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THE DIVISION OF LABOR: FURTHER EXPLORATION IN THE ANALYSIS OF AN ECOLOGICAL CONCEPT*

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ABSTRACT

The Division of Labor (DL), a core concept in sociology, is usually operationalized in either one of two dimensions–DL1 or DL2–for the generation of testable hypotheses. The analytic value of the decomposition of DL into these two dimensions is not without a cost for, as it is noted by focusing on DL2, the comparability of data gathered under the same system of occupational classification is restricted by the sometime presence of zero-member categories. It is proposed that this restriction be evaluated in terms of the C-Measure, which by using Shannon's conception of information, measures the relative cost of information loss incurred when DL2 is measured for two sets of data drawn from the same classification scheme, one of which contains zero-member categories. The C-Measure is judged to be of potential use for two areas important to the further specification of DL, namely replication and cross-cultural research. Finally, it is noted that the C-Measure serves as a way to reconcile DL1 and DL2 so that both dimensions are taken into account in the measurement of DL.

As an analytical concept, the division of labor (DL) recently has received much needed attention. This attention is not unwarranted, for as Kemper (1972:739) observes: "The division of labor is a core concept in sociology. At a minimum it implies such additional concepts as interaction, goals, roles (i.e., differentiated functions), technology, integration, rules."

Yet, as pointed out by Browning and Gibbs (1971:233), it is only recently that sociologists have engaged in systematic research on the concept of DL. According to Clemente and Sturgis (1972:181), this is due to the fact that DL is "an extremely complex concept that presents severe problems in terms of operationalization."

The last remark notwithstanding, attempts have been made to operationalize DL and utilize it in the generation of testable hypotheses. One approach defines DL as having two dimensions: (1) functional specialization (DL1), the number of sustenance-producing activities in a population; and (2) functional dispersion (DL2), the actual dispersion of individuals among these sustenance-producing activities (Cf. Gibbs and Martin, 1962; Labovitz and Gibbs, 1964; Rushing, 1967, 1968; Pondy, 1969; Blau, 1970; Rushing and Davies, 1971; Childers, Mayhew, and Gray, 1971; Land, 1969; Clemente, 1972; Kemper, 1972; Webb, 1972; Swanson, 1973).

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The decomposition of DL into DL1 and DL2 has contributed to the development of two major research currents.[1] One current, stressing DL1, includes research by: Hawley, Boland, and Boland (1965); Blau, Heydebrand, and Stauffer (1966); Hall, Haas, and Johnson (1967); Blau (1970); Childers, Mayhew, and Gray (1971); and Blau and Schoenherr (1971). DL2, on the other hand, is utilized in studies conducted by: Gibbs and Martin (1962); Amemiya (1963, 1964); Labovitz and Gibbs (1964); Rushing (1967, 1968); Pondy (1969); Land (1969); Browning and Gibbs (1971); Clemente (1972); Clemente and Sturgis (1972); Mayhew et al. (1972); Webb (1972); Mayhew and Rushing (1973), Swanson (1972); and Tyler (1973).

These two major trends have advanced the conceptual and analytic clarity of DL, but it has not been without a price. For, as Rushing (1968:236) observes:

> The measures of structural differentiation (note: structural differentiation is DL1.) and dispersion-concentration (note: dispersion-concentration is DL2.) are not entirely independent, as is indicated by the product-moment correlation of .57 between them (p=.58). At the same time, however, the correlation is sufficiently low (common variance being only 32 per cent) to reveal that the two measures are not measuring precisely the same dimension.

Rushing and Davies (1970:395) later stress this in a slightly different form:

> ...N (e.g., number of occupations) is also a dimension of division of labor and structural complexity. Therefore the combined values of D' (note: D' is equivalent to a measure of DL2 that will be taken up later in this discussion) and N provide a better measure than D' alone.

Thus, while DL has gained empirical and theoretical specification through its decomposition into DL1 and DL2, a degree of analytic indistinctness nevertheless remains.

The indistinctness of DL becomes especially apparent in the area of comparative research. We shall now focus upon this indistinctness by considering the most frequently encountered measure of DL2. This measure, introduced by Gibbs and Martin (1962), is called the Measurement of Functional Dispersion (MFD) by Clemente (1972:35).[2] Following Swanson's (1972:404) transformation of MFD it is defined as:

$$MFD = \frac{1 - \frac{\{\Sigma_{X_i}{}^2\}}{\{\Sigma_{X_i}\}^2}}{1 - \frac{1}{n}} \qquad (1)$$

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[1] These two major streams of research also tend to be correlated with two substantive areas: formal organization analysis, and macro-social analysis. DL1 is associated with the former and DL2 with the latter. The possible theoretical implications of this phenomenon are, however, beyond the scope of the present discussion.

