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HOUSEHOLD PANEL STUDY**

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DESIGN ISSUES IN THE BRITISH HOUSEHOLD PANEL STUDY

David Rose, Nick Buck and Louise Corti

Abstract

The British Household Panel Study is the largest single project ever funded by the UK Economic and Social Research Council. Housed in the ESRC's Centre on Micro-social Change in Britain at the University of Essex, the BHPS will comprise an initial 5,000 households and 10,000 individuals. This paper introduces the Study through an overview of its coverage and some key aspects of its design. A short discussion of some of the analytic advantages of panel data is complemented by three examples of substantive research issues where panel data can assist in our understanding of micro-social change. The BHPS is discussed as an instance of a dynamic approach to social change and its overall rationale is briefly examined. The Study's six substantive research areas - household organisation and dynamics; labour market behaviour and activity; income and wealth dynamics; housing; health; and socio-economic values - are described. The remainder of the paper is concerned with three key design issues for panel studies and explains how these have been tackled on the BHPS. The issues are (1) changing populations; (2) non-sampling errors (and especially non-response and panel conditioning); and (3) sample design. The paper is accompanied by a substantial biography on panel design and methodology. **Micro-social change. Panel Studies. Following rules. Non-response. Panel conditioning. Longitudinal sample design.**

Introduction

Social change can be studied in a variety of ways and by employing a number of different methods. Change may be studied retrospectively, as, for example, when researchers include questions in a cross-sectional survey on past events; or it may be studied prospectively, in which case a sample must be followed over a period of time in order to monitor change. Of course, change could also be investigated through the analysis of repeated cross-sectional surveys such as the General Household Survey (GHS) or the Family Expenditure Survey (FES). However, since such surveys do not have the same or even overlapping samples each year, they only permit analysis of net change at the macro-level (for example, proportion of the population below the poverty line at time t could be compared with the proportion at time $t-1$). In order to study change at the micro-level, however, it is necessary to employ a longitudinal design and, therefore, a prospective method such as a

Second, panel data allow analysts to control for certain unobserved determinants of behaviour, in particular those unobserved factors which vary across individuals but remain the same across time for any given individual. Factors such as these are referred to as **individual specific effects** and their presence as **population heterogeneity**. For analytic purposes, the ability to control for these effects is regarded as one of the most important advantages of panel data (see, for example, Solon 1989).

Third, panel data also allow for the control of **period, age and cohort specific effects**. Period effects are those which vary across a time period but are the same for all respondents at any particular point in time. Age specific effects are those which vary across age but are the same for all respondents of a particular age. Finally there are cohort effects where effects are the same for all individuals born in a certain time period but otherwise differ across respondents. The problems of dealing with these effects in cross-sectional surveys are well known (see, for example, Hobcraft *et al* 1982; *cf* Mayer and Huinink 1990; Labouvie and Nesselroade 1985; Peters 1988; Baltes 1968).

Fourth, as noted in the Introduction, panel data make it possible to examine **transitions between states** in a way not possible where only cross-sectional data are available. In particular, because they are micro-data, panel data permit the analysis of gross change at the individual level. Thus it is possible to make a deeper analysis of the incidence of conditions and events such as poverty and unemployment over time (see Duncan 1989:7-8). In turn such events can be examined for dynamic links with other factors. These points, and others relevant to the concerns of this paper, are all examined in greater detail in standard texts and papers on longitudinal analysis (see, for example, Kemp 1991; Hageaars 1990; Magnusson and Bergman 1990; Blossfeld *et al* 1989; Kasprzyk *et al* 1989; Uncles 1988; Crouchley 1987; Duncan and Kalton 1987; Hsiao 1986 and 1985; Elder 1985; Heckman and Singer 1985; Nesselroade and von Eye 1985; Plewis 1985; Allison 1984; Chamberlain 1984; Duncan *et al* 1984; Mednick *et al* 1984; Tuma and Hannan 1984; Coleman 1981; Kessler and Greenberg 1981; Schulsinger *et al* 1981; Markus 1979; Nesselroade and Baltes 1979; Social Science Research Council 1975; Crider *et al* 1973; Wall and Williams 1970).

panel survey. Panel data will then allow researchers not only to examine the proportion of the population at different times in states such as poverty but, because of their panel nature, these *micro*-data can also be used to examine flows into and out of these states, thus opening up a wider range of possibilities in terms of causal analyses and inferences. In this paper we examine some of the problems and potentials of panel surveys as a method for the study of social change through a discussion of certain features of the design of a new panel study - the British Household Panel Study (BHPS) - funded by the Economic and Social Research Council at its Research Centre on Micro-social Change in Britain, based at the University of Essex.

Why Panel Data?

The above Introduction has asserted rather baldly some of the broad reasons why panel data are generally regarded as superior for the study of micro-social change. We wish to expand briefly on these before we examine some of the key issues in panel design and analysis and our own understanding of them as incorporated into the design of the BHPS.¹ So why panel data?

First, panel data are precisely concerned with the behaviour of individuals over time. For this reason, they are well-suited to the statistical analysis of change and of dynamic behaviour more generally. While it is true that cross-sections can introduce retrospective elements in order to study change, nevertheless the quality of retrospective data decreases the further back one wishes to take respondents (see, for example, Janson 1990; Bradburn *et al* 1987; Jabine *et al* 1984; Sudman and Bradburn 1983; Moss and Goldstein 1979). Moreover, the ways in which individuals interpret their own past behaviour are coloured by subsequent events. Without retrospective elements, however, cross-sectional data produce little of help to the analyst of social change. To make inferences about dynamic behaviour requires one to make often dubious assumptions which link what indirect information can be gleaned from the cross-section to variations in the behaviour of population cohorts (see Deaton 1985; Heckman and Robb 1985; Goldstein 1979).

