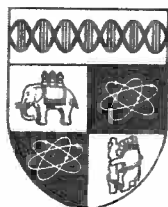Assessing the Degree of Employee
Participation : Guttman Scale
Tests for the West German Metal-
Working Industry*

by

John Cable

Number 257

WARWICK ECONOMIC RESEARCH PAPERS

DEPARTMENT OF ECONOMICS

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1.   INTRODUCTION

In recent years there has been a widespread growth
of producer cooperatives, codetermination, profit-sharing and
other participation schemes. This has occurred not only in
Western industrialised countries, including Britain, but also
in the developing world, and in some Eastern-bloc 'command'
economies. These developments provide social scientists
with rich and expanding opportunities for research on self-
managed and participatory firms: on their relative survival,
growth and productivity rates; on the interrelationship
between participation and human capital formation or the
'quality' of the labour force; on the implications for wage
determination, unionisation, the quality of working life;
and so on.

At present, however, the lack of reliable measures of the
extent of employee involvement in the actual running of the
production enterprise is a limiting factor on research. This,
after all, is the nub of participation, which can vary extensively
under both cooperative and conventional production arrangements,
in ways not necessarily caught by directly observable variables
(like the proportion of workers belonging to a cooperative, the
existence of a works council, the number of worker-directors,
etc.), which feature in previous work. The essence of the
problem is that participation in this sense is a multi-faceted
phenomenon, whereas for many research purposes an overall
measure of the degree of workforce involvement is needed. The
"solution" most commonly applied in past work has been to

compile an index of participation. Espinosa and Zimbalist's (1978) early work on Chilean cooperatives under the Allende government remains one of the most detailed and carefully constructed examples. Yet this and other, less detailed such indices remain open to the objection that arbitrary weighting structures must be imposed by the researcher, e.g. for participation at different hierarchical levels or in different decision areas. Thus subsequent analysis is no longer based solely on observation, and there is a danger that researchers may unwittingly have imposed the relationships they subsequently 'find'.

An alternative approach is clearly needed which avoids these problems. This paper considers the use of scalogram analysis, pioneered by Guttman (1950). Guttman scales have been widely used in some areas of the social sciences, notably in psychometrics as a method of measuring attitudes. One of the earliest and best known studies created social distance or prejudice scales (Bogardus, 1958). Isolated applications are to be found elsewhere, e.g. in the measurement of disability and medical need in health economics (Williams, 1953; Williams et al 1976; Culyer 1978). So far as I am aware, however, the application to participation is entirely novel. Standard procedures to test Guttman scales in this area are carried out, using data previously collected from a sample of firms in the West German metalworking industries. The scales are found to be valid and thus provide a possible alternative way forward for

future research.   The test outcomes incidentally provide statistical evidence on the essentially cumulative nature of participatory developments.

2.   THE NATURE OF PARTICIPATION

Participation is a loose term, capable of various
meanings and a source of some confusion in the literature.
It is not always clear, for example, whether collective bargaining
and grievance procedures would or would not fall within the
definition in a given context. Similarly, it can be unclear
whether financial participation (in the form of profit-sharing
or possibly the provision of debt capital by employees) would
constitute a part or indeed the whole of what is meant by
participation.   However from a motivational, human capital
utilisation and group behaviour point of view, the key aspect
of participation is the extent to which workers are able to
control the decision-making process within the firm, which
under traditional organisation is regarded as the exclusive
prerogative of management.

It is in this sense that Espinosa and Zimbalist (1978)
appear to use the term:

> "Worker participation at the firm level
> is the ability of workers to directly
> influence or form the management and
> work process in an enterprise".

Espinosa and Zimbalist emphasise three principal dimensions of
participation under this definition: the range of the firm's
activities over which workers have influence; their role in
the decision-making process; and the degree of influence they
are able to exert.   Conceptually, measuring the extent of

participation within the production enterprise is then a
question of calibrating the vector OP in Figure 1.

Espinosa and Zimbalist's own empirical work was under-
taken in the Chilean cooperatives that flourished under the
Allende regime.   In circumstances such as these considerable
variation up to high values on the Y axis of Figure 1 (the
magnitude of workers' presence) is to be expected.   In surveys
of conventionally-owned firms, on the other hand, we might
expect to observe relatively slight variation in this dimension,
at a comparatively low value; survey responses very often will
at best be able to reveal the type or form of worker involvement
in the making of certain specified decisions.

