Outline for a Study of the Use of Statistical Models in Social Research and Policy-Making.

This working paper focuses on the use of statistical (or 'empirical') models, to be distinguished from what might be termed 'rational' models. Diesing describes the difference as follows: "An empirical model is derived from a set of data by some curve-fitting technique and serves to summarize and extropolate from those data. A rational model attempts to describe some structure that underlies data and produces them, though it can also be used empirically to summarise data. In other words, a rational model is composed of theoretical terms while an empirical model is more nearly observational". (1972, p.32). This direction may not be so neat; for example, in which category, if either, would we put the Rasch model (Goldstein, 1979)?

In this outline, I concentrate mainly on the type of model produced by least-squares regression (which is usually of linear form). However, I expect that the approach can be generalised.

Some Distinctions: I would like to follow on from some earlier work on models (Evans and Bibby, 1978a and 1978b). 1978b used the term 'commitment' to denote relatively consistent "orientations (conscious or unconscious) which underlie the creation and use of models", and 1978a attempted to show how constraints built into the structure of linear regression constrained the scope of the social analysis. Responses to both drafts from a number of people suggested that (a) some of the criticisms of models were more to do with the way they happened to be used, than the structure of the model (and the modelling process) - and that if linear regression didn't avoid some of the constraints, then other models could. And (b), more fundamentally, that the term 'commitment' could be used in a broad or a narrow sense.

The narrow sense refers to tendencies, structured into the technique or the methodology, that affect in an unexpected or unexplored way the outputs of the model and the theoretical or practical conclusions proposed . The broad sense is more polemical (directed against claims of "objectivity" put forward by users of highly technical methods, as in Easlea, 1973) and refers to various dimensions of absence of value-freedom in the research enterprise (e.g. "theoretical" vs "practical" commitments, as in Evans, 1979).

Suggestion (a) leads to a distinction between necessary and contingent commitments (considered in the narrow sense). Necessary commitments are forced on the user(s) - who may nevertheless be unaware of these, or may not have explored fully their implications - by the mathematics and the assumptions and the basic ontology (Diesing, pp.125 ca.) of the model; for example, you can't investigate two-way causality using the standard regression model. Contingent commitments in the use of models, on the other hand, may be adopted for reasons of convenience or fashion or otherwise; for example, almost all educational attainment studies use linear, rather than curvilinear, models. The separation between the two sorts of commitments cannot be drawn too neatly: for example, the minimisation of the sum of the squared residuals is an essential stage in least-squares regression, but not in all conceivable types of regression model; different mathematics could be marshalled (or developed, if necessary) to minimise the absolute values of residuals, say. This distinction between necessary and contingent commitments is like Cathie Marsh's between 'philosophical' and 'technical'criticisms in her thoughtful and spirited defence of The Survey Method.

Necessary Commitments - Examples from Regression.

(i) one-way dependence: The theoretical appropriateness of such an assumption has been questioned, for example in connection with the Plowden regression model (e.g. Hutchison, 1980). I think we need pointers to the literature on alternative models which do not require this assumption (I believe Blalock, 1969 is a start which will lead into the econometric literature), and any discussions on the consequences of using such an assumption 'inappropriately' (see below).

(ii) least squares: The use of I.S. naturally produces regression coefficients that would be different if another optimising criterim were used. I know of no one who has done regression analysis using another criterion, but Healy and Goldstein (1976) have shown in connection with the construction of a maturity index for children that using a linear constraint, rather than a quadratic constraint produces substantially different scores.

(iii) R^2 as a measure of "importance" of independent variables: There are a range of limitations in this sort of use of R^2: its indication of correlation rather than causality; its susceptibility to increase simply when more variables are added to the model, etc. Goldstein (1976) has argued that it may be especially inappropriate, for instance when positive discrimination or remedial action is being contemplated, and therefore that in certain situations scores below a certain point should be more strongly weighted.

