spate of professional discussion from those in the past is the unanimity of a broad cross section of the users of Census occupational data on the fundamental lack of relevance of the current scheme in supplying meaningful data for analytical purposes. Increasingly, both sociologists and economists have become aware of the difficulties in using the broad or detailed occupational data for analysis of, for example, changes in socio-economic status or projections of manpower requirements.

Concurrent with this interest and criticism has been the experimentation with possible "candidates" for replacement of the existing structure. This experimentation has taken two basic directions.

First, development of "Convertibility Lists" between the existing Census occupational classification and the Bureau of Employment Security Dictionary of Occupational Titles, as well as a similar "List" between the D.O.T. and the International Standard Classification of Occupations (I.S.C.O.) of the International Labour Office (I.L.O.).[2] Second, examination of existing occupational taxonomic principles and development of new taxonomic principles resulting in more "homogeneous" detailed as well as broad occupational groupings.[3] Expectations from the work above would be: 1) a reduction in classification errors (e.g., reduction of the proportion of individuals reported as "N.E.C."); 2) the construction of job-families based on job content for projection of manpower supply and demand by, for example, skill; 3) availability of suitable data for analyzing and evaluating alternative manpower policies and programs.[4]

The purposes of this paper, then, are three: first, to briefly review the dimensions of the criticism of the existing Census occupational classification; second, to examine some of the suggested solutions for revising the current occupational classification; third, to display and discuss a major occupational schema devised by the author, meeting some of the objections in the current debate within the constraints of the existing occupational classification.

Dimensions of the current criticism

According to Webster the generally accepted definition of "Occupation" is: "the principal business of one's life; a craft, trade, profession or other means of earning a living."[5] The sociologists and students of occupational data are a bit more rigorous in defining the "pigeonhole" marked "occupation." Reiss, for one, defines "occupation" as follows:

> The social valuations attached to work in a society may be thought of as referring to both the kind of work a person does and the situation in which one works. The specific kind of work a person does in a socially evaluated work situation generally is thought of as a job, while an occupation refers to the characteristics that are transferable among employers.[6]

Some of the dimensions used to define "work" or "job" are:[7] 1) specific tasks or functions performed; 2) the purpose for which the job is done; 3) the materials, tools, and equipment used; 4) the standard to be met in the working environment; 5) the education and training needed by a worker to perform a job. Hence, an "occupation" is the sum total of homogeneous work characteristics that are, theoretically, transferable among employers, industries and classes of workers.

This leads us to the fulcrum of criticism in the literature. That is, that the taxonomic principle of "homogeneity" in defining both broad and detailed occupations is being violated in the current Census classification. Witness this comment:

> "...occupational codes are not formed solely by reference to the similarity in tasks performed by individual incumbents of specific jobs. Instead, work settings, industrial affiliations, (class of worker) and other factors are used to define detailed occupational groups."[8]

A more fundamental criticism is that this "heterogeneity" in the existing classification is fostered by the current standards of determining broad as well as detailed groups: the use of "socio-economic status."[9] This standard, according to one analyst, results in sizable enumeration and classification errors. For example, the residual categories, the n.e.c. groups, of the major occupations contain over one-third of those employed![10] Further, even if socio-economic position is used as a guide to determining major occupational groups, it does not seem to be applied rigorously. Again, this comment from the investigative literature:

> "...despite the obvious use of socio-economic criteria to form them (the major occupations), they do not comprise a grouping of detailed

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> occupations effected on the basis of status alone....we know...that ratings assigned by respondents to specific jobs or occupations falling in different major occupational groups overlap appreciably."[11]

Lastly, the compounding of the heterogenity in content of the occupational groups, the problems with the magnitude of the residual categories--and the large expected classification and enumeration errors, present the most important problem: the relevance of the data. Among labor force and manpower specialists there is an increasing realization that the current classification is not providing useful information for a host of analytical areas.

Current occupational data are not amenable to analysis of labor resource allocation decisions, e.g., projection of manpower supply and demand requirements.[12] There appears to be too little information on a) the number of jobs available at different combinations of skill and wage levels, and b) the numbers of workers possessing different skill levels at prevailing or expected wage levels. Hence, the current occupational structure falls down at precisely the point where the economist, for one, needs it--that is, supplying data on the range of substitution possibilities between occupation groups.

With this in mind, let us turn to the several schemes suggested as possible substitutes for the existing Census occupational classification, and the associated problems in changing to another system of classification.

Suggested occupational classifications

While there have been innumerable suggested schema put forth for classifying occupations, most of these fall into two "families" of technique. The first, which was the route followed in the development of the current Census schema, is the so-called "direct approach"--that is, the classification of the labor force by an independent criterion--for example, ranking occupations by median level of education or "socio-economic status" score.[13] The second, currently being used by development planners, is the "distilled technique." This consists of first grouping occupations by the "work performed" or "job content" and then stratifying the groups in terms of "skill prerequisites." Most of the current experiments with occupational classification schemes have been of the latter variety.