As we shall see for our own study, beyond the general advantages of panel data, other benefits can accrue through the particular way in which the BHPS is designed. In particular, because **all** household members will be interviewed, the effects of the interaction of changes at the individual level can be examined for the whole household or for other individuals. Equally, because sample members will be followed as they leave their original households, the Study will provide unique information for Britain on the processes of household formation and dissolution. However, before we examine the BHPS and its design in more detail, we can illustrate some of the points we have made about the advantages of panel data through a brief consideration of three substantive research issues where panel data can assist our understanding of micro-social change.²

Transitions into and out of poverty is perhaps the area in which the potentials of panel data to social science and social policy have been most clearly established. First, only panel designs can distinguish between the 'stock' and 'flow' of a social condition such as poverty. By tracing variations in income over time for the same set of individuals, panel studies can identify transitions into and out of poverty and attempts can then be made to test various hypotheses regarding causal factors in this process. For example, the American Panel Study of Income Dynamics (PSID) has documented both a striking rapidity of movements into and out of poverty and a close association between such transitions and changes in household composition. PSID data have shown that in the USA the great proportion of the poor at any one time are suffering temporary rather than long-term poverty, i.e. are moving into poverty through a crisis such as divorce, redundancy or illness in the household and out again on remarriage, re-employment or the recovery of good health (*cf* Duncan 1989 and 1984; Bane and Ellwood 1986). In turn it is also possible to obtain a deeper understanding of the circumstances of persistent poverty (see, for example, Duncan and Rodgers 1988 and 1987).

PSID data have also demonstrated that only a small proportion of poverty is inter-generational. For instance, 46 per cent of the married male family heads who were poor (in the sense of being in the bottom quintile of the income distribution) in 1967 had become non-poor by 1973, while an unmarried female head who was poor in 1967 more than doubled her chances of leaving poverty by marrying (Duncan and Morgan 1976). Taken together these findings have undermined assumptions about a 'culture of poverty' and the

inter-generational transmission of poverty. They also have implications for the way in which poverty is perceived, by both analysts and policy-makers, and for the design of policies towards its alleviation.

The analysis of **life cycle effects** is a second area where panel data can be especially useful. The life cycle model remains the preferred analytical framework of many micro-economists (*cf* Peters 1988; Creedy 1985; Peterson 1980). Much has been written on the life cycle model's compatibility (or otherwise) with observed behaviour. Panel data, with their consequent ability to disentangle age, period and cohort effects and to control for unobserved heterogeneity, provide the most promising basis for a more reliable investigation. Amongst the issues analysts might wish to address are both the extent to which individuals and households are able to reallocate resources across the lifetime in response to their changing needs; and observed patterns of savings and wealth holdings and their relationship to the life cycle. Clearly, there are also links with labour market (see Psacharopoulos 1981) and consumption behaviour to be explored. At the most fundamental level, the usefulness of life cycle paradigms becomes open to question. Might it be, for instance, that economic dynamics are driven more by discontinuous events - family splits, unemployment and so on - than by the smooth processes underlying the textbook economic theories?

Finally there is **the relationship between income and family composition**. Changes in family composition are liable both to influence, and be influenced by, household income and its allocation within the family group (see, for example, Duncan and Morgan 1981). Children's decisions to form separate households, for instance, may be affected by their own earning capacity and their effective claim on any parental income. Such questions seem to have received comparatively little attention, largely as a result of data deficiencies.

Given the above discussion, it is not surprising that the cross-sectional survey is often referred to as a snapshot in time whereas the panel study is depicted as closer in character to a moving picture. Nor is it surprising, given the inherent problems (see, for example, Thomas and Sillitoe 1980) and high costs (see Duncan 1989:14-17) of conducting panel research, that cross-sectional surveys have been far more commonly used than panel surveys in the study of social change. Nevertheless, panel studies are being initiated and conducted with increasing frequency for the analysis of a variety of problems which require data on change

at the micro-level. One such type of study which has become increasingly popular is the general-purpose, national household panel study. The original model was provided by the Panel Study of Income Dynamics, although the broader conception of a household panel study has its origins in the German Socio-Economic Panel (see, for example, Hanefeld 1984a and b). The BHPS is the latest in the line of these national studies, all of which have broadly similar aims without being identical.³ In the next section we discuss the particular rationale of the Study.

The BHPS as a Dynamic Approach to Social Change

The design of any study begins from its theoretical blueprint. It is our intention to study micro-social change in Britain. Those involved with developing the ESRC Research Centre on Micro-social Change had already been studying particular aspects of social change using a variety of methods ranging from the analysis of their own cross-sectional surveys (for example, Marshall *et al* 1988; Sarlvik and Crewe 1983) through to the secondary analysis of various government and other data sets (for example, Rose *et al* 1988). At best, however, the research which was undertaken rested on quasi-longitudinal designs rather than truly longitudinal ones. Hence it was not the decision to study social change which was new but the recognition that Britain needed to follow the German example and establish a general purpose study of micro-social change which employed the more appropriate panel methodology.

The need for this major new research initiative can be simply stated. Academic social science has been ill equipped to meet Britain's social research needs, whether basic, applied or, in particular, strategic. It has lacked an adequate major, national database and the requisite organisational structure to study micro-social change and to anticipate the incipient policy problems which arise from changes in the social and economic structure. The Research Centre has the ambitious aim to remedy this weakness. Its purpose is to provide social scientists with data more relevant to the study of social change and to anticipate the social and policy concerns of the twenty-first century by monitoring trends, and collecting, analyzing and reporting relevant data in advance.