[2] Gibbs and Martin (1962) first called this measure the Measure of Industrial Diversification (MID); Rushing (1967) renamed it D; Clemente (1972) argued that MID could be given more general import by calling it the Measure of Functional Dispersion (MFD); and Swanson (1972) corrected a shortcoming in MFD that was acknowledged by Clement (1972). Swanson (1972) further demonstrated the relation between MFD and the Index of Industrial Differentiation (IED) developed by Amemiya (1963). Both Swanson (1972) and Clemente (1972), however, overlooked the fact that Labovitz and Gibbs (1964) resolved the shortcoming observed by Clemente (1972) in MID. Meanwhile, Rushing and Da (1970) demonstrated that MID was equivalent to the Index of Qualitative Variation developed by Mueller and Schuessler (1961). Land (1969) also noted that Carter and Rockwell (1966) demonstrated the equivalency of MID and IQV.

where n = the number of occupational categories,

χ^{ι} = the number of persons in category ι

and $0.0 \leq MFD \leq 1.0$

If we want to compare, for example, the structure of DL2 for two regions, using MFD as the indicator of DL2, we find that if the two regions possess different numbers of occupational categories, we face a dilemma first confronted by Labovitz and Gibbs (1964:5-6): Are the categories 'real' or just statistical artifacts? If, for example, region A has only three non-zero occupational categories and region B has six, each with members, can we, by caveat, say that region A should have three zero member categories to 'equalize' the comparison? Frequently, we are faced with just such a decision when we compare the DL structure of a small region, such as a county, with a superordinate region, such as the United States as a whole.

This problem is recognized by other researchers. Mayhew et al. (1972) avoid the use of zero-member occupational categories by using data from organizations having a planned system of role allocation; i.e., military units.

The strategy employed by Mayhew and his associates does not, however, lend itself to a social system lacking a planned structure of role allocation. Consequently, the problem remains for units of analyses such as cities, counties, states, and all other areas not under a centralized planning structure. (For other aspects of this problem see e.g., Labovitz and Gibbs, 1964:5-6; Rushing, 1967:281-283; Gibbs, 1969:38-40; and Featherman and Hauser, 1973:242-244.)

The following discussion contends that this problem is resolvable when it is conceived as a case of 'information loss.' Further, it is argued that a systematic measure of this 'information loss' may be constructed that reconciles the two dimensions of DL, and satisfies both the guidelines established by Rushing and Davies (1970:395) that DL1 and DL2 *together* must enter into a meaningful operationalization of DL; and the logical requirements of an analytic concept.

The Relative Cost of Information Loss

Keeping in mind that DL refers to the *occupations* present in a population (as opposed to the industries),[3] we see in Table 1 (adapted from Clemente, 1972:351) the occupational structures of two hypothetical regions. In region A, the dispersion of individuals among the 12 categories is at a minimum, while in region B it is at a maximum. The MFD statistic reflects this condition with a value of zero for region A, and a value of 1.00 for region B. Intuitively, this seems both straightforward and satisfying.

However, let us now consider Table 2, where regions A through G are displayed. We observe that regions B through F exhibit MFD scores reflecting various degrees of concentration but that they have *an equal dispersion of individuals among their respective non-zero categories.* Thus, while it is certainly true that only region G has equal dispersion

[3] DL1 and DL2 are used across both occupational and industrial categories. Gibbs and Martin (1962), for example, use industrial categories, while Labovitz and Gibbs (1964) use occupational categories. For a description of these categories in the United States, see the 1970 Census of Population Alphabetical Index of Industries and Occupations.

TABLE 1

ILLUSTRATION OF THE MEASURE OF FUNCTIONAL DISPERSION (MFD)

Occupation Category	Region A	Region B
1	1,200	100
2	–	100
3	–	100
4	–	100
5	–	100
6	–	100
7	–	100
8	–	100
9	–	100
10	–	100
11	–	100
12	–	100
Σ_{X_i}	1,200	1,200
$\Sigma_{X_i}{}^2$	1,440,000	120,000
$\Sigma\{_{X_i}\}^2$	1,440,000	1,440,000
MFD	0.00	1.00

Adapted from Clemente (1972:35). (Note: MFD follows the transformation made by Swanson (1973.)

among all 12 categories, regions B through F have equalized dispersions among their own 'real' categories; i.e., among those categories that actually contain individuals.

