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Understanding Mobility Field Theory and its Application ; A Test Study in India

THE main human problem of rural to urban movements in the Third World is that people are mostly moving from unemployment to underemployment, from one kind of poverty to another, resulting in a colossal waste of human resources and great human misery. Set within this context, there is surprising lack of concern among geographers, demographers and population specialists with such problems and no adequate spatial theory for understanding and dealing with such considerable mobility. This paper attempts to fill this lacuna. A mobility field theory model is developed, at the level of both the individual and the aggregate system, to provide a theoretical basis for understanding the complex of factors that lead people to move, as well as to generate clues for migration-mobility planning to help alleviate such human problems. The field theory is tested with fine-grained data collected from detailed field survey of parts of Eastern Uttar Pradesh, India.

In this paper, canonical model has been employed, not merely as a statistical tool, but as an integral part of the mobility field theory construction and its empirical verification with the real world data. As such, a brief discussion of the canonical model is also incorporated.

Mobility Field Theory

The mobility field theory states that spatial behaviour such as migration or circulation, is a linear function of the individual mover's need-stress-attribute structure and of his subjectively evaluated place utility distances between places,

It also states that different kinds of mobility behaviour are mere manifestations of the changing configuration of an individual's these two structures at different time points. In essence, the theory states that an individual's specific need-stress-attribute sets and, in relation to that, his specific utility-distances between a given pair of places are the causal psycho-social and spatial-behavioural forces which induce his specific kind of movement between that pair of places.

Speaking at an aggregated systems level, mobility field theory states that the need-stress-attribute structure of the individuals in a population and their perceived place utility distances are the causal psycho-social and spatial-behavioural forces underlying different types of mobility behaviour of the population. These two forces and their resultant mobility behaviour types are interdependent parts of the mobility field or mobility system. Thus, a change in any one of them will generate corresponding change in the other.

This field theory is based on the following seven propositions which are easily verifiable :

1. Mobility systems is a field consisting of all the attribute of persons and of places and all movement behaviour of persons towards places, and their complex interrelationships.
2. The mobility field can be divided analytically into person's attribute, A, utility, U, and mobility-behavioural, M, spaces into which attribute of persons, perceived utility of places and movement behaviour of the person to places are projected, as vectors with length and direction.
3. The attribute, utility and mobility-behaviour spaces are spanned by dimensions which generate the spaces and which are finite and empirically determinant.
4. Geographic units such as places and persons are located as vectors, respectively, in utility and attribute spaces and are coupled into dyads in mobility behaviour space, i.e., a dyad connoting a mover (p) located at a place i moving towards a place j.
5. Attribute vectors, A_1, A_2, in A space that describe the needstress systems of the individual persons and the distance vectors. d_1, d_2, in U space that connect a pair of geographical units (origin and destination) and which measure utility differences between them, are spatial-behavioural forces determining the location, M, of dyads in M space, according to linear function $M_{i-j} = \alpha_q \, d_{q,i-j} + \alpha_r^* A_r$. The basic axiom of mobility field theory is that the movement behaviour of a person located at a place i, towards another place j, is a linear transformation of the person's specific need-stress attribute set and in relation to that, his perception of place

utility differences between that pair of places.

6. The direction and velocity of movement over time of a dyad in mobility behaviour space is along the resolution vectors of the forces, d and A_t as person's needs grow, place multiply and perception of their utilities change over time.
7. Mobility behaviour space is a sub-space of combined A and U spaces. M space is completely contained in $A — U$ space and the dimensionality of Af-space is less than or equal to that of $A — U$ space. That is, a basis of M-space is a linear combination of a basis of $A — U$ space and that a basis of M-sp?.ce is also possible to find that is a subset of a basis of $A — U$ space.

The crux of the theory lies in mapping out the bases of mobility behaviour space *(M)* on to that of the combination of utility distance-cum-need-attribute space *(AU),* and ascertaining the degree of interdependence and isomorphism between the structure of attribute-cum-utilities and the patterns of mobility behaviour. Canonical analysis provides the appropriate mathematical model for testing the interdependencies of the these matrix bases and for specifying causal-functional linkages between structure of atLribute-cum-utilities and structure of mobility behaviour. Canonical analysis permits mapping out of the bases of the mobility behaviour space on to the bases of the combined need-attribute-cum-utility space (as in propositions 5 and 7). Mobility field theory thus indicates the causa] relationships between people's needs, as filtered through place utility considerations, and the resultant mobility behaviour that arises from attempting to satisfy those needs. Consequently, this theory also permits to indicate what needs of the people are to be fulfilled, what stresses are to be eliminated, what utilities of places are to be augmented, and what can be and should be done to redress the human problems in people's movement under stress. In short, the theory may act as a tool for formulating migration-mobility planning for any country.

Field data

Although presented theoretically, all those components, spaces, and componential structures of the field must be empirically defined and derived from the data on individuals in a study population so that the resultant mobility field can have relevance and meaning to explain spatial behaviour of the population studied. Thus, the theory is tested with fine-grained data that refers to 305 sampled individuals and was collected during April to November, 1973 in a

field survey of Varanasi city and adjoining region in Eastern Uttar Pradesh. Individuals were selected through a multi-stage selection procedure constituting a stratified simple random sample. Questionnaire surveys were conducted to elicit detailed information on recent movement history of the individuals and their social, economic and political conditions. The questionnaire contained three sets of information : spatial aspects and reasons for movement behaviour, perception of place utilities, and need-attribute-stress characteristics of movers. The 305 individuals made about 436 moves (in and out of Varanasi and between other places) and analysis of these 436 moves are presented in this paper.