Of course, as Rutter (1981:334) has argued, many longitudinal studies "have involved a mindless collection of large amounts of data which are never adequately analyzed, and which continue over so many years that by the end the original measures are hopelessly inappropriate for the purposes for which they are being used". We have attempted to take heed of this warning, as well as the related problem concerning the fading relevancy of longitudinal data, in the design of the BHPS (*cf* Bergman and Magnusson 1990:25-26; Janson 1990). Thus, for example, although the precise concerns of social scientists and policy-makers ten years hence cannot be predicted, we believe that the broad areas which are likely to be of concern can be anticipated. The panel will, in any event, have a flexible design which will allow new issues to be introduced at relatively short notice. Beyond this, the experience of studies such as PSID suggest that the panel's accumulating socio-economic database will enable social scientists to respond flexibly and rapidly to the research demands of government, the private sector and the academic community.

The central claim we would make for the BHPS is that it will allow researchers to describe and analyze how individuals, families and households experience changes in their socio-economic environment and how they act in relation to these changes, whether these be experienced as constraints or opportunities. A fundamental aspect of this environment is the need to make a living. In multi-person households this involves household decisions - perhaps strategies - as well as individual ones. As Bernard and his colleagues (1988) have noted, to understand how people adjust to their circumstances and changes in them, and the repercussions of change for both individuals and the environment, requires the situation to be examined as it develops in time (longitudinally) and in different areas of social life (latitudinally).

From the viewpoint of the actors involved it is not possible to separate the individual from the household context when a change in the environment takes place. For example, if an individual changes jobs or becomes unemployed there may then be consequent changes in income, health, household composition, domestic organisation, socio-political attitudes and so on. Since such factors are dynamic and inter-related they must be studied using an appropriate methodology which is capable in principle of comprehending the complexity of the relationships between individuals, households and socio-economic circumstances. Indeed, any analysis of individual behaviour needs to make reference to the family and household

context because of the strong interdependencies between family and/or household members. Individual behaviour cannot be explained adequately without reference to other household members. Similarly individual welfare depends on household and family contexts since income, wealth and welfare distribution are closely linked to family and household structures. At the same time, many measures in fields such as taxation, transfer programmes and social policy in general depend on an understanding of these structures (*cf* Bernard *et al* 1988; Galler 1988).

Beyond these considerations the design of the BHPS is naturally influenced by a number of the distinctive features and opportunities afforded by a longitudinal research design. First, research is focused on change at the level of the individual and the household rather than change at the population level. However, this type of longitudinal research may well use similar survey questions and variables to those used in cross-sectional surveys. Obviously the key issue is the need for questions to be targeted on characteristics, behaviour or values which are either expected to be the subject of change or are significant factors affecting the likelihood of change. Since panel studies allow an analysis of the same individuals over time, the questionnaire will allow the construction of continuous measures of, for example, income, employment histories and labour market participation, household structure and residential mobility over the life cycle. Such data are collected more reliably in panel surveys than in long-term retrospective history surveys (*cf* Janson 1990; Bailar 1989; Peters 1988; Menner 1979; Kulka 1978). Nevertheless it is, of course, necessary to collect some long-term retrospective data in the first few waves of the panel in order to understand initial conditions as well as to obtain some snapshot information on situations at the time of interview. Equally questions will be asked to compare expectations about change with change which is observed, as, for example, in the cases of occupational change and residential mobility.

These prolegomena provide the background against which design aspects of the BHPS need to be considered. In the following central part of this paper we consider some of the broader issues which have been at the forefront of the design of the BHPS and the way in which they relate to its more substantive concerns.

An Overview of the BHPS

In a paper of this kind it is obviously not possible to cover all aspects of panel design as they relate to the particularities of the BHPS. Rather we intend to discuss three common problems in panel design and the way they are handled within our Study. These problems are (1) changing populations; (2) non-sampling errors in panel surveys; and (3) sample design. In order to place our discussion in context, we first give an overview of the Study and discuss the substantive issues with which it deals.

The BHPS will involve a series of annual surveys beginning in 1991 and currently planned to continue until 1998. The Wave 1 survey will cover five thousand households drawn from across Great Britain.⁴ Each adult member in these households will be interviewed, yielding an initial sample size of approximately ten thousand individuals. Respondents will, of course, be re-interviewed at each successive wave and, if they split off from original households, all adult members of the new household they enter or form will also be interviewed.

The questionnaire for each respondent will last approximately forty five minutes. There will be an additional short self completion questionnaire as well as a ten minute household level questionnaire. Approximately three quarters of the individual questionnaire will constitute a core of questions to be repeated each year. The remaining quarter will form a variable component containing (a) core questions which need not be asked annually but will be repeated at least once; (b) new questions engendered by changing policy and research issues; and (c) questions to elicit retrospective data on panel members' life histories before first interview.

In addition to the main panel the BHPS will also conduct a pilot panel each year. This will contain four hundred and fifty households and approximately nine hundred individuals. It will be used to test both new questions and panel procedures, as well as providing a test bed for methodological experiments. The survey data will be collected and initially processed by a fieldwork/research agency. Interviews will be conducted face-to-face by traditional methods, although both telephone and proxy interviews will be allowed *in extremis*. The resulting data will be managed within a data base designed and maintained by

the BHPS using the SIR database management program. It is hoped that data will be deposited in the ESRC Data Archive within twelve months of each completed fieldwork period.

Substantive Focus

The Study concentrates on six substantive areas. These are household organization and dynamics; the labour market; housing and residential mobility; income and wealth; health; and socio-economic values.