Thus, the raw data is typically in the form of qualit-
ative information in the XY plane of Figure 1.   Participation
responses to survey questions might, for example, permit firms to
be classified as level A, B or C in decision areas I and II.
The data for each firm may then be set out in matrix form:

		LEVEL	
	A	B	C
Decision I	0	1	0
II	0	0	1

where the units indicate where the firm is classified.   The
index method, mentioned earlier, then awards points based on
arbitrary weights for each level and decision, and takes the sum.

Figure 1.
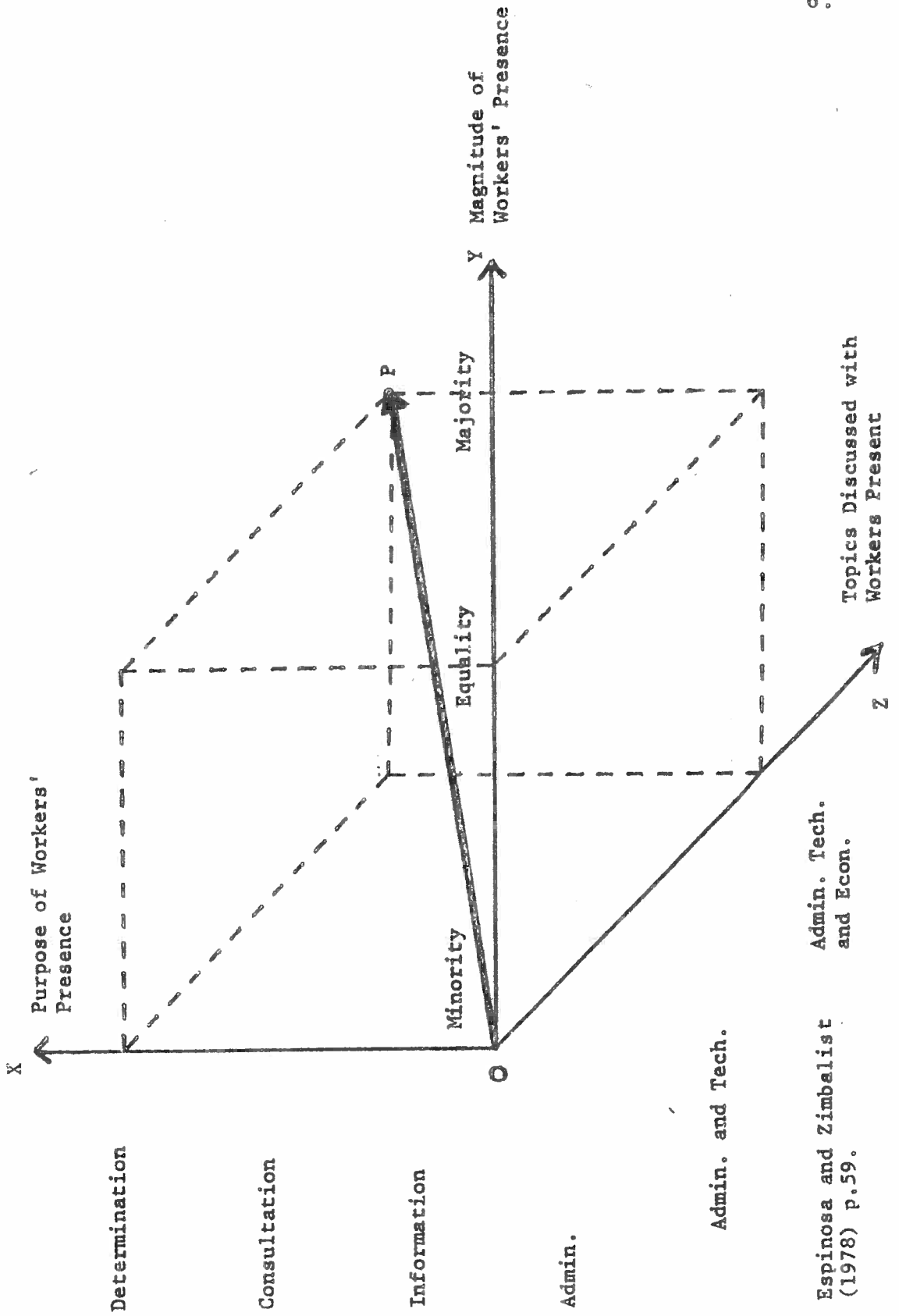
Source: Espinosa and Zimbalist (1978) p.59.