Analytic Procedure

Total analytic design of the mobility field theory consists of four steps. First, three principal axes factor analyses are performed on the three data matrices (A_t U, and M). These analyses systematically explored many relationships between spatial characteristics of movements, between need-stress-attributes of movers, and between mover's place utility considerations about a given set of locations, and consequently, generated three sets of under lying basis dimensions to describe the respective structure of the matrices and produced corresponding sets of factor scores. These dimensions are to be regarded as 'potentials', rather than manifestations, of behaviour, attributes and utilities—describing the broad range of probabilities that can happen, Analytical design also involves, secondly, calculating each individual's perceived place utility distance between each pair of origin and destination, thirdly, combining attribute factor score matrix with utility distance score matrix; and finally, performing a canonical (regression) analysis on the mobility behaviour factor score matrix and the combined attribute-utility distance score matrix. Out of these four steps, only the last final step of canonical analysis and its results are discussed in this paper. Detail discussions of preliminary results of first three steps are presented in the two papers, mentioned in the references. However, it must be noted here that those preliminary results become 'inputs' in the final canonical analysis, and as such, the final results incorporate everything without losing any one of the previous steps.

Canonical Model

Developed by Hotelling (1936 : 321-377), the canonical analysis basically elicits the maximum correlation between linear functions of the two sets of variates describing the same subjects. Though powerful as a mathemetical tool in constructing and testing concepts, canonical analysis is not much employed in

social science research, and much less in population studies or in geography (see Greer-Wooten, 1972 : 40-60; Pyle 1974 : 107-129).

Given the two sets of data on behaviour and attribute-cum-utility variables, canonical analysis permits to answer to two related basic research questions : (1) what is the overall general relationship between individual's attributes-cum-utility considerations and mobility behaviour; and (2) given this overall relationship, what are the underlying causal relationships between specific combinations of movement behaviour variables and attribute-utility variables?

What canonical analysis does is delineate independent patterns in two sets of data in such a way as to ascertain maximum interrelationships between these new sets of patterns or dimensions. Just as factor analysis separates outdistinct clusters of variables that vary together over a set of observations, canonical analysis uncovers clusters or patterns in two sets of observations or matrices by maximizing the correlation between linear combinations of variables or inputed factors. Such combinations of factors or patterns delineated in each set are independent of other patterns in the same matrix, but each is maximally correlated with a specific pattern found in the other matrix.

Simultaneously each pattern in the original matrix is independent of all but one pattern in the second matrix. In other words, each linear combination of variables or inputed factors become independent of the previously derived linear combinations, just as factors are independent of each other in factor analysis.

Without labouring on the complex mathematics involved in the canonical mode], probably it will be appropriate here just briefly to provide an outline of the model (for details, sec Cooley and Lohnes, 1962 : 35-45; Phillip, 1972 : 1-30). The nature of canonical correlation analysis probably can be best explained through the algebraic model of a set of simultaneous questions :

$$\beta_1 Y_1 + \beta_2 Y_2 + \beta_3 Y_3 = \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \alpha_4 X_4 \quad (1)$$

$$\beta_1 {}^{*} Y_1 + \beta_2 {}^{*} Y_2 + \beta_3 {}^{*} Y_3 = \alpha_1 {}^{*} X_1 + \alpha_2 {}^{*} X_2 + \alpha_3 {}^{*} X_3 + \alpha_4 {}^{*} X_4 \quad (2)$$

$$\beta_1 {}^{**} Y_1 + \beta_2 {}^{**} Y_2 + \beta_3 {}^{**} Y_3 = \alpha_1 {}^{**} X_1 + \alpha_2 {}^{**} X_2 + \alpha_3 {}^{**} X_3 + \alpha_4 {}^{**} X_4 \quad (3)$$

Here the beta and alpha are co-efficients, analogous to regression co-efficients, weighting *Y* and *X* sets of variables in two data matrices. Here, the *Y's* represent three behaviour variables and the X's represent four attribute (and utility) variables. The asterisks indicate that the co-efficients assume different values in the three equations. The canonical correlation analysis, then, simply attempts to maximize the correlations between pairs of weighted combination of *X's* and *Y's*. Within each equation (1-3), if The weighted combination of Y's (behaviour) on the left hand side of the equation is termed as the new vector, U, then the

weighted combination of X's (attributes) on the righth and side, can be termed as the new vector, *V*. These new pairs are termed as *canonical variates.* Within each equation, these new pair of vectors *U* and *V* are matched in a way such that the correlations between them is maximized. Successively, three matched pairs of *U* and *V* can be extracted as in regression analysis, subject to the criteria that these be independent of previously derived linear combinations (Cooley and Lohnes, 1962: 35-37).

Now, in our analytic design, three matrices are : Mobility Behaviour *(M),* Utility Distances *(D),* and Attribute (,4)—the last two are then simply combined together to produce a new predictor matrix. From henceforth, this new matrix would be called Attribute Matrix, but would be denoted by *DA* matrix to avoid confusion. This new matrix *(DA)* comprises 3 distance scores and 10 attribute factors scores, forming 13 sets of scores,

Hence, these become two factor-score matrices, Behaviour *(M),* and Attribute-cum-utility(CU),eachofrt X *k* dimensions *(n* =-- 436, number of moves, *k* =• 13, number of factor scores or distance scores related to 13 factors). In canonical analysis, these two matrices are put together considering behaviour matrix *(M)* as the dependent set and new predictor or attribute matrix *(DA)* as independent set. Each vector of *M* provides a measure of an independent kind of mobility behaviour, and each vector of *DA* provides the same for mover attributes or utility distances. Canonical analysis of these two matrices transforms the vectors from **Af** and *DA* to an independent, uncorrelated pair of vectors, *U* and *V,* in both the matrices without changing them. Unlike factor analysis, which maximizes the variance explained by individual factors, canonical analysis maximizes the correlations between certain vectors of the *M* and *DA* sets while reducing other correlations to zero. These correlations are called canonical correlations between each matched pair of variates, *V* and *V* (see Anderson, 1958; Rao, 1965). Corresponding to these correlations, a_{fc} are vectors of canonical coefficients, $3'_A$ and $\hat{}'$ (like factor loadings), which are like regression weights that indicate which original sets of variables from *M* and *DA* are maximally intercorrelated or involved in the new canonical vectors U_k and V_K and to what extent they determine variate scores of *uk* and v_K. The new canonical vectors consist of standardized (of zero mean and unit variance) canonical variates (like factor scores).