As noted earlier, the observation made by Labovitz and Gibbs (1964:5-6) about categories being 'real' or statistical artifacts becomes relevant in this hypothetical example. Can we systematically determine if the two non-zero categories in region B, for example, are the only two 'real' categories? Is the convenient overlay of the 12 'official' categories over region B justifiable on an analytic basis. Present methodology gives no answer. We propose that this dilemma can be resolved by considering the overlay to be accompanied by a 'cost of information loss,' an analytic and systematic concept capable of mathematical expression. Stated in another manner, instead of asking the question of whether or not the categories are 'real' or statistical artifacts, we propose that the descriptive constraints of a given classification system (such as the U.S. Census) be accepted *in toto*, and that the *cost* of this acceptance be calculated.

In accomplishing this task, first note that a measurement of dispersion *relative to the number of non-zero categories* is created by replacing the denominator of MFD as follows:

$$\text{since MFD} = \frac{1 - \dfrac{\{\Sigma \chi_i^2\}}{\{\Sigma \chi_i\}^2}}{1 - \dfrac{1}{n}} \qquad (2)$$

we may substitute the denominator, which gives the maximum possible value of the numerator if all n categories are used, with a term that gives the maximum possible value if only non-zero categories are used. This becomes:

$$\text{MFD}' = \frac{1 - \dfrac{\{\Sigma \chi_i^2\}}{\{\Sigma \chi_i\}^2}}{\dfrac{(n \neq 0) - 1}{n \neq 0}} \qquad (3)$$

where $n \neq 0$ is the number of categories with non-zero members
and $n \neq 0$ is an integer greater than 1.

By adapting Shannon's (1963) mathematical conception of information as being the difference between two possible states of knowledge,[4] we may define the *Relative Cost of Information Loss* 'C,' as being:

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[4]Information (I) is defined by Shannon (1963) to be the difference between two states of knowledge. In symbols,

$$I = S(Q]X) - S(Q]X')$$

where S(Q]X) is a state of knowledge I
and S(Q]X') is a state of knowledge j.

TABLE 2

ILLUSTRATION OF THE MEASURE OF FUNCTIONAL DISPERSION (MFD)

Occupation Category	Region A	Region B	Region C	Region D	Region E	Region F	Region G
1	0	600	400	300	200	150	100
2	0	600	400	300	200	150	100
3	0	0	400	300	200	150	100
4	0	0	0	300	200	150	100
5	0	0	0	0	200	150	100
6	0	0	0	0	200	150	100
7	0	0	0	0	0	150	100
8	0	0	0	0	0	150	100
9	0	0	0	0	0	0	100
10	0	0	0	0	0	0	100
11	0	0	0	0	0	0	100
12	0	0	0	0	0	0	100
MFD	0.00	.545	.7267	.8175	.9079	.9537	1.00

$$C = MFD' - MFD \tag{4}$$

where $0.00 \leq C < 1.00$

and $\lim_{MFD \to 0} C = 1.00 \qquad MFD_i \leq MFD'_i$

for any given region i

Thus, the higher the value of C, the greater the relative cost of information loss. The C statistic has several useful properties to recommend its use. First, it is an interval scale measure. This implies that in dealing with an aggregate of regions we may determine measures of central tendency and variance for the set of C scores. Second, it employs an analytical structure rather than an ad hoc device to evaluate the effects of both the DL1 and DL2 dimensions of DL. Third, it is relatively easy to conceptualize and compute.

Using the data that are contained in Table 2, the C statistic is determined for all of the regions, B through G (note: region A by definition has no dispersion and a C score is not computed).

TABLE 3

THE COST OF INFORMATION LOSS: REGIONS A - G

	Region A	Region B	Region C	Region D	Region E	Region F	Region G
MFD'	-*	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
MFD	0.00	.5450	.7267	.8175	.9079	.9537	1.0000
C	-*	.455	.2733	.1825	.0921	.0463	0.0000

*MFD' is undefined for a region possessing but one non-zero category since there is no dispersion when only one such category is present.

Upon inspection of Table 3, the C score is observed to increase in value from region G to region B. This reflects the increasing cost of information loss that imparts by the overlay of the constant 12 occupational categories over a decreasing number of non-zero categories.