For example, if we treat the decisions as of equal importance
(i.e. unit weights) and weight levels A, B and C according to
the scale O, 2 and 5, the above firm scores 7.   This yields
oneobservation for a continuous participation index, which
may then be calculated similarly for all firms in the samples
to be researched.

As has, however, been pointed out, the drawback is
that while many alternative weighting structures may be tried,
all are arbitrary and must be imposed by the researcher.
Where in the indices are then incorporated in statistical
regression models (e.g. Cable-FitzRoy, 1980, FitzRoy-Kraft
(1984) it is possible to spell out the assumptions implied
by the wighting structure and test these directly.   In
practice the assumptions will almost invariably be found to
imply restrictions which are statistically unacceptable.
The statistical procedures involved, and the research implic-
ations of these results, are discussed at greater length in
a companion paper (Cable 1985).   It is the fact that partic-
ipation indices of this sort appear to hit a dead-end that
motivates search for alternative measures.

3.   GUTTMAN SCALES

In principle Guttman scales may be used to measure
any phenomenon which is both <u>unidimensional</u> and <u>cumulative</u>.
Unidimensionality implies that the movements measured must be
towards or away from the same single object or position. The
cumulative requirement is that there must be a stable and
predictable ordering of items or characteristics by degree of
'difficulty' or 'intensity' (according to the application in
question), so that subjects possessing a higher-degree character-
istic will also possess lower-degree characteristics, but not
vice-versa. In a (simplified) disability/medical need example,
for instance, the observer might evaluate a patient's ability
(i) to get out of bed, (ii) to move about indoors, and (iii)
to move about outside. Anyone capable of (iii) should
also be capable of (ii) and (i); anyone capable of (ii)
but not (iii) should also be capable of (i); but anyone
incapable of (i) will be incapable of (ii) and (iii) also.
Once the relevant ordering of 'items' is established,
subjects may be ranked according to the number of character-
istics they exhibit; that is, by establishing the ordering
sequence, one can then say that a subject is further on, or
less far on, in regard to that sequence. This cumulative
feature is what distinguishes Guttman scales from almost all
others.

The idea of applying Guttman scales to participation
measurement comes from an hypothesis, drawn from observation,
that worker participation begins in areas close to workers'
knowledge and experience, and gradually spreads to other areas
which are increasingly remote in this respect (Espinosa and
Zimbalist, 1978). If this is the case, we could then expect

that a firm which has participatory decision making over, say, investment decisions, will also be participatory in the determination of job-design, but the reverse is unlikely to be true. If so, the crucial cumulative property of Guttman scaling would be present.

More generally, consider a case where there are four decision-making areas, ranked A to D in descending order of 'remoteness' from workers' direct, shop-floor experience (Table 1). If participation were cumulative as hypothesised, and if all firms conformed exactly to the sequence, only the scale types in Table 1(a) would be observed, and these are the only acceptable observation patterns for a perfect Guttman scale. In practice, of course, we expect some deviant observations, which are treated as 'errors' (Table 1(b)). Thus when using Guttman scales the first step is to test the validity of the scale, by reference to the error pattern in a given application. Two principle test statistics are used.[1] The coefficient of reproducibility (CR) measures the extent to which the scale score for a given observation (i.e. the number of unit entries, Table 1) predicts the pattern of entries, and is simply

$$CR = 1 - e/n$$

where e is the number of error cases and n is the total number of observations. As a general guideline CR > 0.9 is considered to indicate a valid scale. However it is possible to obtain a high CR value simply because the observations are 'predicting' the most commonly possessed characteristic. A

TABLE 1(a) : Guttman Scale Types

Scale Type (and score)	Decisions			
	A	B	C	D
4	1	1	1	1
3	O	1	1	1
2	O	O	1	1
1	O	O	O	1
O	O	O	O	O