Geometrically, the canonical analysis measures the extent to which individuals occupy the same relative locations in the m-dimensional mobility behaviour space as they do in r + *q* dimensional attribute-cum-utility space. Thus, overall correspondence between the two spaces, between two matrix bases, are tested.

Canonical analysis provides a number of statistic fot assessing the statistical

significance of the relationships. First is called the trace correlation which indicates overall general goodness of fit between the two sets of input variables or two matrices, that is, it measures the amount of variance in the one set being explained by the variance in the other set. The higher the value of trace correlation, the greater the statistical overlap between the two spaces, between behaviour and attribute-cum-utilities.

Generally, it is more meaningful to observe the second set of statistic, that is, the successive sets of canonical correlation *(R_c* or *rho)* which measure the degree of interdependencies or associations between each matched pair of variates. The square of canonical correlation times 100 indicates the amount of variance explained in the variate of dependent set by the variate of independent set.

The third feature of canonical analysis is the chi-square statistic. The chi-square test indicates the statistical significance of these canonical correlations between each matched pair of variates or linear combination of input variables (for calculation of chi-square, see Cooley and Lohnes, 1962 : 37).

Fourth feature is the canonical coefficients (similar to factor loadings) which relate each input variables to a canonical variate. Examination of such coefficients permit precise interpretation of a canonical variate in terms of those input variables which constitute that specific variate and indicate high loadings.

Canonical Findings

Results of the canonical analysis are presented in Table 1. Since there were thirteen patterns in our *M* and *AU* matrices, thirteen pairs of canonical vectors are extracted successively from M and *AU* with decreasing order of predictability, in the same manner as in principal components analysis. Of these, only the first nine statistically significant patterns are reported in this study, the last four non-significant results are being omitted. As can be easily seen from each such canonical interrelationships, a specific *(m)* type of mobility behaviour and a specific *(a)* type of attribute-cum-utility distance are linked, and in each case the correlation between the pair of vectors maximized. In simpler words, the relationships between the nced-stress-attributes and utility distances of the movers and resultant mobility behaviour are specified (Table 1).

The trace correlation is quite high, 0.518, indicating a significantly high overlap in the two spaces described by the original behaviour and attribute-cum-utility variables. This also means that the total set of attribute variables explain about 27% (trace correlation squared times 100) of the variance in the total set of behaviour indicators. Given the fact that most *multivariate* tests in social science research have correlations ranging only around 0.4 or 0.5, and also

TABLE 1—THE CANONICAL STRUCTURE MATRIX
Canonical Analysis of Indian Mobility, Utility and Attribute Dala

Canonical Varieties	*1**	*2**	*3**	*4*	*5*	*6*	*7*	*8*	*9*	*10*
No. Mobility Behaviour Variables										
1. Migration to search manual job/ circulation for vacation	*0.610***	*—0.515*	0.086	—0.060	*0.411*	0.103	—0.110	—0.178	—0.200	—0.113
2. Transferred for family security	—0.273**	—0.098	0.410	-0.354	0.327	—0.112	—0.236	—0.091	—0.107	—0.343
3. Moves for college/university study	*—0.552*	*—0.447*	0.410	0.372	-0.122	0.151	—0.091	—0.095	—0.060	0.040
4. Urban to rural circulation for harvesting and meeting family	—0.121	0.508	0.135	0.130	0.255	0.391	—0.464	—0.027	0.077	—0.277
5. Moves for professional job of unemployed	—0.178	—0.243	*—0.849*	0.145	0.073	0.320	—0.123	—0.121	0.131	0.071
6. Moves for prospect and more earning	—0.320	—0.145	—0.073	—0.363	*0.353*	—0.127	—0.046	0.317	0.029	0.018
7. Short distance move/medium distance	0.151	—0.155	0.014	—0.018	—0.201	—0.132	—0.161	0.193	0.570	0.100
8. Migration for more than 1 year/ temporary move for 3-12 months	—0.164	0.022	—0.023	—0.165	0.012	—0.274	0.336	*—0.656*	0.363	—0.305
9. Circulation to urban area to resume work	—0.067	—0.050	0.057	—0.321	0.054	—0.258	—0.383	0.044	0.243	*0.458*
10. Oscillation because near native Place	0.039	—0.082	0.197	—0.035	0.295	*0.432*	0.414	0.291	*0.561*	—0.076
11. Moves of unemployed	0.025	0.050	—0.073	0.550	*0.437*	*—0.558*	—0.045	0.135	0.158	—0.081
12. U to U long distance/R-U short distance	—0.116	0.203	0.081	0.036	*0.436*	0.108	0.271	—0.287	—0.146	0.650
13. Medium distance moves/short distance moves	—0.175	*—0.003*	—0.155	—0.075	0.047	—0.116	0.599	0.424	—0.330	—0,165