Simple moves towards the type of homogeneous occupational structure desired by analysts are those currently involved in matching Census and Dictionary of Occupational Titles data. The distinction between the Census and D.O.T. classifications rests largely on the stratification of the blue-collar occupations by the stage and type of production process. Recent developments leading towards a "convertibility" list between the two classification schemes have attempted to define similar "work content" differences in the lower white-collar occupations, i.e., clericals.[14]

A slightly more advanced schema was that used by Parnes in his examination of manpower and skill requirements in the OECD Mediterranean Region Research Project.[15] Using the International Standard Classification of Occupations (I.S.C.O.) of the International Labour Office (I.L.O.), Parnes coded detailed occupations by their skill prerequisites, i.e., the level of education required. The resulting four basic groups formed the basis for determined skill requirements for individual countries.[16]

By far the most sophisticated suggestion put forth to date is the creation of "job-families."[17] "Job-families" would comprise aggregates of common demand characteristics of detailed occupations. That is, the "families" would have relatively common content--the tasks the individual job-holder performs--and would be stratified by degree of complexity involved in the conduct of work. Job content, of course, would be intimately interwoven with educational and training prerequisites. Further, considerations of wage structure and mobility patterns would also affect the definition of "job-families."[18] Thus, occupational classes or job-families would be relatively homogeneous. In economic terms, there would be a high degree of substitutability of detailed occupations within each class. Similarly, occupational classes or "job-families" would be differentiated from one another by a low degree of substitutability between one another, i.e., low cross-elasticity of demand. On the supply side of the picture, similar ground rules would be employed to define so-called "worker" classes. Advocates of such a classification system contend that the benefits accruing will be "adaptability to changes in technology and educational policy to isolate new jobs and hence new skills which alter substitution possibilities."[19]

Problems of changing the existing occupational classification

While some of the suggestions put forth in the previous section would not result in too great a modification of the existing Census occupational schema, others, particularly those directed towards creation of so-called "job-families," would. The problems to be faced in changing the existing classification system can be viewed as falling into three areas: comparability considerations, measurement and analysis, and costs and benefits.

All of the suggestions discussed earlier generally have the following beneficial characteristics: 1) all are concerned with devising more homogeneous occupational classes; 2) all of them are directed toward better definition of the labor force, e.g., reduction of the proportion of the total labor force "not elsewhere classified" (n.e.c.); 3) all of them expect, as an end product, better and more relevant data for use in manpower and labor force analysis.

Let us now turn to the problems engendered by changing the occupational structure.

The ideal of creating an occupational classification composed of more homogeneous groupings is plagued by the bogey of comparability. A radical departure from the existing system will cause considerable mental anguish in the community of census users, one of whose primary desires is the investigation of historical trends. Further, to recast prior census materials in any contemplated schema would be a costly operation. Lastly, but not an unimportant consideration, is the matter of timing and tooling up for any change in the occupational classification. A substantive revision in the Census occupational schema could not be implemented much before the 1980 Census at the earliest. Rigorous statistical standards and numerous tests of any radical schema would have to be established before any intended classification system could be implemented.

While the comparability issue is a constraint in the consideration of alternative occupational classifications, it is not a rigorous one. Supplemental classification schemas have been devised and used with the existing Census occupational structure. Limited departures from the existing codes, in the directions desired by the current crop of critics, can be handled without much degradation in comparability. The suggested modification presented in this paper is one such revision.

While the development of an occupational code with numerous homogeneous groups may be a desirable goal, it runs right into another constraint: statistical reliability. A very refined structure, which is desired by many of the critics of the existing one, when crossed with other socio-economic variables for analysis purposes, will very quickly run out of expected cases per cell. Thus, the accuracy of parameters at very refined levels of aggregation will become more dubious than they are at present.[20] Depending upon the number of variables used to define an occupational code, too fine a structure may represent a less objective and hence less independent yardstick for statistical analysis.[21]

The foregoing is meant only as food for thought in the evaluation of alternative occupational classifications; it is not meant to throw cold water on thinking about or design of alternatives. To the contrary, what it does do is define the decision space within which alternatives should be considered.

A Suggested Interim Solution

Discussion

The 10 or 12 Census major occupational groups are a mixed bag. The present classification places certain detailed occupations in what would seem a priori to be the wrong major occupational group. For example, in a recent study of differential occupational mobility by color, a significant amount of net in-movement was observed in a residual service category for white males.[22] On closer examination, a significant proportion of the net in-movement in this residual service category was explained by the growth of "protective service" occupations. The socio-economic characteristics of this group were not only significantly different from the other "Service" groupings, but also were significantly different from the socio-economic characteristics of the major occupational groupings purportedly above "Service Workers" in the occupational hierarchy, i.e., operatives, craftsmen and clericals.[23] Hence, contrary to Scoville's criticisms, the current Census major occupational groups would appear to be a "weak" ordering of occupations on the basis of socio-economic characteristics. Numerous other examples of mis-classification, using the existing major occupational groupings, can, I am sure, be documented.