(1 = participatory, O = non-participatory)

(b) Error Patterns

Error Case	Decisions				Scale Score
	A	B	C	D	
(i)	O	1	1	O	2
(ii)	O	1	O	1	2
(iii)	1	O	O	O	1
(iv)	1	O	1	O	2
etc.					⋮

second test statistic due to Menzel (1953) takes account of this, recognising that CR cannot be less than the ratio of the sum of majority responses to each item to the total number of responses. Thus the coefficient of scalability measures the proportion of non-majority cases correctly predicted by the scale. In this case C5 > 0.6 is regarded as confirming the existence of a valid cumulative and unidimensional Guttman scale. Though the levels of acceptable error are based on

mathematical and statistical analysis of the scalogram technique, they do not have an interpretation in sampling terms. The conventional view is that the critical CR and CS values are set at a 'fairly stringent' level (Williams, et al, 1976).

4.　　　　　AN APPLICATION IN THE WEST GERMAN METALWORKING
　　　　　INDUSTRY

　　　　Guttman scales of employee participation were tested

on data for a sample of 85 firms in the West German metalworking

industry.　　The data had been obtained by interview-survey

methods for a previous study.　　The firms surveyed were mostly

conventionally-owned, small or medium-sized enterprises.　　The

largest firm in the sample had 6867 employees and the smallest

10; average employment was 649.

The Participation Data

　　　　Participation responses from the firms took the form

of statements describing workers' roles in each four decision-

making areas as 'none', 'prior information given', opinion

sought and 'full participation'.[2/]　　The four decision-making

areas were investment/rationalisation, employment, wage-setting

and job-design.　　Managements' assessments were available for

all firms in the sample, and independent assessments by workers

and by works council representatives were available for sub-

samples (with 77 and 64 observations respectively).　　Table 2

sets out the response matrices in each case; the entries may be

interpreted　as probabilities that the firm will be located

in the column in question, each row summing to unity (subject

to rounding error).　　Strictly speaking the matrices are not

comparable, because the samples differ.　　However management

responses are in fact remarkably constant across the three

samples, with only one major discrepancy. $^{3/}$ Thus it is not
unreasonable in practice to compare the alternative perceptions
of participation as recorded in Table 2.

On the whole these are surprisingly similar.   Thus,
summing over the four decisions, the mean responses of manage-
ment and of workers indicate very close agreement over the level
and forms of worker involvement.   Works Council representatives
consistently perceive a higher level of participation, but the
differences are not unduly large.   The fact that works council
representatives judge the level of participation to be higher
than other groups might be thought to arise from their own close
involvement in the process.

In the field of employment decisions all groups agree
that the workers' role tends towards either receiving prior
information or having their views sought, in roughly equal
proportions.   A similar central tendency is suggested for
investment/rationalisation decisions, though less strongly.
Thus there is a higher incidence of firms with no participation
in this area and also a noticeable discrepancy between the views
of workers and, especially, works council representatives as
against management; in a substantial number of cases workers
and their representatives see as the receipt of prior notif-
ication of decisions what managements believe to be the sounding
of workers' views.

Interestingly, all groups agree that full participation
is most prevalent in the area of job design.   This category

TABLE 2 : Participation Responses, Management, Workers and Works Council Representatives

(Proportion of firms with affirmative response in each row/column).

	None	Prior Information	Opinion Sought	Full Participation
Management (n = 128)				
Investment/ rationalisation	0.21	0.32	0.39	0.08
Employment	0.16	0.32	0.33	0.19
Wage setting	0.31	0.37	0.11	0.21
Job design	0.11	0.11	0.31	0.47
Mean (4 decisions)	0.20	0.28	0.29	0.24
Workers (n = 77)				
Investment/ rationalisation	0.23	0.35	0.29	0.13
Employment	0.17	0.38	0.35	0.10
Wage setting	0.43	0.32	0.06	0.18
Job Design	0.00	0.10	0.26	0.66
Mean (4 decisions)	0.21	0.28	0.24	0.27
Works Council (n = 64)				
Investment/ rationalisation	0.28	0.44	0.16	0.13
Employment	0.11	0.36	0.31	0.22
Wage setting	0.31	0.23	0.09	0.36
Job Design	0.03	0.00	0.36	0.61
Mean (4 decisions)	0.18	0.26	0.23	0.33

attracts the highest proportion of firms in any cell of all three matrices, and the proportion of firms with no participation with this decision-making area is very small.   In the case of wage setting, by contrast, participation is either absent or limited to receipt of prior information in two-thirds or more of all firms according to both management and workers.   Works council representatives, however, find this to be the case in only a half of the total cases, and, moreover, detect full participation over wage-setting in more than a third. It is primarily in this area that their overall perception of greater participation occurs.