The **Household Organisation and Dynamics** component includes not only the collection of basic demographic information, but also of information on the intra-household division of labour and on household economic organisation, in particular the control of money and access to consumption goods within the household. From a longitudinal perspective the basic information will permit new research on patterns and processes of household formation and dissolution, while the information on internal organisation can be related to other changes affecting the household, for example to analyze how changes in the work patterns or income of individual household members influence internal organisation.

The **Labour Market** component will be shaped by two main agenda. Firstly, it will be concerned to allow research focused on patterns of individual mobility, either by comparing jobs and labour market position at successive waves, or by analyzing the detailed work histories collected over the course of the panel. Such career patterns can clearly be related to other components of panel data, such as education, income, health or household organisation. To facilitate this type of analysis the panel will collect relatively detailed information on job characteristics, covering such issues as promotion within jobs, job security, training and fringe benefits. Secondly, it will be concerned with collecting data on how individual labour market participation decisions relate to the household context and thus, for example, to support economic research on household labour supply models as well as sociological research on married women's labour market participation. Hence it will be particularly concerned with collecting data on transitions.

The **Income and Wealth** component will provide data to be used in research for many of the other components, but more distinctively it will be concerned with income and wealth dynamics at the household level, related to other individual and household changes. In particular it can be used to develop research on transitions into and out of poverty, on life cycle models of income, on the relationships between income change and family composition change, and on lifetime patterns of wealth accumulation and savings. These priorities will imply a focus in the questionnaire on income levels over the year, and also, though not in early waves, on data on wealth and savings.

The **Housing** component will collect basic information on housing costs and conditions and other features of housing consumption, as well as data on perceptions of residential neighbourhoods and aspirations and intentions to move. This will have clear value for housing research as well as other research domains. More distinctively longitudinal concerns will be housing and tenure mobility and the accumulation of wealth through housing. The BHPS will be a particularly valuable research resource for the analysis of migration and migration decisions.

The **Health** component will be concerned with relating aspects of individuals' health and health related behaviour over time to other aspects of their situation and behaviour. This will involve collecting data which will allow both analysis of the impact of health and illness on other aspects of behaviour and of social explanations of health and illness. A particular focus will be on measures of psychological well-being, in order to explore how changes relate to life events. Data will also be collected on patterns of health service usage over time.

The focus on **Socio-Economic Values** within the BHPS will be largely related to the five domains outlined above. The aim will be to provide data which will allow an exploration of how value change is affected by changing individual and household situations; how values themselves can be seen to influence behaviour; and also how stable they appear to be over time. A more specific focus of the component will be on political values and on social participation.

Design Features

The BHPS will complement a number of the major datasets familiar to many British researchers. As far as possible the questionnaire is being designed in order to ensure comparability with these datasets but clearly it will have its own particular strengths. For example, a major focus of the design of the income section is to allow the construction of improved measures of annual income. As Duncan has noted, panel studies 'make it possible to collect a great deal of economic...information on a more or less continuous basis' (1989:19-20). This is in contrast to what is possible using cross-sections such as the Family Expenditure Survey (where income data is collected only for the last pay period) and, as already noted, panel data are necessary both for the analysis of lifetime earnings and for movements into and out of poverty. Similarly the BHPS will contain greater longitudinal depth of information on labour market mobility than the Labour Force Survey (LFS) can provide. Perhaps the closest model is the General Household Survey but here again the BHPS will provide unique information on change over time, as well as covering subjects not included in the GHS, such as intra-household decision making and socio-economic values. The extent of attitudinal data will be less than in the British Social Attitudes Survey (see, for example, Jowell and Witherspoon 1985) but the BHPS will allow analysis of how attitude and value change relates to life events and behaviour. The first wave of the BHPS will be at approximately the same time as the fifth wave of the National Child Development Study (see Fox and Fogelman 1990; Marsh 1988) and so there will be possibilities of comparative research based on the two datasets. The BHPS will also follow shortly after the Population Census, allowing the data to be related to a population baseline, while also allowing comparative work with data from the Office of Population Censuses and Surveys' (OPCS) Longitudinal Study (see Mills 1988).

Of course the range of topics in the BHPS means that on individual subjects the depth of coverage cannot be as great as it is in these other surveys. Equally, because the sample size is significantly smaller than the LFS and GHS, analysis of small population groups or of the smaller regions will not be possible. It is, however, intended to provide some information on the characteristics of the area of residence so that analysis of the impact of change in local contexts can be undertaken.

Design Issues

In the remainder of the paper we discuss certain key aspects of panel design and the way these have been interpreted on the BHPS. So far as the basic design of surveys across time is concerned, the literature points to several alternatives for repeated surveys of individuals (see, for example, Bailer 1989; Duncan and Kalton 1987). Amongst these are, first, the cohort survey, with selection according to shared initial conditions, such as the National Child Development Study (Marsh 1988) and the US National Longitudinal Studies of Labour Market Experience (Parnes 1981). Second, there is the rotating panel, in which a fraction of sample households is replaced at each wave, as in the case of the US Census Bureau's Current Population Survey (US Bureau of the Census 1978) and the Labour Force Survey (Manners 1990:2-3).⁵ Third is the split panel (with a repeated or rotating component) such as the British Social Attitudes Survey (Lievesley and Waterton 1985). Repeated cross-sectional surveys, such as the General Household Survey (Office of Population Censuses and Surveys 1981), form a fourth type of survey across time. Finally, there is the more classic type of panel survey consisting of a representative sample of individuals or units who are followed over a series of waves. This design needs to incorporate 'following rules' which allow for new members to enter the panel under specified circumstances. The latter provides the model for the BHPS and other European household panels and is derived from the design of PSID (see Duncan and Morgan 1983).