Thus, it would appear that a first attempt at deriving more homogeneous major groupings can be to use the existing materials on the socio-economic characteristics of occupations in conjunction with their relationship to, for example, the functioning and development of the economy. Once a definition of the socio-economic characteristics of the detailed occupations was established, the resulting ranking could be broken into an initial major grouping based on the relative importance of the occupational socio-economic characteristics. A final major occupational classification could then be developed by segregating the occupations into groups on the basis of their relationship to technological change. This composite major occupational code would have the benefits of greater homogeneity than is presently available with the Census groups, greater adaptation to change in detailed occupation, as well as greater analytical clarity in considering questions of skill requirements.

These desirable features of such a major occupational classification should not be underestimated. No matter what the form or composition of the index used to compute the socio-economic score for the detailed occupation, the original breaks in the ranking of socio-economic scores on the basis of relative importance will not change.[24] Thus, the introduction of totally new detailed occupations--achieved through better definition of the current residual "n.e.c." categories or through technological change--will not perturb the original structure of major occupational groupings. It will simply expand the number of occupations falling in a specific socio-economic grouping. This will significantly reduce the problem of intercensus comparability, and lessen the likelihood of classification errors due to arbitrary allocation standards. The major differences between Censuses will, however, be very sensitive to the standard used in further subdividing the detailed occupations into groups for analysis of manpower and skill requirements.

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With these considerations in mind, an attempt was undertaken to produce: 1) a system of major occupations on the basis of relative importance of socio-economic characteristics of detailed occupations, using 1960 Census materials; 2) a further subdivision of the resulting major occupational code, using the "livelihood code" system suggested by Jaffe.[25]

Data and methods

As mentioned previously, the objective of the exercise was to recast the present Census Occupational classification into a more homogeneous one. This was accomplished by utilizing the existing ordering of the detailed occupations by Socio-Economic Status (SES) Scores and devising new major occupational groupings on the basis of differences in the relative values of the Socio-Economic Status (SES) Scores.[26] Relative values for Socio-Economic Status (SES) Scores were estimated, using the Ordinal-Relative Value Conversion technique developed by the Research Analysis Corporation (RAC).[27]

The technique has the following features.

First, estimates of relative value are derived through successive chains of co-ordinates of plotted points of half-values from a truncated ordering.[28]

Second, estimates of relative value from each chain of plotted points of half-values are normalized to derive a common scale.

Third, normalized estimates of relative value from each chain of plotted points of half-value are averaged on the common scale to derive a final composite estimate.

Fourth, where relative values are lacking at the extremes of the ordering--for example, in the truncated portion--they are built up from pairs of order numbers which have equivalent values to the order numbers previously dropped during the estimating.

The decision rule used in defining the major occupational groupings was that major breaks in the occupational ranking occurred when second differences between composite relative values of Socio-Economic Status (SES) reached zero.

Suggested Alternative Interim Major Occupational Codes

The following three tables depict the "menu" of possible major occupational groups, using the class intervals in Socio-Economic Status (SES) Scores, derived through the RAC Ordinal-Relative Value technique. These represent different levels of aggregation using combinations of the Current Census Codes, the Socio-Economic Status Score class intervals and the Jaffe "livelihood" codes. Based on a benchmark minimum of 100,000 cases per grouping, the table below summarizes the number of possible major occupational groups for each alternative.

Occupational Classification Scheme	Number of possible major occupational groups having a minimum of 100,000 per group
1. Current Census Occupational Code	12
2. Socio-Economic Status (SES) Score - (Table 1)	16
3. Jaffe Livelihood Codes	19
4. Socio-Economic Status (SES) Score x Major Jaffe Livelihood Occupational Codes - (Table 3)	41
5. Socio-Economic Status (SES) Score x Current Census Occupational Code - (Table 2)	52

Choice of an appropriate alternative from the array suggested here will depend largely on the scope and nature of the investigation. Modification of these suggested alternatives is of course possible. For example, analyses may be undertaken using the alternative occupational codes and new groups formed based on the degree of similarity in mobility patterns, or differences in the wage structure.

The Socio-Economic Status (SES) Score major occupational code, shown in Table 1, represents a moderate improvement towards greater homogeneity over the existing Census major occupational code. By cross-classifying the Socio-Economic Status (SES) Score code with the current Census major occupational code, we can get a better feel for the extent of heterogeneity in

the existing Census major occupational classification. For example, the range in Socio-Economic Status (SES) Scores for "Professionals" is approximately 50 points, and in the case of "Operatives" it is over 70 points. (See Table 2.) It would appear, then, that part of the lack of association between Socio-Economic Status (SES) and the current major occupational hierarchy is explained by the extensive variability in Socio-Economic Status within each major occupation. Hence, one improvement, using the current Census code, might simply be to develop a major occupational code stratified by the Socio-Economic Status (SES) Score intervals as shown in Table 1.