Notwithstanding these individual differences, there is a broad congruence in the three independent assessments of the degree of participation.   In view of this, and in order to allow the broadest available scale-tests to be carried out, management-response data for the full sample was employed.

Test Results

Scalogram tests were carried out using the GUTTMAN SCALE subprogram of SPSS (Nie et al, 1975).   This program enables the researcher either to impose an ordering of 'items' (in this case, decision-making areas) according to theory or prior belief, or to allow an 'optimal' ordering to emerge by experimentation.   It also permits up to three 'cutting points' to be used to convert continuous or ranked variables (in this case the degree of participation) into the dichotomised responses required for scaling purposes.   This proved highly

convenient in the present application, where the raw data was in the form of the four participation levels: no participation; prior information; opinion sought; and full participation. Hence cutting points could be placed between any two levels, as desired.

In an initial run with the four decision areas (investment; employment; wage setting; and job-design) no predetermined ordering of the items was imposed and all permutations of item-order and cutting-points were covered. This yielded 81 scales, of which 20 met the required acceptance levels in terms of CR and CS prior to rounding, and a further 5 after rounding CR and CS to two decimal places. A further three scales were close to the acceptance limits.

In general this seems to provide rather strong support for the Espinosa-Zimbalist hypothesis about the cumulative nature and development pattern of worker participation. However several of the valid scales involved a priori implausible rankings of the decision areas, while others did well only because the cutting point was set 'high' (i.e. at full participation level) for the most difficult item and then sharply reduced for 'less difficult' items, thus increasing the probability of valid scale being found. Accordingly all scales were rejected which did not meet one or the other of two orderings considered a priori plausible, namely investment-employment-wage setting-job design, or investment-wage setting-employment-job design.

A small set of 'best' scales was then identified from

those remaining, containing all those not dominated by any
other scale in terms of CR and CS values, and the degree
of 'tapering' of cutting points.   Details of these four scales
are given in Table 3.   GUTSCAL 4 has minimum 'tapering',
setting the cutting point at full participation in all areas,
but only just meets CR and CS requirements.   GUTSCAL 2
has maximum CR, and GUTSCAL 3 mazimum CS.   GUTSCAL 1 is
the single 'best' scale for the decision ordering A, B, C, D
and is not dominated by any other scale, having higher CR
than GUTSCAL 3 and 4, higher CS than GUTSCAL 4, and less
tapering than GUTSCAL 2.   As can be seen from Table 4, the
four alternative scales are quite highly intercorrelated, but
not so interrelated as to appear near-perfect substitutes.
The implication for research is that more than one scale may
need to be used experimentally, from any given data set.

The relevance of the Guttman scale exercise for
research into the productivity effects of participation is that
it provides an alternative method of ranking firms according to
the degree of participation, which, unlike arbitrarily weighted
participation indices, is statistically acceptable according to
conventional tests. The main limitation of the scalogram
approach is that, when a given scale is generated, it merely
allocates each firm in the sample a scale score which identifies
the firm's scale type in the cumulative categories as, for
example, in Table 1(a). [4/]   Thus the scale gives only an ordinal
rather than a cardinal ranking and, moreover, is not fully
continuous (merely classifying observations into a limited

TABLE 3 : Four Best Guttman Scales

	Order[1]				Cutting Points[2]				CR	CS
GUTSCAL 1	A	B	C	D	3	3	2	2	.9360	.6812
GUTSCAL 2	A	C	B	D	3	2	1	1	.9477	.6897
GUTSCAL 3	A	C	B	D	3	3	2	2	.9302	.7037
GUTSCAL 4	A	C	B	D	3	3	3	3	.9070	.6049

Note (1) A = investment; B = employment; C = wage setting; D = job design

(2) 1 = 'prior information' or more;

2 = 'opinion sought' or more;

3 = 'full participation'.