Utility Distances and Attribute Variables

1. Job-Urban utility distance	0.522	—0.655	0.037	—0.067	—0.153	—0.274	—0.072	—0.010	—0.044	0.291
2. Physical-kinship utility distance —	0.106	0.345	0.187	0.043	0.377	0.113	0.251	*—0.427*	0.236	**0.594**
3. Perceived nearness utility distance	0.008	—0.112	0.040	—0.105	0.118	0.072	0.045	—0.358	0.022	—0.363
4. Poor, landless socio-economically deprived	*0.815*	0.390	0.161	—0.040	0.111	0.116	—0.128	—0.030	—0.047	—0.220
5. Want vertical social mobility	0.320	*—O.S75*	0.137	—0.111	0.146	0.029	0.068	0.083	—0.058	—0.184
6. Small awareness space	0.036	0.053	0.054	—0.003	—0.127	—0.037	0.302	—0.053	0.269	—0.072
7. Young adult with no family burden	—0.012	—0.127	0.075	*0.661*	—0.353	0.530	0.099	0.021	—0.207	—0.016
8. Job-income dissatisfaction	0.091	0,083	—0.123	—0.126	0.380	0.290	0.260	0.620	—0.220	0.309
9. Educated unemployed wanting earning	0.178	—0.081	—0.952	0.092	—0.009	0.043	—0.034	—0.045	0.128	—0.047
10. High caste and rich landowners	—0.103	0.055	0.008	—0.074	—0.025	—0.158	0.659	0.220	0.205	—0.308
11. Landless and unemployed	0.103	0.023	0.035	0.705	0.380	*—0.538*	0.034	0.106	0.024	—0.041
12. In debt and stress	—0.264	—0.061	0.075	0.060	0.455	0.255	*—0.451*	0.143	0.482	—0.154
13. Scheduled castes suffering droughts	0.241	—0.029	0.083	0.066	—0.389	0.071	—0.033	0.303	*0.685*	0.156
CANONICAL CORRELATION	0.912[a]	0.885	0.791	0.645	0.572	0.482	0.324	0.250	0.211	0.170
Chi-square	2434.333	1683.300	1038.749	623.612	396.608	229.527	118.084	71.264	41.732	22.472
Degrees of Freedom	169	144	121	100	81	64	49	36	25	16
Probability[5]										
Trace Correlation	0.51760[b]									

* Canonical variates are separate patterns of relationships between 'input' variables,

** Loading : degree and direction of relationship of the specific variables with this pattern.

a Canonical Correlation ; the statistical dependence between each matched pair of variables,

b Trace Correlation : general overlap between Attribute Utilities set and mobility behaviour sets.

c See Table II.

given the fact that only sample survey data are employed in the present research, this value of trace correlation can be considered quite significant. The interdependence of the attribute and behaviour matrices is also tested by such a significant value for the trace correlation. Besides, successive canonical correlations between pairs of canonical variates also provide nine statistically significant measures of interdependence of the bases of the behaviour and attribute matrices, the first three of which are as high as 0.79 or 0.88, or even 0.91. In social sciences, especially In psychology, to have *multiple correlations* consistently at .7 or .8 level, such as in this study, would be remarkable. However, it is also true that while handling with such a large number of variates (13 by 13), the trace correlation often have been found to be of moderate value with high canonical correlations only for the first half of the variate pairs, but dropping off quite quickly after that, as it has happened here.[1]

The largest canonical correlation is 0.912, showing a very high interdependence between the behaviour and attribute sets of compound variables in the first interdependent pair of variates. Corresponding canonical loadings describing the correlations of the variables with the variates are also given for the behaviour and attribute sets. These canonical loadings or co-efficients indicate the degree of correlations of variables with canonical variates. For instance, in the first column (Table 1), the loading of 0.815 shows the correlation of variable 'poor economically deprived' with the first variate. Comparison of the loadings for all variables with the pair of variates permits the identification of those attribute and utility variables most highly related to particular mobility behaviour *(s) (underlined in* Table 1).

Significance of Canonical Findings

Significance levels of various canonical correlations are presented in great detail in column 6 of Table 2. Briefly, the following observations can be made. Firstly, it shows, that out of thirteen possible pairs of relationships, first *nine* are statistically significant, and remaining only four patterns non-significant. In the

1. Formula for trace correlation,

$$\bar{r} = \left(1/P \sum_{i}^{p} = 1\, r_i^2 \right)^{\frac{1}{2}};$$

where $\bar{r}$ is (race correlation; r^2 is the squared canonical between V and F variates, and p is the number of variate pairs. This may also indicate the point made, that amount of trace correlation may be reduced to only moderate value due to the presence of very low relationships successively at the end of the iteration process.

present study, then, non-trivial solutions are as many as nine out of the total thirteen considered. Seldom so many significant results emerge in a single study. It also testifies all basic concepts of field theory, and its notion of interdependence between field's parts, between its structure of need-attributes, utilities, and mobility behaviour.

Secondly, column 4 of this table also reveals that first six canonical correlations all have very high values : first 0.91, the second 0.88, the third, 0.79, the fourth 0.64, the fifth, as high as 0.57, and the sixth, close to 0.49. Even the seventh is also of quite importance (0.32), after which correlations however drop rapidly showing weaker relationships,

Thirdly, columns 5 and 6 of Table 2 also indicate that the first six canonical relationships are significant at 1 in a billion level or more.[2] That is, the chance is only one in a billion tests that such relationships could occur only by random or systematic error. In other words, odd of accepting such results as trivial is only one in a billion.

In fact, first three results have z-scores considerably higher than 5.99 (the maximum value available from statistical table), and in this respect the first relationship (with z-score of 51.41) surely can be regarded significant at one in more than a billion level. However, in the absence of any supporting statistical table, this is not claimed here.

These first three results are labelled as the major findings. By comparison, the next three canonical results are regarded as the minor findings. Besides, the seventh canonical correlation (of value 0.323) is also significant at .000,000,05 level; that is, odds are only 5 in a 100 million that this could happen by chance error or randomness, which is sufficiently strong to be included within the minor findings (Table 2, col. *6).*

These seven results are not only statistically significant but also practically significant. This will be evident from the causal-functional relationships thus emerged between mobility behaviour and attribute-utilities and their interpretations, presented in the next section.

Fourthly, the eighth and ninth canonical correlations are also statistically

2. Usual chi-square tests of significance are *also* done which show that first eight correlations are significant at least *at* '001 level or beyond—exact level of which cannot be estimated **from** the chi-square table. Instead, Z-score transformations of the chi-square are used here Which indicate much finer and precise significance levels. Z-score transformation (for degrees of freedom greater than 30) specifies the correspoding areas under the normal curve for each such correlation and tells the probabilities of occurring such relationships only by chances or random error. Thus, first six results are found to be significant at 1 in a billion level or more. **For** more details, see R. J. Rummel, *Field Theory Evolving* (1975), chapter 16.