A more involved modification of the existing code is the development of a major occupational code based on a cross-classification of the Socio-Economic Status (SES) Score intervals and the Jaffe "livelihood" code. The result would be an identification of occupations by their involvement--or non-involvement--with the development of and use of technology and other economic functions, i.e., "Modern," "Classical" and ancillary occupations; e.g., administration and distributive functions, service functions, agricultural functions and the pool of industrial unskilled. Table 3 shows such a code for the 1960 male labor force. The breakdown is useful in several respects. First, it enables one to identify groups for more refined analysis of changes in the occupational requirements of the economy over time, i.e., during different stages of economic development and growth. Second, it prevents the masking of trends, presently a problem in the use of the existing Census major occupational code for forecasting occupational requirements. Third, the recasting of the existing Census occupational code into this suggested format can be accomplished with a minimum of significant technical problems.[29]

The Usefulness of SES Score Groupings: The Measurement of Socio-Economic Inequality

A variety of tools has been used by sociologists and economists to detect dissimilarities in status and income. The SES Score groupings presented in this report provide another means of estimating the presence and extent of inequalities in both status and income within and between occupational groups and countries. The measure of socio-economic inequality can further be analyzed to detect sources or possible causes of the inequalities, as well as--in a policy sense--the programs that might ameliorate them.

To illustrate this use of the SES Score classification scheme, data on the distribution of socio-economic status for the United States and Panama were used.[30] The extent of socio-economic inequality in both countries and the differences between them can be graphically portrayed through the device of a Lorenz curve.

Socio-economic status Lorenz curves were developed for the United States and Panama by plotting the cumulative proportion of units arrayed in order, from the lowest SES Score group to the highest, against the cumulative proportional share of the aggregate socio-economic status accounted for by these units. Theoretically, if all units had exactly the same amount of socio-economic status, the Lorenz curve would be represented by a 45° line drawn through the origin. For a variety of reasons, curves drawn to actual data will fall below the diagonal. Generally, the greater the inequality in socio-economic status, the greater will be the area between the diagonal and the Lorenz curve. A measure of inequality or concentration is the Gini coefficient, which is the proportion of the total area under the 45° line that is between the diagonal and the Lorenz curve.[31]

Examining the socio-economic status score Lorenz curve drawn for the United States and Panama in Figure 1, one can quite easily see the greater degree of socio-economic inequality in Panama. In the case of Panama 50 per cent of the units have 25 per cent of the aggregate socio-economic status, while in the case of the United States the same proportion of units has 35 per cent of the aggregate socio-economic status. This is further summarized when one examines the Gini coefficients of socio-economic status concentration. For the United States it is .232, while for Panama it is .312. The question remaining, in a speculative sense, is what are the possible causes for socio-economic inequality.

In an a priori sense, a lower limit for the aggregate socio-economic inequality in a country or region is the statistical distribution of the abilities of the basic population. Hence, depending upon the shape of the distribution of abilities, in a very real sense there will never be perfect socio-economic equality in a country or society. That is, the socio-economic Lorenz curve will depart from the diagonal by some minimal area between the diagonal and the Lorenz curve as a function of the distribution of abilities of the population. Anything above this minimal degree of socio-economic inequality is the product of several factors: 1) the mix of institutional arrangements in the country or region, 2) the degree of industrialization, 3) the proportion of the total population of working force age employed in the market sector of the economy, 4) the universality and availability of education on all levels, 5) status consistency, 6) the ease of socio-economic mobility, etc.

In terms of a continuum of economic development--ranging from the less to the more developed countries--it is possible that socio-economic inequality may be significantly related to the extent of underemployment, and the rigidity of societal and government controls on upward socio-economic movement. Thus, a country with substantial urban and rural underemployment, low levels of literacy, and limited social mobility opportunities may have relatively greater

socio-economic inequality than a more advanced nation with a majority of its working force employed in non-agricultural pursuits, a substantial number of its younger population enrolled in secondary and higher education institutions, and a government, one of whose major policies is the reduction of social immobility.

Thus, the existence of the socio-economic concentration measure permits us to undertake a whole new range of investigations in a previously large and unmeasured aspect of development. In a policy vein, we can analyse the determinates of socio-economic inequality within or between countries over time and detect those factors which offer relatively greater leverage in the reduction of socio-economic inequality. We now have a socio-economic target or indicator that could tell us how far development programs or governmental regulations have gone in reducing socio-economic inequalities. In the instance of international aid programs such as the Alliance for Progress, through appropriate analysis of the relationships of socio-economic inequality to the stage of economic development and rate of economic growth, we could determine the aggregate amount and type of effort required to achieve national integration. In the case of racial integration in the United States, one could determine how much or how little progress has been made in reducing the socio-economic inequality of the American Negro to the approximate lower relative limit of that of the rest of American society.

In any case, the potential use of socio-economic status grouping, such as the one developed here, can serve a variety of statistical and analytical purposes.

Conclusions

1. While innumerable problems beset the existing Census major occupational classification, several means are currently available for developing new major occupational codes with varying degrees of technical feasibility.

2. A series of alternative major occupational codes can be developed by stratifying occupations by the relative importance of their respective Socio-Economic Status (SES) Scores.

3. The alternative major occupational codes developed, using this scheme, offer greater homogeneity in occupational grouping than is possible with the current code, greater usefulness to investigators involved in manpower analysis and forecasting, as well as a vehicle for future research into occupational classification.

FOOTNOTES

1. See, for example, the collection of papers on the subject in the Proceedings of the Social Statistics Section, American Statistical Association, 1966, pp. 176-208.

2. See L. Lewis, "Development of a Convertibility List Between the DOT and Census Classification Systems," in Proceedings, op. cit., pp. 204-206.