TABLE 4 : Correlation Matrix of Alternative Guttman Scales

	GUTSCAL 2	GUTSCAL 3	GUTSCAL 4
GUTSCAL 1	.83	.86	.84
GUTSCAL 2		.76	.63
GUTSCAL 3			.79

number of participation categories).   Nevertheless this kind

of scale should suffice for a wide range of research purposes,

and its intrinsic statistical acceptability is a paramount

advantage.

5/

5.   CONCLUSIONS

Research on the nature, causes and effects of self-management and participatory firms is hampered at present by the lack of reliable measures of the degree of employee involvement in decision-making; previously used indices, with arbitrarily imposed weights, have involved statistically unacceptable assumptions.   Guttman scales provide an alternative approach and were found to meet conventional standards when tested on data for West German metalworking firms.   Given the essentially cumulative nature of Guttman scales, the fact that they were found to be valid in this case is, in itself, an interesting research result; it provides statistical support for the view expressed in earlier literature that participation begins in areas close to workers' knowledge and experience, and gradually spreads to other areas which are increasingly remote in this respect.   If participation is thought to merit encouragement via public policy, it would therefore seem that measures to foster shopfloor initiatives would have the advantage of working with a natural development process, whereas legal requirements for worker representation at board level could be working against this.

FOOTNOTES

1/ For a full discussion see Togerson (1958).

2/ The survey focussed on participation over and above that required of all firms under German codetermination law.

3/ The figure for employment/opinion sought is only 0.18 in the Works Council sub-sample, compared with 0.33 in the full sample and 0.25 in the workers sub-sample.

4/ In the absence of instructions to the contrary from the researcher (none in this case), error cases are allocated to scale types according to scale score.

5/ In regression models, for example, Guttman scales can be used to partition the sample at different points for the purpose of 'switching regressions'. Provided the number of participation categories is not too large (as in the present case where there are only five) the Guttman scale ranking can also be used in simultaneous equation systems incorporating multionominal logit equations. Finally, the Guttman scales lend themselves easily to dummy variable structures based on participation categories.

REFERENCES

BOGARDUS, E.S. (1958), "Racial Distance Changes in the United
    States During the Past Thirty Years", Sociology and
    Social Research, 43, 127-137.

CABLE, J.R. (1985) "Some Tests of Employee Participation
    Indices", Warwick Economic Research Paper 258, March.

CABLE, J.R. and F.R.FITZROY (1980) "Productive Efficiency,
    Incentives and Employee Participation : A Study of West
    German Firms", Kyklos, 33, 1.

CULYER, A.J. (1978) "Need, Values and Health Status Measure-
    ment" in Economic Aspects of Health Services, A.J.Culyer
    and K.G.Wright (eds.), Martin Robertson.

ESPINOSA, J.G. and A.S.ZIMBALIST (1978) Economic Democracy :
    Workers' Participation in Chilean Industry 1970-73, New
    York, Academic Press.

FITZROY, F.R. and C.KRAFT (1984) "Mitarbeiter Beteiligung und
    Produktivität: Eine Ökonometrische Untersuchung" forth-
    coming, Zeitschrift für Betriebswirtschaft.

GUTTMAN, L. (1950) "The Basis of Scalogram Analysis" in
    S.A.Stouffer (ed.) Measurement and Prediction, Princeton
    University Press.

MENZEL, H. (1953) "A New Coefficient for Scalogram Analysis",
    Public Opinion Quarterly, 17, 268.

NIE, N.G., C.H.HULL, J.G.JENKINS, K.STEINBRENNER and D.H.BENT
    (1975), Statistical Package for the Social Sciences,
    McGraw-Hill, Second edition.

TORGERSON, W.S. (1958) Theory and Methods of Scaling, Wiley,
    New York.

WILLIAMS, R.G.A. (1983) "Disability as a Health Indicator", in
    A.J.Culyer (ed.) Health Indicators, Martin Robertson.

————————————————— M, JOHNSTON, L.A.WILLIS and A.E.BENNET (1976)
    "Disability: A Model and Measurement Technique",
    British Journal of Preventive and Social Medicine, 30,
    71-78.