As Duncan and Kalton (1987) have argued, a panel survey of this type is particularly useful where the objectives include the measurement of various components of individual change (such as gross change at the element level between two time points or average individual change as in, say, earnings); or where researchers seek to aggregate data for individuals over time; or where the objective is to measure net change at the aggregate level. It was for these kinds of reason that the BHPS opted for this design. Nonetheless, once this basic design choice had been made, the problems inherent in the design had to be faced. In particular, three matters were of major concern. First, it was necessary to deal with changes in population composition over time. Second, there were the particular non-response problems and other sources of non-sampling error in panel surveys to be considered. Third, the design of the study needed to take account of the requirements of the different forms of

longitudinal analyses. In this latter context, the sample design of the BHPS has been particularly contested.

Changing Populations

Changing populations mandate clear following rules which define, first, which units are to be retained at each wave; second, which new units are to be added; and, third, which units, if any, should be dropped. The BHPS will follow all members of the original households it samples at Wave 1. It will then bring into the sample *and retain* at least some so-called non-sample individuals who become 'infected' by original sample members by virtue of sharing a household with them. Equally all children in (or subsequently born to members of) original households will become sample members when they reach the age of sixteen. Sample members who move to institutions will not be followed but proxy data will be obtained for them. However, if they return to the non-institutional population, they will once again be interviewed personally. Similarly those who emigrate will not be followed for interviews but will be tracked so that they can be interviewed again if they return to the mainland UK.

These rules are similar to those of PSID with the addition of the permanent inclusion in the panel of non-sample members whom PSID ceases to follow once they are no longer living with sample members (see Beckett *et al* 1988). Whilst this decision has cost implications in later years of the panel, there are sound theoretical reasons for following non-sample members to the extent that they provide a family and household context for original sample members and continue to have socio-economic links to them. The precise definition of this aspect of the following rules is still currently under review.

Of course, following rules of this kind do not take account of all the ways in which a population may change during the life of a panel. In particular there is no mechanism to cover new immigrants to the original population of interest. Thus, the BHPS panel contains procedures for maintaining a representative sample of the non-immigrant population only. At the same time, sample members will be lost as they enter institutions or emigrate, hence the importance of continuing to track such people in order that they are interviewed again

when this is feasible. However, with these exceptions, it will be possible, with an appropriate scheme of weights (see Kalton 1989:579-584) to take account of sample attrition, to maintain the BHPS as representative of the current British population through the life of the panel. Given that the initial sample will be an equal probability sample of the whole population, it will be possible to determine the selection probability of new entrants to the panel after the first wave, and hence possible to assign weights, and use these new entrants in analyses. The data provided by these new members also provide information necessary to understand the situation of those panel members with whom they still have socio-economic ties.

Finally, there are problems posed by changes in household structure during the life of a panel. Where an original panel household splits, as a result of, say, divorce, which is the 'longitudinal' household in the sense of being the same one as the original household? This problem is important from the viewpoint of attempts to use the household as the unit of analysis. Following similar work undertaken by the National Medical Care Utilization and Expenditure Survey (see Dicker and Casady 1982), the US Census Bureau endeavoured to define longitudinal households for its Survey of Income and Program Participation (McMillen and Herriot 1985; Citro *et al* 1986). However, the BHPS prefers to follow the PSID conception in this matter. Duncan and Hill (1985) argue that definitions of longitudinal households are both chimerical and unnecessary and we concur with this. Rather, one should use the individual as the basic unit of analysis and the household as the unit of measurement.

Non-sampling errors in panel surveys

Kalton *et al* (1989) have provided a detailed overview of this problem. As they note, there are two broad classes of non-sampling error in surveys. First, there are non-observation errors such as non-response and non-coverage errors. Second, there are measurement errors which include both response and processing errors. Here our comments on non-sampling errors will be restricted to the particular problems of panel surveys and hence will concentrate on non-response and panel conditioning.

Non-response is, of course, a problem for any social survey, not only because of its effects on sample size but also due to the possible introduction of bias into the results (see

Panel on Incomplete Data Vol 1, Chs. 2 and 3, 1983; *cf.* Bogestrom *et al* 1983). However, in panel surveys non-response can be a more severe problem since some attrition from the sample occurs at each wave. Hence its cumulative effect can be substantial for later waves (Kalton *et al* 1986; *cf.* Waterton and Lievesley 1987). Conventionally a distinction is made between unit non-response and item non-response (see, for example, Barnes 1991). The former refers to situations where there is no data for a sample member due to refusal or non-contact. The latter refers to missing data on some items where data should have been supplied by a respondent who otherwise has supplied responses, as when, for example, a respondent may have refused to answer a particular question or the interviewer might have skipped past a question which should have been asked.

However, there is a form of non-response which is unique to panel surveys - so-called wave non-response (see Lepkowski 1989; Scheuren 1989). Wave non-response occurs when data for a panel member are completely missing for at least one wave although present for one or more of the other waves. As Kalton and his colleagues observe, there is a tendency for wave non-response to increase with the age of a panel. This must, therefore, be countered in every way feasible in order to minimise its effects (see Farrington *et al* 1990; Murphy 1990; Capaldi and Patterson 1987; Freedman *et al* 1980). In general, non-response can be seen as a 'more complex problem (in panel surveys) as more information about non-respondents is available for use in non-response compensation procedures' (Kalton *et al* 1989:249). Each form of non-response, and the methods developed on the BHPS to counter it, is discussed below.