3. R. W. Hodge and P. M. Siegel, "The Classification of Occupations: Some Problems of Sociological Interpretation," in Proceedings, op. cit., pp. 176-192.

4. J. Scoville, "Making Occupational Statistics More Relevant," Proceedings of the Business and Economic Statistics Section, American Statistical Association, 1965, pp. 317-323.

5. Philip Babcock Gove, ed., Webster's 3rd New International Dictionary. Springfield: G. & C. Merriam, 1961, p. 1560.

6. Albert J. Reiss, et al., Occupations and Social Status. New York: The Free Press of Glencoe, 1961, p. 10.

7. G. Alexandrin, "Notes on Occupational Classification," Quarterly Review of Industrial Relations, Vol. 21, No. 4 (1966), p. 531.

8. Hodge and Siegel, op. cit., p. 178.

9. Scoville, op. cit., p. 317.

10. Scoville, ibid., p. 318.

11. Hodge and Siegel, op. cit., p. 185. See also: Otis Dudley Duncan, "A Socio-Economic Index for All Occupations," in Reiss, op. cit., pp. 109-138.

12. See W. Lee Hansen, "Labor Force and Occupational Projections," Proceedings of the Industrial Relations Research Association, 1965, pp. 10-20.

13. See J. Scoville, "The Development and Relevance of U.S. Occupational Data," Industrial and Labor Relations Review, Vol. 19, No. 1 (1965), pp. 70-79; and U.S. Bureau of the Census, "Methodology and Scores of Socioeconomic Status," Working Paper No. 15, Washington, D.C., 1963.

14. See Lewis, op. cit., p. 205.

15. See H. S. Parnes, Forecasting Educational Needs for Economic and Social Development, Organization for Economic Co-operation and Development, Paris, 1962.

16. Parnes, op. cit., p. 26. The four groups were:

Class A: All occupations for which a university education ...is required.

Class B: Occupations for which two or three years of education beyond the secondary level...are required.

Class C: Occupations for which a secondary education...is required.

Class D: All other occupations.

17. Scoville, "Making Occupational Statistics More Relevant," op. cit., p. 320.

18. See Stanley Lebergott's suggestion for stratifying detailed occupations by wage levels in Proceedings of the Social Statistics Section, American Statistical Association, 1966, p. 207.

19. G. G. Cain, W. L. Hansen and B. A. Weisbrod, "Occupational Classification: An Economic Approach," Monthly Labor Review, Vol. 90, No. 2 (1967), pp. 48-52.

20. See Oskar Morgenstern, On the Accuracy of Economic Observations, 2nd ed. (Princeton: Princeton University Press, 1963), especially Chapter XIII, "Employment and Unemployment Statistics," pp. 228-234.

21. See Robert Solow's comment on the problem of level of aggregation of analysis in reply to G. H. Orcutt and A. M. Rivlin, "An Economic and Demographic Model of the Household Sector; A Progress Report," in Demographic and Economic Change in Developed Countries, Universities-National Bureau of Economic Research, Princeton University, 1960, pp. 318-321.

22. See A. J. Jaffe and J. B. Gordon, "Occupational Mobility for White and Nonwhite Males: 1950-1965," The New York Statistician, New York Area Chapter of American Statistical Association, Vol. 18, No. 4 (1966), pp. 1-3.

23. Jaffe and Gordon, op. cit., Table 1.

24. That is, the components of the index may be independent--hence the index would be "additive"--or the index may be interdependent--hence the index would be multiplicative. Weighting of components of a socio-economic index would be a thorny issue, and one which would require more experimentation to test the sensitivity of final composite scores to changes in the weighting schemes.

25. See A. J. Jaffe, "Suggestions for a Supplemental Grouping of the Occupational Classification System," Estadistica, March 1957, pp. 13-23. Jaffe's schema utilized a simple dichotomy of occupations between those classes of occupations that involved the use of technology and those that did not, i.e., "Classical" versus "Modern" occupations. Detailed codes were developed by Jaffe and Froomkin for the 1960 Census and a 5 per cent sample tape of the labor force was created, using the code.

26. The Socio-Economic Status (SES) Scores computed and published by the Census Bureau with the 1960 Census of Population, provide a multiple-item index of socio-economic ranking by occupation. The three components are occupation, educational attainment and family income for the chief income recipient. Scores are obtained for each component on a scale ranging from 1 to 100 and averaged to provide a single over-all figure. For more information on the methodology and use of Socio-Economic Status (SES) Scores, see U.S. Bureau of the Census, "Methodology and Scores of Socioeconomic Status," op. cit.

27. See, for example, Jerome B. Gordon, "Conversion of Ordinal Values to Relative Values for Research and Exploratory Development Project Proposals," The Research Analysis Corporation, McLean, Va., December 1965. Reprinted in The Proceedings of the 15th Military Operations Research Symposia, Office of Naval Research, 1966.

28. "The RAC technique makes the assumption that there is an underlying regularity between rank and relative value....As can be seen the RAC technique rests only on the assumption about the regularity of the universe of relative values implying the ability to interpolate between directly estimated points. A logarithmic scale (is used) because the half-values plotted in tests exhibited general linearity where the scale was logarithmic." Gordon, ibid., pp. 3 and 9.