Several cautions should be maintained in using both C and MFD. First, MFD, whether alone or in conjunction with C, does not measure the *homogeneity* of two regions. It is possible for two regions to share identical MFD values and a C value equal to zero while having their respective populations dispersed differently among the

occupational categories. For example, region A could have 60 percent of its population in agriculture and 40 percent in mining. Region B, on the other hand, could have 60 percent in mining and 40 percent in agriculture. Both would possess identical MFD scores and produce a C statistic equal to zero, but they are not homogeneous.[5] Secondly it is highly unlikely that complete minimum or maximum functional dispersion exists. More likely, as suggested by Stephan (1972:318), the equilibrium sizes of occupational categories are a more complex phenomenon. Furthermore, the use of MFD and C do not exhaust all of the analytical dimensions of DL.[6] The theoretical richness of this concept is well documented (see Duncan, 1957; Labovitz, 1965; Gibbs, 1968; Stephan, 1971; Lewis, 1972; Martin, 1972; Miley and Micklin, 1972; Kemper, 1972; Tyler, 1973).

Conclusion

This discussion points out the two emergent trends in sociology dealing with the two analytic components of DL: DL1 and DL2. It is noted that these two major trends, while advancing the operationalization of these two components of DL, do so at the expense of their demonstrated inter-relatedness (Rushing, 1968:236) and, consequently, at the expense of DL itself, which is observed to be a core concept in sociology by Kemper (1972:739). The development of an analytic link between DL1 and DL2 is suggested in the form of using MFD, a measure of DL2, together with a measure of the cost of information loss, C, developed in this paper. This suggestion follows guidelines proposed by Rushing and Davies (1970:394-395), and is demonstrated to be conceptually related to Shannon's (1963) mathematical definition of information. Furthermore, this presents a method to resolve the problem of dealing with zero-member occupational categories, often present in a region of research (cf. Labovitz and Gibbs, 1964:5-6; Mayhew et al., 1972). This is claimed to contribute to the effectiveness of MFD, especially in comparative research, by opening up two areas observed by Clemente (1972:36) to be of critical importance if a theory of functional-dispersion is to be developed: (1) replication, and (2) cross-cultural research.

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[5] The topic of homogeneity is taken up by Sherr (1966). He constructs a measure, which he terms I_2 to determine the degree of homogeneity between two regions.

[6] To give just one such example, another measure of DL is the Index of Dissimilarity (D). Duncan and Duncan (1955) use it to measure the spatial distance between occupational groups; Gibbs (1965), Bahr and Gibbs (1967), and Martin (1972) measure occupational differentiation by color with it; Gibbs (1968) and Miley and Micklin (1972) use it to measure change in industry structure; and Duncan and Lieberson (1970) and Beckman (1973) measur inter-urban division of labor with it. In general, this index measures the extent to which two percentage distributions are non-overlapping. For a detailed treatment see Duncan and Duncan (1955) and Duncan (1957).

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COMMENTARY

[Editor's note: In our last issue we had an article which analyzed the concept of pseudo-gemeinschaft and implications of pseudo-gemeinschaft as an entity in modern society. The article drew from Robert K. Merton's use and formulations of it in earlier writings. Upon reading the article Professor Merton was kind enough to share with the author of the article and now with us how it was that the term was first used and coined by him.]

ON THE ORIGINS OF THE TERM: PSEUDO-GEMEINSCHAFT

Robert K. Merton
Columbia University

Before the term pseudo-Gemeinschaft emerged in *Mass Persuasion,* I had been thinking about this pattern of behavior for some time. That is why it surfaced briefly in the 1945 paper on the Sociology of Knowledge which, as indicated in the paper, is reprinted in *Social Theory and Social Structure,* p. 459. But I must report that in undertaking to study the War Bond Marathon as a strategic research site for investigating processes of mass persuasion, I had no prior notion that pseudo-Gemeinschaft would turn up as central to the entire enterprise. Indeed, I had not before seen the connection between pseudo-Gemeinschaft and the search for sincerity and trustfulness in social relations. (Afterwards, it seemed altogether self-evident and I wondered why it did not come to mind before the experience gained in the research.)

As a matter of fact, I had at first been a 'purist' in coining the term. Philologists, of course, wince at the combining of roots taken from different languages. They often describe that sort of coinage as a barbarism. And so, at the outset, I deliberately avoided combining the Greek and the German. So far as I am aware, *echt-Deutsch* includes only one term which contains the prefix pseudo: the wholly Greek word, *pseudonym.* (Diffusion of a word rather than a coined 'barbarism.') And so, my working term was the thoroughly *echt-Deutsch* coinage: *Scheingemeinschaft.* Any German would instantly recognize that this referred to a false or sham or feigned *gemeinschaftliche* relationship. I was ready to go to press with this. Only then, did I realize that, after all, I was not writing in German but in that language-amalgam known as American. Why require readers of an American or English text to respond to a wholly German term? I therefore decided to sacrifice etymological purity to swift understandability—at least, for those social scientists who are acquainted with the ancient and honorable concept of *Gemeinschaft.*