Unit non-response can arise either from respondents refusing to become members of the panel or from a failure to contact respondents who would be prepared to co-operate. Of course, both refusals and contact failures are normal in all surveys but special methods are required for dealing with them in panel surveys. Beyond standard survey procedures for limiting rates of refusal (see Barnes 1980 and 1991; Rao 1983; Thomas 1980), panel studies mandate extra calls-back and special efforts to gain the moral commitment of respondents while simultaneously appealing to their more material sides. Hence, the BHPS will attempt to ensure that potential respondents are made aware of the importance of the study and of their participation in it through such means as persuasion letters (see Clarke *et al* 1987; Finch 1981), leaflets and brochures (see Capaldi and Patterson 1987) as well as assurances of both

confidentiality and anonymity. However, respondents will also be rewarded for taking part in each wave.

This issue of respondent incentives has been discussed extensively by BHPS researchers with colleagues at OPCS, PSID, the US Census Bureau's Survey of Income and Program Participation (SIPP), the German Socio-Economic Panel and also at a seminar given by the authors of this paper at the Survey Research Center of the Institute of Social Research, University of Michigan. All the national panel studies we have consulted employ incentives (see, for example, Jean and McArthur 1987) and, of course, OPCS makes a payment in respect of their demanding Family Expenditure Survey (Barnes 1991 and 1987). The Centre has received the strongest possible advice that respondents must be rewarded as a part of the strategy for reducing attrition and as a recognition of their time and trouble in taking part in the panel. Moreover, evidence does exist that incentives do improve response rates in panel studies. For example, the Dutch socio-economic panel reported a 14% higher initial response and a 93% response on second wave compared to an 84% response from those not rewarded on first wave. The form of reward we shall employ for the main panel will be a gift voucher redeemable at a national chain store, although a charity payment on behalf of the respondent may be offered from Wave 2 as an alternative.⁶

Of course, it is not only the moral and material commitments of respondents which need to be considered but also those of the interviewers (see, for example, Barnes 1991; Capaldi and Patterson 1987). With this in mind the BHPS will pay particular attention to the training of interviewers and may pay bonuses to interviewers who are able to maintain high response rates. Since the motivation of interviewers also relates to problems of item non-response, we shall return to this point below. Finally, there is at least anecdotal evidence from the German Socio-Economic Panel and PSELL (the Luxembourg household panel study) that the use of the same interviewer for each wave is itself a factor in maintaining a respondent's commitment and, therefore, is conducive to high response rates. Thus, this practice will be encouraged in all possible circumstances.

Contact failures must be minimised in any panel survey, again because of the tendency for attrition to increase with the age of the panel. Tracing procedures must be devised and considerable resources need to be devoted to them (Farrington 1990; Burgess 1989; Jean and

McArthur 1987; Thornton *et al* 1982 and 1979; Call 1982; Clarridge *et al* 1978; McAllister *et al* 1973; Crider *et al* 1971). A number of such procedures will be employed on the BHPS. They include the collection of information concerning friends and relatives of respondents who would know of address changes; the return of change of address cards (for which payment will be made); and possibly the use (with respondents' prior permission) of national insurance records held by the Department of Social Security.

Item non-response is perhaps a less severe problem unless it is either systematic and/or related to a subsequent propensity to refuse to take part in future waves. With this proviso, item non-response can be treated as a problem common to all surveys except that panel analysts need to take account of responses at other waves in order to counter its effects in analysis via the process of imputation (see Little and Su 1989). In the BHPS there has been some concern over the level to which item non-response might rise in respect of income. Not only is income a sensitive area, and, therefore, one where questions might have high levels of non-response, but also it is an area where respondents may genuinely find it difficult to give accurate responses. Precisely because income is a sensitive subject, there may also be a tendency for interviewers to feel uncomfortable about asking income questions as well as for respondents to refuse to participate in future waves because of their dislike of being asked these questions. In order to counteract these problems the BHPS will attempt to use the experience of OPCS in the training of interviewers for the purpose of collecting reliable income data. It might also be necessary to reward interviewers who are successful in obtaining such data. For respondents it will be necessary to explain why these data are needed, the confidential basis on which income data are supplied and to try to persuade them to keep records - such as pay slips and income tax records - which would be useful to researchers. Again it might be possible to gear respondent payments towards this aim.

Depending on the circumstances, complete **wave non-response** may be avoidable in some cases via the collection of proxy data, a practice which the BHPS intends to use as a last resort. However, there will always be some non-response of this type and so measures need to be devised to reduce its impact. Discussion of this problem inevitably leads to the issue of the compensatory strategies which can be employed, some of which are equally relevant whatever the form of non-response.

There are three basic compensatory strategies which the BHPS will use to counter the effects of non-response. Firstly, weights based on respondent characteristics will be adjusted to take account of unit and wave non-response (see, for example, Lock Oh and Scheuren 1983). Of course, there will be much greater information on which to base this for those who fail to respond after the first wave. This leads to the second strategy, the intensive investigation of possible non-response bias by, for example, comparing the responses of continuing respondents with those of non-respondents for questions asked of each group in earlier waves (see Lievesley and Waterton 1985; Hausman and Wise 1979 and 1977). Finally, imputation will almost certainly be necessary in the case of item non-response (see Kalton 1987 and 1986; Ford 1983; Herzog and Rubin 1983; Platek and Gray 1983). As usual it is easier to state the means for countering non-response than it is to achieve it in practice (cf. Rubin 1983). In principle we are clear that all these methods will need to be employed on the BHPS; in practice it is too soon to say what precise methods will be used, although active consideration is being given to the problems.