29. The suggested occupational codes will not, of course, remedy the problems of reporting and definition. These are additional issues: issues that impinge on any occupational classification. However, the occupational codes suggested here offer great flexibility in terms of use with the existing code, as well as adaptability to changes in definition of detailed occupations.

30. Socio-Economic Status Scores for Panama were developed from tabulations of the educational, earnings and employment characteristics of detailed occupations in the Metropolitan areas of the Republic, drawn from the monthly Current Population Survey of the Republic of Panama. A special memorandum listing the detailed occupations falling into the major SES group classification for the Republic of Panama, as well as a similar one prepared for the United States, are available from the author upon request.

31. For a graphical explanation of how the Gini coefficient is derived, see James Morgan, "The Anatomy of Income Distribution," The Review of Economics and Statistics, August 1962, pp. 281-282.

APPENDIX A*

STEPS IN CONVERSION OF ORDINAL TO RELATIVE VALUES

The problem is to estimate relative values for a set of objects or items where the value rankings are given. It is assumed that, in the course of the estimating procedure, usefully accurate judgments can be made to determine which of any two given pairs of objects has a combined value for the pair that more nearly approximates the value of some given, single object.

Presented below are formal steps. The following symbols are used:

n The number of objects to be valued.

p A number in the sequence $1, (1+1/3), (1+2/3), 2, \ldots, (n-1/3), n$.

$\bar{p}$ A number in the set $1, 2, \ldots, n$.

V_p The value associated with p. The p may be subscripted. For any $\bar{p}$,

$$V_{\bar{p}} = V_{\bar{p}-1}.$$

P_j The coordinate on the p scale for the jth plotted point of a sequence of plotted points.

$\bar{p}_j$ The $\bar{p}$ closest in magnitude to P_j.

$\bar{p}_{jk}$ $\bar{p} + k$, where k is -1, 0, or $+1$.

$p'_{(j+1)k}$ An estimate of what p_{j+1} would be if $\bar{p}_{jk}$ were the last previously plotted point.

The steps in the procedure follow.

1. Select a p_1 (the first of the p_j) from among the highest-ranking $\bar{p}$, but low enough to be in a region where it is judged that the ratios between values associated with adjacent $\bar{p}$ are not significantly greater than the ratios between values for adjacent $\bar{p}$ in the region of middle $\bar{p}$ levels. In the absence of ability to make such judgment, a $\bar{p}$ at about the 90th percentile will be satisfactory.

2. The first plotted point is (p_1, V_{p_1}), where V_{p_1} is selected arbitrarily (but preferably near the top of the graph to leave room for later plotted points of lower value).

*Bernard Sobin and J. B. Gordon, "Improvement of Army Methods of Determining Research and Exploratory Development Programs," T-482, Research Analysis Corporation, McLean, Va., September, 1966.

The graph paper has a horizontal arithmetic scale for p and a vertical logarithmic scale for V_p. The units of measurement on the vertical scale are arbitrary.

3. For each of the three possible levels of k, estimate a $p'_{(j+1)k}$ such that, as nearly as possible,

$$V_{\bar{p}_{jk}} = V_{p'_{(j+1)k}} + 1 + V_{p'_{(j+1)k}} - 1.$$

4. Calculate

$$P_{j+1} = p_j - \underset{k}{(\bar{p}_{jk} - p'_{(j+1)k})/3}$$

5. Plot the point $(p_{j+1}, V_{p_j}/2$; and then call this point the new base (p_j, V_{p_j}) for additional iterations of steps 2 through 5. Continue iterations until a point is plotted after which no further points can be plotted, because the step 3 condition can no longer be approximated.

6. Connect all plotted points by a straight line between adjacent points. The lines as joined at the plotted points are hereafter referred to as a plotted chain.

7. The plotted points and the straight lines between them on a plotted chain provide estimates of the relative values $(V_{\bar{p}})$ for all $\bar{p}$ within the range of the plotted chain. Additional estimates may be made for later averaging by calculating additional plotted chains, starting from points with coordinates between p_1 and p_2 of the first plotted chain. Calculate as many additional plotted chains as desired, with the starting point of each so determined that the intervals on the p scale between starting points of all plotted chains are approximately equal.

8. Tabulate the $V_{\bar{p}}$ for all plotted chains and for all $\bar{p}$ covered by any of the chains.

9. Retabulate dividing each tabulated $V_{\bar{p}}$ for a plotted chain by the $V_{\bar{p}}$ for some middle level of $\bar{p}$, using the same $\bar{p}$ to determine the divisor value in the case of each of the plotted chains. The result is a table of scaled relative values where, for each plotted chain, the relative value is unity at the same level of $\bar{p}$.

10. Calculate an arithmetic mean of scaled relative values across plotted chains for each level of $\bar{p}$. Make sure that the divisor in calculation of an arithmetic mean is equal to the number of plotted chains that have scaled relative values for the $\bar{p}$ concerned; do not consider a missing scaled relative value as a zero. The arithmetic means that are calculated with as many items as there are plotted chains are the final estimates of relative values within the $\bar{p}$ ranges of the plotted chains.