TABLE 2—SIGNIFICANCE LEVELS OF THE MOBILITY FIELD THEORY RESULTS

No. of canonical variate pair	*Name of canonical variate pair*	*Results*	*Eigen-Value*	*Corresponding canonical correlation*	*Z-Transformation for D. F. => 30*	*Significance level**	*Range of Significance from standard table**	*Corresponding Z-score*
1.	Poor economically disadvantaged searching any manual jobs		0.83096	0.91157	51.41826	.000,000,0011	*P* < .000,000,001	6.00+
2.	Young aspiring to vertical mobility moving for higher studies	Major Findings	0.78250	0.88459	41.08136	.000,000,001 +	*P* < .000,000,001	6.00 +
3.	Educated unemployed moving for professional job		0.62565	0.79098	30.05540	.000,000,00] +	*P* < .000,000,001	6.00+
4.	Landless-unemployed. move for jobs		0.41567	0.64472	21.20932	.000,000,001 +	*P* < .000,000,001	6.00+
5.	Move of dissatisfied-debted for employment-security prospect	Minor Findings	0.32663	0.57151	15.47553	.000,000,001 +	*p* = < .000,000,001	6.00+
6.	Moves of underemployed		0.23185	0.48151	10.15614	.000,000,001+	.000.000.001 < *p* < .000,000,001	5.62-5.99
7.	High caste rich landowner migrating for 1 year +		0.10490	0.32388	5.51890	,000,000,05	.000,000,01 < *p* < .000,033	4.00-5.61

8.	Temporary migration for high job-income dissatisfaction	Satistically Significant but not	0.06751	0.25983	3.51236	.0003	.0001 <P<.001	3.10-3.71
9.	Oscillation of scheduled castes suffering drought	Practically	0.04456	0.2111O	2.13586	.02	.01 <.p<.05	1.65-2.33
10.	Not easily interpretable		0.02889	0.16998	1.13633	.13"	.05<P><-16	1.00-1.64
11.	Not easily interpretable	Random	0.01630	0.12766	0.36812	.35		
12.	Not easily interpretable	Behaviour	0.00609	0.07805	—0.13858	.40	Not applicable	N.A.
13.	Not easily interpretable		0.00133	0.03644	0.05962	.48		

a These estimations of significance levels from Z-Scores are available in R. B. Owen, *Handbook for Statistics* (Oxford, 1971), p. 12, (especially see inverse of the Normal Probability Distribution),

& In standard table significance levels arc available only up to Z-Score value of 5.99 (with corresponding significance level of .000,000,001), beyond which significance levels can be estimated. For similar use, see R. J. Rummel, *Field Theory Evolving*, (in press, 1974), Chapter 16, table 6.

c At least first six have Z-Score value above 5.99, that is, significant at .000,000,001 level and above. Probabilities are one-tailed since the canonical (regression) equation gives a specified direction of relationship.

d Significance levels of last four results are estimated from chi-square tables when degrees of freedom Jess than 30.

e In such cases, many Attributes Variables appear to be related to many Behaviour Variables, thus making them difficult to be easily *labelled with* simpler names.

significant at .02 level or beyond. But since these show much weaker relationships, they are not of that much 'practical' significance as of the former seven stronger results.

And, finally, the remaining four patterns of relationships, the tenth through the thirteenth canonical results, are statistically not significant and which can be regarded as patternings of *random behaviour.*

Interpretations of Canonical Variates : Field Theory Findings

1. Poor, Economically Disadvantaged People Searching for Manual Job. In the first pair canonical vectors the behaviour variate 'migration moves to search for any kind of manual job', of canonical loading of 0.619, is found to be highly correlated with the attribute variate 'the poor and landless socio-economically deprived dimension' (0.815) and with larger 'job-urban utility distance' (0.522).' Amidst multitudes of data, observations, and relationships, this particular relationship is of greatest importance. Corresponding canonical correlation is remarkably high, 0.912, which indisputably testifies that in the Indian situation the reality is that the poor landless socio-economically disadvantaged and deprived people are migrating merely in search of any means for sustenance, and in their movement decision-making the fundamental criterion is simply to have greater job-urban utility difference between the places of origin and the destination—i.e., to obtain higher job utility gains from such moves. Telling against a simplistic push-pull theory, this canonical result indisputably establishes a causal relationship between people's basic needs and people's movements for survival, a relationship that is of overriding significance for migration planning in the Indian situation.

For those unfamiliar with such canonical interpretations, may be the following elaboration of this pair of variates is helpful. Since each Behaviour and Attribute variate are linear combinations of the vectors of earlier Behaviour and Attribute (plus utilities) Matrices, interpretations of relationships of mobility behaviour patterns to patterns of need-attributes and utility distances become more complicated. The following kinds of relationships can be shown for new canonically-transformed scores *(u* and v) written with respect to the first pair of behaviour and attribute variates (see Table 1) :

$U_1 = 0.62$ (migration to search for any manual job) — 0.27 (transfer moves for

3. Important canonical loadings of value greater than 0.40 are usually considered (i.e., explaining about 16% of variance) and are *underlined* in the table. However, there is no rule of thumb, and such cut-off points are decided by the individual researchers.

security) - 0.55 (moves for higher study) -0.12 (urban to rural circulation for agricultural work)—0.18 (moves for professional job) —0.32 (moves for prospect) 4-0.15 (short distance move) —0.16 (migration for more than 1 year) —0.06 (circulation to resume work) - 0.04 (oscillation to near native place) +0.02 (moves of unemployed)-0.12 (longdistance urban to urban move) - 0.17 (medium distance moves).

v_1 = 0.52 (job-urban utility distance) —0.10 (physical and kinship distance) 4-0.01 (perceived nearness) *-{-0.82* (poor landless socio-economically deprived) +0.32 (want vertical social mobility) +0.03 (small awareness space) —0.01 (young adult with no family burden) 4-0.09 (job-income dissatisfaction) +0.17 (educated unemployed) —0.10 (high caste rich landowners) 4-0-10 (landless unemployed) —0.26 (in debt and familial stress) 4-0-24 (scheduled castes drought-stricken).