Wave non-response raises particular difficulties in relation to these compensatory strategies. While weighting is commonly used to compensate for unit non-response and imputation for item non-response, the precise form of compensation for wave non-response is debatable, as Duncan and Kalton (1987) have noted. Nonetheless, progress is being made in this area (see, for example, Lepkowski 1989; Scheuren 1989; Singh and Petroni 1988; Samuhel and Huggins 1985). While there can be no definitive strategy for dealing with wave non-response, some issues are clear. The precise techniques to be employed depend on the purpose and types of missing data. For 'stable' categorical variables missing waves can be well predicted from other wave values and imputation by a cross-wave 'carry-over' procedure is then adequate. However, for continuous variables this method fails to track net changes over time and underestimates gross change, rendering longitudinal imputation a preferable technique (see Heeringa and Lepkowski 1987; Kobilarcik and Singh 1986).

Success at countering non-response, and avoiding the consequent need for too much expenditure of effort on bias checks, weighting and imputation, by no means resolves the problem of response errors in panel surveys. One of the ironies of panel studies is that they give rise to particular response problems which are the inverse of their non-response problems and a further potential source of error and bias. That is, respondents who are successfully

contacted and interviewed from wave to wave may become atypical of the population they represent by virtue of their panel membership and consequent repeated exposure to its questionnaire stimuli. This is the problem of **panel conditioning**, 'the situation when repeated questioning of panel members affects their survey responses, either by changing the behaviour being reported or by changing the quality of the responses given' (Kalton *et al* 1989:249-250).

A number of studies have been made of panel conditioning (for example, Waterton and Lievesley 1989; Corder and Horvitz 1989; Silberstein and Jacobs 1989; Lievesley and Waterton 1985; Traugott and Katosh 1979; Sudman and Bradburn 1974; and *cf* Bailar 1989; Holt 1989; O'Muircheartaigh 1989; Kalton *et al* 1986) which provide evidence concerning the existence of the effect. In principle it is possible to examine the problem through the use of rotating designs. With this (and other considerations) in mind, the BHPS pilot panel has a rotating design. This panel will therefore be used to check for conditioning effects and as an aid to such procedures on the main panel. Equally, the practice of replicating General Household Survey questions and undertaking comparisons between GHS and BHPS data should help analysts in their search for conditioning effects. We take further comfort from the comments of Duncan and Kalton to the effect that 'economic behaviour such as work effort, saving, commuting and home ownership are all unlikely to be affected by responses to occasional interviews' (1987:109). Sudman and Ferber (1979) reached similar conclusions while Duncan (1989) has suggested that panel studies can **increase** data quality.

More generally, measurement error on estimates and parameters from panel data have received some attention in the literature although many problems remain (see Groves 1989). There have been few studies which have attempted to assess measurement error (but see Bound *et al* 1989; and Duncan and Mathiowetz 1985) but what evidence there is suggests that it does have some significant effects, particularly where such errors occur in explanatory variables in regression models (Rodgers and Herzog 1988). Measurement error will be addressed in a number of ways on the BHPS. First, in pre-test and pilot work, techniques developed by Cannell and his colleagues (1989, 1981, 1979; and *cf* Belson 1981; Sykes and Morton-Williams 1984) are being employed to identify problems leading to unreliable and invalid survey data. These include behaviour coding of interviews, interviewer rating of questions and special probes at the end of interviews. Second, the pilot panel will be used

for a variety of purposes relating to measurement error, including various context effects and interviewer variability. Techniques of multi-trait multi-method tests will be explored as a way of examining construct validity (*cf* Andrews 1984).

Sample Design

The sample design of the BHPS has been the subject of much discussion.⁷ While there are many ways in which the design of a panel survey interacts with features of panel data analysis, one issue has so far dominated all others on the BHPS - the relationship between sample design and the requirements of certain longitudinal models. Increasing attention has recently been paid to the effect of sample designs on the complexity of longitudinal models (see, for example, Pickles and Davies 1987). For this reason the sample design of the BHPS has stimulated much debate over the appropriateness of multi-stage sample designs for panel surveys (Davies 1989; Holt *et al* 1989; Hedges 1989). This debate raised a number of important issues concerning the relationship between panel analysis and sample design. In particular, there were calls from some econometricians and statisticians for the BHPS to use a simple random sample design in order to satisfy the assumptions of certain statistical modelling techniques, rather than employing the commonly used complex sample design with stratification and clustering.

The objections raised to stratification of the sample relate to the familiar problem of stratifying variables which might become endogenous in some future analysis, thus leading to bias. Holt *et al* (1989) have argued that the introduction of proportionate stratification into the sample design would be acceptable. For the great majority of analyses stratification is of significant benefit in increasing the precision of estimates for the population. The BHPS has therefore adopted a relatively complex stratification scheme involving region and neighbourhood characteristics related to social status and household characteristics. Clustering of the sample, it has been suggested, raises a different but potentially more intractable set of problems since it substantially affects estimates of standard errors and model testing generally and, it is claimed, these problems are particularly intractable in a longitudinal study. Since this issue has caused so much comment, it is worth some elaboration.

While clustering has a number of advantages it is basically used to reduce fieldwork costs. However, there have been some claims that clustering introduces unpredictable and unquantifiable bias into the parameter estimates of longitudinal models (see Davies 1987; Chambless and Boyle 1985). It has also been argued that the dispersion of clusters over time will pose further difficulties in the modelling of panel data which will offset clustering's initial cost advantage, since the design effect of the clustering will become indeterminate (see, for example, Davies 1989). While it is true that costs will tend to increase as clusters disperse, the resulting analytic problems can be handled by techniques developed from the literature on job-matching (see, for example, Altonji and Shakotko 1987). Notwithstanding the views of Davies and others on the problems of clustered sample designs, it has also been argued that to design the sample in order to privilege one form of modelling would be a mistake. As Holt *et al* (1989:3) have noted "if cluster sampling were foregone in order to allow some analysts to use the likelihood ratio tests with which they are familiar, the reduction in sample size implied by a fixed budget constraint would render almost all other types of statistical analysis less powerful". This point is emphasised by Hedges (1989) who has estimated that BHPS fieldwork costs would increase by at least 40% without the use of clustering. Hence, given a fixed budget, it would be necessary to reduce the sample size from five thousand to three thousand households in order to accommodate a simple random sample design. Moreover, the problem faced by the BHPS in this area is not simply one of cost.