11. Where an arithmetic mean has been calculated with fewer items than the number of plotted chains (because one or more of the plotted chains does not have sufficient range), multiply that mean by a scale factor. The scale factor is calculated as

$$S_p = M_{p*}/M_{p*}^{(p)} \text{ , where}$$

S_p is the scale factor for the arithmetic mean at order number p ; M_{p*} , the mean at the order number nearest to p that is within the range of every one of the plotted chains; and $M_{p*}^{(p)}$, what the mean at p^* would have been had it been calculated only with items from plotted chains that include p within their ranges.

12. Calculate the value to be associated with the smallest $\bar{p}$ that is above the range of the plotted chains, calculating it as a sum of any two of the arithmetic means calculated in steps 10 and 11 as are estimated to be most nearly equal to it in aggregate value.

13. Calculate the value to be associated with the next largest $\bar{p}$ in the same way, except that the selection of pairs of values can be not only from the adjusted arithmetic means calculated in steps 10 and 11, but also any values calculated in later steps. Continue this procedure iteratively until values have been estimated for all $\bar{p}$ above the range of the plotted chains.

Table 1

MAJOR OCCUPATIONAL GROUPS BASED ON RELATIVE VALUES OF SOCIO-ECONOMIC STATUS (SES) SCORES: EMPLOYED MALES (000), 1960

Group #	SES Score Range	Total No. of Employed Males (000)
1	96 - 100	1,947.4
2	90 - 95	2,585.9
3	81 - 89	4,232.8
4	76 - 80	2,486.5
5	71 - 75	4,197.4
6	64 - 70	2,101.0
7	56 - 63	6,202.5
8	49 - 55	2,067.5
9	40 - 48	3,579.1
10	31 - 39	5,782.5
11	25 - 30	1,130.5
12	20 - 24	490.1
13	14 - 19	2,319.9
14	1 - 13	753.8
15	*	2,387.6
16	**	1,201.8
	TOTAL	43,466.3

*Farmers and Farm Managers

**Farm Laborers and Foremen

NOTE: These groups do not have Socio-Economic Status Scores calculated for them.

Source: U.S. Bureau of the Census, U.S. Census of Population: 1960. Detailed Characteristics. U.S. Summary. Final Report PC(1)-1D. U.S. Government Printing Office, Washington, D.C. Table 202, pp. 1-522-29.

Table 2

CROSS-CLASSIFICATION OF MAJOR OCCUPATIONAL GROUPS BASED RELATIVE VALUES OF SOCIO-ECONOMIC STATUS (SES) SCORES AND THE CENSUS MAJOR OCCUPATIONAL GROUPS: EMPLOYED MALES (000), 1960

		Census Major Occupational Groups										
Group #	SES Score Range	Pro-fessionals	Managers	Clericals	Sales	Craftsmen	Operatives	Service	Laborers	Farmers & Farm Managers	Farm Laborers	Occupation Not Reported
1	96 - 100	1,582.0	365.4	--	--	--	--	--	--	--	--	--
2	90 - 95	915.5	1,440.7	173.7	56.0	--	--	--	--	--	--	--
3	81 - 89	1,217.9	1,219.5	188.9	1,367.8	238.7	--	--	--	--	--	--
4	76 - 80	278.7	572.5	192.5	133.4	1,241.1	68.3	--	--	--	--	--
5	71 - 75	235.9	380.5	1,974.5	--	1,049.6	188.9	368.0	--	--	--	--
6	64 - 70	210.2	174.2	205.1	4.0	1,331.4	138.4	37.7	--	--	--	--
7	56 - 63	29.7	208.3	258.6	1,211.8	1,831.1	2,621.5	28.3	13.2	--	--	--
8	49 - 55	0.8	192.8	12.6	--	1,217.6	627.9	0.2	15.6	--	--	--
9	40 - 48	8.6	33.2	48.2	--	215.3	2,972.0	224.1	77.7	--	--	--
10	31 - 39	--	--	3.8	--	1,320.4	1,323.1	896.5	251.7	--	--	1,987.0
11	25 - 30	--	--	--	--	--	230.8	104.4	795.3	--	--	--
12	20 - 24	--	--	--	182.1	43.6	10.2	--	254.2	--	--	--
13	14 - 19	--	--	--	--	--	267.6	939.4	1,112.9	--	--	--
14	1 - 13	--	--	--	22.7	--	192.4	61.3	477.4	--	--	--
15	Farmers	--	--	--	--	--	--	--	--	2,387.6	--	--
16	Farm Wkers.	--	--	--	--	--	--	--	--	--	1,201.8	
TOTAL		4,479.3	4,629.6	3,015.4	2,977.8	8,488.8	8,641.1	2,659.9	2,998.0	2,387.6	1,201.8	1,987.0

Sources: U.S. Bureau of the Census. U.S. Census of Population: 1960. Detailed Characteristics. U.S. Summary. Final Report PC(1)-1D. U.S. Government Printing Office, Washington, D.C. Table 202, pp. 1-522-29.
See also Table 1, preceding page.