Important loadings are underlined. Noteworthy feature is that while a few specific variables (with higher loadings) are picked-off from both attribute and behaviour set to show their maximal relationship, the relationships with other variables are reduced to near zero. This can be interpreted that, for the first largest set of canonical variates, the attribute 'poor landless socio-economically deprived' condition of the people and the utility variable 'job-urban utility distance* (or utility gains) between origins and destinations are significantly -of much greater importance than other variables in predicting 'migration moves for searching any manual jobs*. Evidently, such moves are not for higher studies, as revealed by this particular variable's high negative loading on the behaviour variate. Detailed scrutiny of canonical variate scores for all the 436 moves and comparing them with corresponding original data also enabled to verify the above interpretation.

Canonical correlation between this matched pair of variates is 0.912, indicating that 83 per cent (correlation of 0.912 squared times 100) of the variance in this set of variate pair has been explained by such Attribute-Behaviour indicators. Closer examination of loadings of different indicators further points out that a single attribute variable 'poor landless socio-economically deprived people' alone explains about 66 per cent (loading of 0.815 squared and multiplied by 100) of the variation in 'migration movement for manual job', that is, there exists almost a one-to-one relationship between the two. And, the utility variable 'job-urban utility gain' explains only another 25 per cent of the variation (0.52 squared times 100). Therefore, the first canon tells that the more an individual is poor, landless and socio-economically deprived, the more probability of his migrating out to search for any kind of manual job and the more

chances of his moving out from a place of less job-urban facilities to a place of larger gain in such utilities.

For the study region in northern India, thus, such relationships clearly reveal at least two important findings: first, it is mainly the need-stress-attribute component—the 'push' factors in the origin places that is of much greater significance to induce and to cause such labour migration than merely job-urban utility gains or attractive 'pull' forces of the city destination, as has been frequently emphasized in many migration-mobility studies. This finding is of tremendous importance for migration policy making, as it emphatically calls for focusing upon the 'need-stress' situations of the people and in the rural areas—to attack and solve them there instead of dilly-dallying with programme of urban renewal or squatter eradication as means for solving the problems of march of the peasants to the city slums. This also indicates that given job facilities in the rural sector, people would also like to live there. These aspects are discussed in greater details in the concluding section.

Secondly, conspicuous absence of two utility factors in this linkage equation—that is, physical-kinship utility distance and perceived nearness utility distance—clearly dispelled another set of current beliefs of most migration researchers which emphasize that as if mere physical distance, kinship facilities or perceptual factors are of greater importance than hunger itself in the mechanism of labour migration in the Third World.* The findings are just the contrary. Hungry people do not consider distance barriers, kinship acquaintance fields or cognitive mapping of their geographic worlds—no wonder why such current concepts thus fail to explain why people move in the Third World. People here rather move anywhere just to survive. Survival is the watchword.

In like manner, successive canonical correlations, canonical loadings and corresponding patterns of causal-functional relationships between the behaviour set and the attribute set can be easily interpreted (Table 1, columns 2-9).

2. Young People Aspiring to Vertical Social Mobility Movingfor Higher Studies. The second pair of canonical variates (Table 1, column 2) is interpreted here as a negative canonical vector, as is cutomarily done with factor analysis results. In such interpretation, higher nagative loadings among both the attribute and behaviour sets are considered to be interrelated. Highest negative behaviour variable loading is for the moves for college-university study (—.447) and the most important negative attribute loading is for a desire for vertical social

4. There is a dearth of studies which categorically emphasise upon hunger, poverty, and need systems of people in order to understand and explain mobility in the Third world, as has been done in the present one.

mobility (—0,875) and that of utility loading is job-urban utility distance (—0.655). Since all of them are negatively loaded, their associations are easy to interpret as: young people who want vertical social mobility are moving for higher studies and they are relocating to places of high urban-educational utility gains. Also note that only young aspirants of the social elites (who do not belong to poor deprived class) are moving for higher studies.

In the same manner, all the positive loadings within this matched pair of variates can also be regarded to be associated. Thence, the two behaviour variables, circulation for vacationing (0.515)[5] and urban to rural circulation for harvesting (0.508), can be considered maximally associated with utility variable 'physical-kinship utility distance' between origins and destinations (0.345). **In** general, both the kinds of circulatory moves are found to be causally-functionally linked with wider physical-kinship utility distances or gains. It confirms the fact that circulatory moves basically are dependent on physical and kinship 'distance'. Greater such distances or utility gains, the more chances of such circulatory moves. Thus, this second pair of canonical variates unfolds two sets of relationships, both of which have great practical and statistical significance, since this pair has a very high correlation of 0.885 (significant at 1 X 10~* level).