(iv) more basic methodological commitments: Pawson (1978) has argued that the conventional path (or regression) model for status attainment (of occupation or education) "rests on a logic that forces us": (a) to separate the individual from the institution, i.e. to prefer explanations in terms of individual characteristics and qualifications to ones involving structural constraints (whether we like it - or know it- or not!)(pp.621 ff). (b) to assume stability in certain social structures (e.g. the occupational) over generations i.e. to deny historical change (pp. 624 ff). (c) to assume shared meanings with respect to any given variable for all individuals (and subcultures) within the population being studied, (pp 626ff).

I think that Pawson's claims could be studied critically by illustrating their force in connection with particular examples; whether (c) is the case in any context would seem to be in principle open to investigation.

Contingent Commitments.

(i) linearity: A number of reasons have been suggested for the widespread use of the linear form of regression models (1978b):

(a) A linear model is easy to manipulate mathematically, and to depict graphically,

(b) Sometimes such an arbitrary assumption "helps us to obtain deductions where our apriori theories would not permit it so easily" (Feldman, 1972, p.100).

(c) Sometimes a linear model is a reasonable approximation to a theoretically preferable form; rarely is the sensitivity of results to this assumption tested but it can be; see Jencks et al. (1973, p.337).

(ii) continuity : Even non-linear regression models are generally of a continuous form. This means that the model is unable to represent "great leaps" in the dependent variable in response to a crucial change in the independent variable. Now this is not a necessary limitation in that the sort of change referred to may be portrayed by including a dummy variable in the model, but the user has to recognise continuity as one of the commitments built into the form of the model.

(iii) reversibility of change: If an independent variable (with a positive regression coefficient) increases to a certain point, and then decreases again to its original value, the value of the dependent variable will return to its original value too. Though this sort of reversibility is not a necessary commitment either, such a model would not be appropriate for representing non-reversible social or historical changes such as learning or consciousness raising.

Methods of Studying Necessary and Contingent Commitments.

A. listing the assumptions and choice-points entailed in using a particular model or technique: some of the necessary commitments are represented by assumptions; others are more basic (cf. Pawson).

Goldstein has set out the challenge for the applied statistician very clearly: "How does he make all the assumptions of his analysis explicit in such a way that some one with a different set of values, and hence different assumptions, can modify the conclusion?" (1976, p.2).

Clearly, this stage of the investigation requires both statisticians to make explicit the assumptionsand features of models which are likely to "commit" social science users along dimensions likely to be of theoretical importance to them, and also social scientists to be explicit about the ontological and other bases of their theories, that might conflict with specific commitments of a given model.

An important issue here is the type of consequences to be expected from a violation of particular assumptions: is it a total failure of the model to produce anything useful, or is it worth investigating the sensitivity of the results to "slight failures" of assumptions?

B. examining simple examples where particular features (or assumptions)can be relaxed - as in Goldstein's (1976) discussion of alternatives to R^2 (see above) - or the importance of factors outside the model can be shown - as in Pawson's demonstration of the effect of structural constraints on individual mobility independently of those individuals' characteristics and efforts.

More complex examples can perhaps be provided by computer simulation, or by reanalysis of previous studies lodged in the S.S.R.C. Survey Archive, for example.

C. in the case of contingent commitments, surveying Journal articles for practices e.g. with respect to assuming linearity, and any justifications given; surveying methodological articles and text books for the injunctions provided there; etc. (see Diesing, 1972, p.19). for other suggestions re methods

D. speculating about the effects of the widespread use of a particular model or technique in the development of a whole research programme; e.g. regression or path analysis in attainment studies; factor analysis (or the Rasch model?) for educational measurement.

Further Areas of Interest for Similar Sorts of Study.

- lab. experiments in the development of psychology.
- population projections (cf. Brass, RSS paper, 15 Jan.1980).

Possible Outcomes.

- dissection of the modelling process, useful for competence-building for social researchers etc.
- clarification of ways of using models that are likely to be fruitful (related to the uses envisaged).
- guidelines for presentation of reports using statistical models to non-statistical audiences.

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