Table 3

CROSS-CLASSIFICATION OF MAJOR OCCUPATIONAL GROUPS BASED ON RELATIVE VALUES OF SOCIO-ECONOMIC STATUS (SES) SCORES AND MAJOR "LIVELIHOOD" CODES EMPLOYED MALES (000), 1960

		Major Livelihood Code Groups						
Group #	SES Score Range	Modern[1]	Classical[2]	Managerial, Administrative & Distribution[3]	Service[4]	Industrial & Commercial, Unskilled[5]	Forestry, Fisheries & Agriculture[6]	Occupation Not Reported[7]
1	96 - 100	1,238.1	343.9	365.4	--	--	--	--
2	90 - 95	808.1	107.4	1,670.4	--	--	--	--
3	81 - 89	748.9	707.7	2,776.2	--	--	--	--
4	76 - 80	1,588.1	--	898.4	--	--	--	--
5	71 - 75	1,391.8	82.6	2,355.0	368.0	--	--	--
6	64 - 70	1,429.5	250.5	383.3	37.7	--	--	--
7	56 - 63	4,227.9	254.4	1,678.7	28.3	13.2	--	--
8	49 - 55	1,601.6	244.7	205.4	0.2	15.6	--	--
9	40 - 48	2,913.5	282.4	81.4	224.1	77.7	--	--
10	31 - 39	1,244.5	1,399.0	3.8	896.5	251.7	--	1,987.0
11	25 - 30	230.8	--	--	104.4	795.3	--	--
12	20 - 24	10.2	43.6	182.1	--	254.2	--	--
13	14 - 19	260.6	7.0	--	939.4	919.5	193.4	--
14	1 - 13	192.4	--	22.7	61.3	325.5	151.9	--
15	Farmers	--	--	--	--	--	2,387.6	--
16	Farm Wkers.	--	--	--	--	--	1,201.8	--
TOTAL		17,886.0	3,723.2	10,622.8	2,659.9	2,652.7	3,934.7	1,987.0

1. Modern occupations are Census Occupation Codes 100 for Professionals, 400 and 410 for Craftsmen, and 600 for Operatives.
2. Classical occupations are Census Occupation Codes 200 and 210 for Professionals, 500 for Craftsmen, and 610 for Operatives.
3. Managerial, Administrative and Distribution occupations are Census Occupation Codes 230 and 240 for Managers, 300 and 310 for Clericals, and 330 for Sales Workers.
4. Service occupations are Census Occupation Codes 800 for Private Household Service Workers, and 810 for Service Workers.
5. Industrial and Commercial Unskilled occupations are Census Occupation Code 902 for Laborers.
6. Forestry, Fisheries and Agricultural occupations are Census Occupation Codes 220 for Farmers and Farm Managers, 900 for Farm Workers, and 901 for Laborers.
7. Occupations not reported are Census Occupation Code 995.

Sources: U.S. Bureau of the Census, U.S. Census of Population: 1960. Detailed Characteristics. U.S. Summary. Final Report PC(1)-1D. U.S. Government Printing Office, Washington, D.C. Table 202, pp. 1-522-29.
Unpublished Jaffe "livelihood" codes for the 1960 U.S. Census listing of Detailed Occupations.

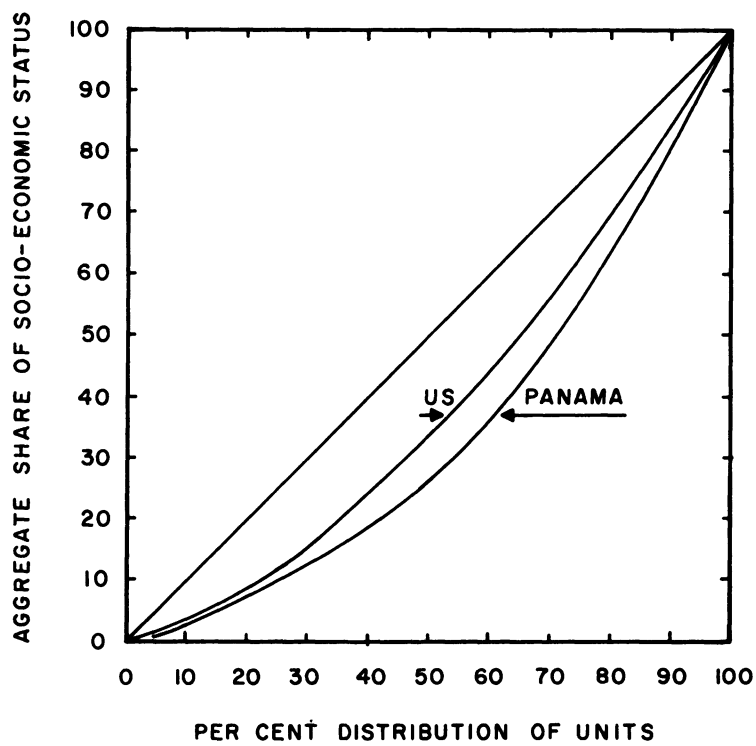

FIG. I. LORENZ CURVES OF SOCIO-ECONOMIC STATUS FOR THE UNITED STATES AND PANAMA