3. *Educated Unemployed Moving for Professional Jobs.* The third canonical correlation is also of high value, 0.791, which is significant at 1 in a billion level or beyond (Table 1). This pair of canonical variates (Table 1, column 3) reveals almost a one-to-one isomorphism between the attribute variable 'educated unemployed wanting jobs and earning (—0.952) (Attribute variate) and the behaviour variable 'moves for professional jobs of unemployed' (0.849) (Behaviour Variate). That is, the attribute 'educated unemployed' alone explains about 90 per cent (loading squared times 100) of the variation in the behaviour variate—which is however comprised mainly of the variable 'moves for professional jobs.' Of course, another behaviour variable, 'moves for college-university', also has a positive loading (0.410), but all other variables both in behaviour and attribute sets become insignificant. Considering these three loadings, this canonical vector then simply can be interpreted as the more an individual is educated and unemployed wanting jobs and earning, the more probability

5. From the preliminary step of analytic design *(Factor* analysis), the first behaviour component was found to be a bipolar factor whose negative polarity, connoted circulatory moves for vacationing. Thence, in canonical structure matrix, when a negative loading appears on that first behaviour component, it can be positively interpreted as circulatory moves for vacationing instead of inverse of the variable 'search for manual job[1].

of his moving only for professional jobs and the less chances of moving for higher studies. Conspicuous absence of any utility variables testifies, quite Strongly, that jobless educated persons are ready to move anywhere, irrespective of presence or absence of distance barriers, kinship ties, urban facilities or proximity.

Since the words 'educated unemployed' appear both in attribute set and behaviour set, these may imply that such an explanation is mere tautology. In this connection, it may be well to remember that throughout our analyses both the attribute and the behaviour sets are defined, measured and operationalized independent of each other and, as such, such argument is unwarranted. And more importantly, none of the 'input variables' in canonical matrix is merely a single variable, rather they themselves are factors or compound variables. Each of them represents a cluster of interrelated variables, each of which, in turn, comprises of many original measures, indices and data. Canonical correlation between such matched pair of canonical variates, then, Indicates inter-relationships at much higher order of complexities, between more compound variables. For example, the attribute variable in question, i.e., 'educated unemployed wanting jobs and earning, (as generated by factor analysis, not reported) represents a basis dimension which comprises three or four original variables; the same is also true for the behaviour variable, 'moves for professional job of educated unemployed'. Consequently, an isomorphism or one-to-one relationship thus discovered does in fact unfold a truer and a higher order causal-functional relationship between them, instead of citing tautology. The above argument holds good for all canonical results.

4. *Landless and Unemployed People's Move for Jobs.* The fourth canonical vector (Table 1, column 4) is characterized by a very high degree of association between behaviour variable 'moves of unemployed'(0.850) with two attribute variables 'landless and unemployed' (0.706) and 'young adult with little/no family burdens' (0.661). Corresponding canonical correlation is still remarkably high, 0.645, which is significant at one in a billion level (Table 2). This association emphasises that the attribute factors 'landless and unemployed' alone accounts for 50 per cent, and the next factor 'young adults with little family burden', another 43.5 per cent, of the variation in movements of unemployed workers (behaviour variate). This shows that the more an individual is landless and unemployed young adult with less family burdens, the higher the probabilities of his moving out from the village for outside employment. Also note the absence of such factors as awareness space, job-urban utility distance, kinship-physical distance or perceived nearness. This clearly establishes the fact that, at least in

the study region, such considerations are unimportant to unemployed persons who are desperately searching any kind of work.

5. *Moves of Unemployed-Dissatisfied'Imh-btcd People for Employment-Security-Prospect.* On the fifth canonical vector, a host of behaviour patterns are found **to be** associated with a host of attribute structures, as listed below :[5]

ATTRIBUTE VARIATE

Physical-kinship utility distance	0.377
Job-income dissatisfaction	0.380
Landless unemployed	0.380
In debt and familial stress	0.455
Scheduled (low) castes suffering drought	—0.389
Young adults with no/little family burden	—0.353

BEHAVIOUR VARIATE

Migration in search for any manual job	0.411
Moves of unemployed	0.437
Urban to urban long distance moves	0.436
Moves for prospect	0.353
Transferred moves for family security	0.327

In contrast to former one-to-one relationship between a single behaviour type and a single attribute type, here a multitude of such attribute and behaviour variables are interrelated in a complex way. Though interpretation becomes much more difficult, nonetheless one major relationship does emerge : older people who do not belong to scheduled caste (or low caste) but who share familial responsibility and who are being affected by medium-level job income dissatisfaction and medium to high level of debt and stress (Attribute set) are moving either for manual job/other kind of employment or for prospect/family security (Behaviour set). In essence, this canonical vector unfolds a hidden dimension commonly shared by different groups of people. This fifth pair of canonical variate shows still a remarkably high correlation (0.572) which is significant at 1 in a billion level.

6. With successive canonical Vectors within each set, numerically lower loadings become increasingly important (based on redundancy measure), thus making loading of less than 0.40 (but above 0.30) worthy of consideration. This has been done here from fifth vectors onwards. For further details, see Donald A. Wood (1973).

6. *Moves of Underemployed and Oscillatory Moves of Young People with no Family Burden.* The sixth canonical correlation, of value 0.482, which is significant at 1 in a billion level, is interpreted rather negatively, considering the negative polarity of the input factors. This may be apparent from the following loadings:

ATTRIBUTE VARIATE	
Underemployed (considering negative polarity of dimension 'landless and unemployed')	(—) 0,538
Young adult with no/little family burden	0.530
BEHAVIOUR VARIATE	
Moves of underemployed (considering negative polarity of dimension 'moves of unemployed')	(—) 0.558
Oscillation because destination is near native place	0.432

When attribute and behaviour factors of preliminary factor analysis results (not reported) are minutely examined, it reveals that in both the cases the negative polarity of 'unemployed' dimension is represented by an 'underemployed* sub-factor. Reversing the signs, then these can be interpreted as 'underemployed* dimension (of Attribute Matrix) and 'moves of underemployed* (of Behaviour Matrix). In the sixth matched pair of canonical variates, the same two dimensions appear highly intercorrelated (but their negative signs are left unchanged as shown in the parentheses), which is interpretable as 'moves of the underemployed'. Such interpretation makes sense, especially when compared with canonical vector number 4 (Table 1, Columns 6 and 4), where the same two attribute and behaviour variables (i.e. unemployed) also appear, but with positive signs. These two canonical vectors, therefore, are not really repeating the same result, rather they are completely independent and should be interpreted as such. In the like manner, the remaining two positively-loaded interrelated variables represent an oscillatory type of moves of single males who have little familial responsibility. In sum, thence, this entire canonical vector represents moves of single male and underemployed labourers and workers.