The basic research design introduces clustering in a number of ways. First, all individuals in each sampled household are to be interviewed, so that there will be household clustering of individuals in any individual based analysis. Second, there will be the normal interviewer clustering effects. Even if the first of these problems were to be avoided, the second is inescapable in the real world of surveys. Hence, while the BHPS researchers acknowledge the issues raised by Davies and others, we are more persuaded by the arguments of those advisers who counsel that in this case the problems of the design should drive the work of modellers rather than the problems of certain models driving the design (see Coxon and Corti 1991; *cf* Heady 1991; Skinner *et al* 1989; O'Muircheartaigh 1977; Bebbington and Smith 1977).

While the discussions and debates over sample design have been the main arena in which issues of longitudinal analysis have been discussed on the BHPS, efforts are being

made to incorporate the requirements of relevant models into the design of the survey. For instance, there is ongoing development work associated with the production of an annual calendar in order to produce data which can be analyzed using event history techniques (see, for example, Freedman *et al* 1988). Among the experiments relating to calendars as an aid to recall, the BHPS is testing various cuing strategies, including visual aids. More generally, we agree with Campbell's observation that while there needs to be a 'fit between the substantive concerns of the researcher and the analysis mode he or she will choose...in the vast majority of longitudinal studies no one is in a position to answer those questions...(hence) it seems obvious that the best measurement approach is to provide retrospective reports and dated transitions with snapshot evaluations of psychological variables and other measures not subject to recall' (1988:62). This is certainly how the BHPS questionnaire has been designed. However, it should not be thought that the BHPS takes a Panglossian view of the links between design and analysis. Work continues in this area based on the insights of experienced analysts of panel data concerning the problems which such data pose (for example, Hagenaars 1990; Mayer and Huinink 1990; Smith and Holt 1989; Skinner *et al* 1989; various authors in Kasprzyk *et al* 1989; van der Pol 1989; Uncles 1988; Crouchley 1987; Duncan and Kalton 1987; Mayer and Tuma 1987; Hsiao 1986; Plewis 1985; Tuma and Hannan 1984; Rogosa 1979). In addition, one of the Centre's Research Associates has recently completed a review of methods and models in the analysis of panel data (see Kemp 1991).

Conclusion

Since work is continuing on the design of the BHPS, there can be no final conclusion to this paper. Indeed, the real proof of whether the design decisions made by the BHPS have been sensible ones will not emerge for a considerable time. An exhaustive review of the literature on panel design has been conducted by BHPS researchers and wide-ranging consultations with panel researchers in the UK and overseas have been undertaken. In principle we believe that the resulting design, a part of which is briefly described in this paper, is optimal, given the wide-ranging purposes to which the BHPS is to be put. However, to adapt an idiom of a respected colleague (Benton 1977:xi) this Study, like

any other, is a social product. If it fails to solve the many intractable design problems with which it is presented, we do not see why we should be held exclusively to blame.

Notes

1. A further overview paper on the design of the BHPS is in preparation. The authors are most grateful to Graham Kalton for detailed comments on an earlier draft of this paper.
2. For a more detailed discussion of the role of the Centre and substantive aspects of its work see Rose *et al* (1991). For general discussions of the use of panel data in economics see Solon (1989) and Duncan *et al* (1987).
3. Researchers on these studies are now undertaking collaborative work within the European Science Foundation Scientific Network on Household Panel Studies (see Schaber 1990). The Network includes researchers from household panels in the following countries: Belgium; France; Germany; Great Britain; Greece; Hungary; Ireland; Luxembourg; the Netherlands; Spain; and the USA. Further details on the Network may be obtained from the Network's Secretary, David Rose, ESRC Research Centre on Micro-social Change in Britain. Expressions of interest from those who would like to attend meetings organised by the Network would be welcome.
4. The Highlands and Islands of Scotland are excluded for cost reasons. It is hoped that there will be a separate sample in Northern Ireland.
5. As we note in a later section of this paper, the BHPS will use a rotating design for its pilot panel.
6. In the first BHPS pilot half of the respondents were given a gift voucher redeemable at a national chain store. Analysis of this split ballot suggests that those offered incentives were more likely to respond. However, there were confounding factors related to the quality of interviewers which make it impossible to conclude with any certainty that it was, in fact, the incentives which had the desired response effect. The same form of incentive has been used for all respondents in the second pilot.
7. The sample as a whole will be drawn from the Postcode Address File (PAF) with sampled addresses constantly distributed across 250 PSUs. The choice of the PAF rather than the electoral registers for our sampling frame has also

been widely discussed. This issue has been examined in detail by Wilson and Elliot (1987) and we accept their view that the PAF gives better coverage of addresses than alternative frames whilst containing less sources of bias. The debates on sample design for the BHPS are discussed more extensively in Coxon and Corti (1991). For general discussions of sampling in longitudinal surveys, see Bergman and Magnusson (1990) and Lillard (1989).

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DESIGN ISSUES IN THE BRITISH HOUSEHOLD PANEL STUDY

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