7. *High Caste Rich Landowners Moving Medium Distances for More than One Year arid Circulation of People in Debt and Stress.* The seventh pair of canonica 1 variates is somewhat difficult to interpret. This is so because at each subsequent Step canonical analysis linearly recombines both sets of variables in order to

determine the new matched pair of variates and to maximize the remaining interrelationships, and more and more variables are added to a canonical vector. This can be easily seen from the following:

ATTRIBUTE VARIATB	
High caste rich landowners	0,659
In debt and stress	—0.451
BEHAVIOUR VARIATB	
Oscillation moves to near native places	0.414
Medium distance moves (200-500 miles)	0.399
Migration for more than one year	0.336
Urban to rural circulation for harvesting	—0.464
Circulation to urban area to resume work	—0.383

Apparently no direct one-to-one relationship can be traced here. Yet two patterns can be discerned, one each for positive and negative associations : (1) high caste rich landowners are migrating or oscillating medium distances, and (2) other people in debt and familial stress are circulating back to their villages for harvesting or returning to the city to resume duty. This variate pair shows a correlation of 0.322 which is significant at 5 in 100 million level of significance.

8. Temporary Migration for High Job-Income Dissatisfaction, The eighth canonical variate pair shows a correlation of 0.260 which is significant at 0.003 level (Table 2). Two movement patterns constitute the behaviour variate : temporary moves for 3 to 12 months (— 0.656)[7] and medium distance moves that are made within 200-500 miles (0.424). These two movement types are found to be causal-functionally linked with two attribute variables : high job-income dissatisfaction (0.620) and no considerations for physical-kinship utility gains (— 0.427). Probably this can be interpreted as that high job-income dissatisfaction among people induces temporary migration for less than one year period and probably such moves are not performed for kinship bonds in the destination places or for proximity. This however perfectly fits with medium distance moves which occur within 200-500 miles. The significance of this canonical component can bo at once apparent as it again confirms the basic fact that it is the 'dissatisfactions' **or** need-stress systems of the people that cause temporary moves to occur, and

7. The negative polarity of this bipolar dimension (from factor analysis) indicates **tern-jwtary** moves.

not mere distance-decay function or kinship facilities, nor even their perception of nearness of a location (—0.358).

9. Oscillation of Scheduled Castes Affected by Drought and Debt. The ninth canonical result is of great policy significance (Table 1, column 9). It clearly indicates that 'scheduled low castes suffering droughts' (0.(-85) and 'people in debt and familial stress' (0.482) (Attribute variate) are forced to make 'oscillatory moves to near native places' (0.561) or to make 'short distance moves within a 100-mile zone' (0.510) (Behaviour variate). In other words, drought and debt-stricken low-caste people and untouchables are helplessly moving to and fro between their origin villages and the city destination (Varanasi) just to survive and settle down somewhere, but under crushing pressure of circumstance* they are unable to do so.

Canonical correlation is 0.211 which is significant at .02 level of significance. That is, chances are only 2 in 100 that this finding could be random, trivial or unacceptable. In comparison to the first seven canonical results, this ninth result is much weaker but, compared with existing social science findings (mostly at .01 to .05 level), it comes out still sufficiently strong to indicate an urgent need for alleviating the social-economic conditions of the low castes in India.

The tenth correlation indicates an association between circulatory moves back to the urban centers for resuming work and other urban to urban long distance moves (Behaviour) and very high physical-kinship utility gains (Attribute), However, this is found to be statistically non-significant, so also the remaining three other patterns of relationships. As such, these are omitted from the present discussion, especially when all the important movement types arc already being explained.

The main findings from the canonical analysis are presented as under :

1. The more an individual is poor, landless and socio-economically deprived, the greater the chance of his migrating from the rural to the urban areas, in search of any kind of manual job and to move from a place of less job-urban utility to a place of greater provision of such facilities. This canonical result is found to be of such great overriding power and statistical significance that it can be easily regarded as a general rule of movement behaviour applicable to the entire population of the study area (Canonical equation 1).
2. The more an individual is young and aspires for vertical social mobility and the wider is the job-urban-educational utility distance (i.e., gain)

between origin and destination places, the more chance of his moving for college-university education (Canonical equation 2).

3. The higher the gain in physical-kinship nearness utility, the more frequent are circulatory moves to native village for harvesting, for meeting families or vacationing (Canonical equation 2).
4. The more an individual is educated and unemployed wanting a job and earning, the more chance of his moving only for professional jobs and the less chance of his making a move for further education (Equation 3).
5. The more an individual is landless, unemployed and young adult and having less family burdens, the more chance of his moving out from his native village for outside employment (Equation 4).
6. The more an individual is an upper-caste, older person with family responsibilities, and the more he is dissatisfied with job and income situations, and at the same time being partially indebted, the more chance of his moving out with the hope of employment, security or future prospect (Equation 5).
7. The more an individual is underemployed, the more chance of his moving out for employment elsewhere. Also, the more an individual is young adult with less or no family burdens, the more chance of his making oscillatory moves (Equation 6).
8. The more an individual is high-caste, rich, and landowner, the more chance of his migrating medium distances (200-500 miles) for more than one year (Equation 7).
9. Also, the more a person is in debt and familial stresses, the more chance of his making frequent circulatory moves from the native village to the city (Equation 7).
10. The higher the job-income dissatisfaction among the individuals, the more chance of their temporarily migrating for a period of less than one year, and less chance of considering physical-kinship utility gains or losses in the decision-making. (Equation 8).
11. The more an individual happens to belong to lower scheduled castes and being affected by drought and debt, the more chances of his helplessly oscillating to and fro between the same pair of origin village and city destination for bare sustenance (every time for less than one year's duration) (Equation 9).

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