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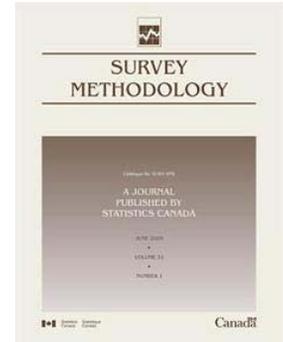
Utilising longitudinally linked data from the British Labour Force Survey

Pam F. Tate [1]

Abstract

The British Labour Force Survey (LFS) uses a rotating sample design, with each sample household retained for five consecutive quarters. Linking together the information on the same persons across quarters produces a potentially very rich source of longitudinal data. There are however serious risks of distortion in the results from such longitudinal linking, mainly arising from sample attrition, and from response errors, which can produce spurious flows between economic activity states. This paper describes the initial results of investigations by the Office for National Statistics (ONS) into the nature and extent of the problems.

Key Words: Longitudinal data; Labour Force Survey; Economic activity; Attrition bias; Response error.

1. Introduction

The British Labour Force Survey (LFS) is a household survey, gathering information on a wide range of labour force characteristics and related topics. Since 1992 it has been conducted on a quarterly basis, with each sample household retained for five consecutive quarters, and a fifth of the sample replaced each quarter.

The survey is designed to produce cross-sectional data, but in recent years it has been recognised that linking together data on each individual across quarters could produce a rich source of longitudinal data, the uses of which include estimation of labour force gross flows.

The process of linking information on the same individual from different quarters in the LFS is relatively straightforward. However, there are methodological problems which pose serious risks of distortion in the results from this new, hitherto untested use of LFS data. Similar problems have been identified in other countries' labour force surveys, but there are as yet no generally accepted methods of dealing with them. The Office for National Statistics (ONS) has therefore undertaken a programme of work to address this issue.

This paper describes the results so far of investigations into the nature and extent of the problems, and the proposed methods of dealing with them. The issues fall into two main groups: biases arising from sample attrition and related factors; and biases arising from response errors, particularly their effects in producing spurious flows between economic activity states. These are considered in turn.

2. Sample attrition and its biasing effects

Some sample members are lost at the initial stage, because of nonresponse to the first interview, either because it has not been possible for them to be contacted during the narrow time window available, or because they have refused to be interviewed. After that, further sample members are lost from each successive quarterly interview round, either because they have moved house (the basic sampling unit for this survey being the dwelling), or because it proves impossible to contact them or they refuse to continue. All these groups of people are, in different ways, atypical of the population as a whole, so their loss from the sample can introduce biases.

Some of these biases are compensated for in the course of applying the normal LFS weighting procedure, which produces population level estimates which are consistent with census-based control totals by sex, age group and region. This process will compensate for biases arising, at all stages of the survey, from differential attrition by sex, age and region. However, biases in other characteristics which are not themselves used in the weighting procedure will not be compensated for (and may even be increased) in that process, except when they are related to age, sex or region, in such a way that the bias is caused entirely by the under- or over-representation of particular age, sex or region categories.

Work on this subject therefore looked first at what characteristics are more or less represented in the LFS sample than the whole population, and in different waves of the LFS sample. (Each quarter, the sample is made up of five waves, the people in the first wave having their first interview, those in the second wave their second interview, and so on.) It then examined whether and to what extent these characteristics are related to each other, and whether it is possible to define a set of variables which characterise those people who are likely to be under-represented.

3. Characteristics of non-respondents

Analysis of the proportions which could not be linked to the next quarter, by wave, for key demographic and

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economic variables (Table 1 gives an illustration for broad age/sex groups), showed that, consistently across all waves, there is a greater propensity to be under-represented for young people aged 18 to 29 (and especially 18 to 24), single people, those living in London, people in rented accommodation (especially privately rented), the unemployed, and those in temporary employment. Most of these characteristics have also been found (by Foster 1994 in a study which linked data from the 1991 Census with non-responding LFS sample households) to be associated with high nonresponse at the first interview, particularly young adults, single people, one person households, and those living in London.

Table 1
Percentage of unlinked cases by sex and age group by wave

Variable & category	Unlinked percentage	
	Wave 1	Wave 4
All persons	8.6	4.8
AGE & SEX		
Male	8.6	4.9
15-17	6.8	4.9
18-29	13.8	10.2
30-44	6.8	4.1
45-64	7.2	2.5
Female	8.7	4.7
15-17	5.9	3.0
18-29	13.9	10.9
30-44	6.3	2.8
45-59	7.5	2.2

Note: More detailed analyses are available from the author.

Several of the characteristics of those who are lost to the sample appear likely to be related, and this was investigated in the first instance using logistic regression. The variables identified as being independently associated with whether the cases were lost from the sample, were found to be largely consistent for the four waves. In each case they included age group, marital status, tenure, (*i.e.*, whether the accommodation was owned, rented from a private landlord, or rented from a local authority or housing association), qualification level, and a combined economic activity variable incorporating broad economic activity (employed, unemployed or inactive), and, for the employed, employment status, part-time/full-time and temporary/permanent. Region was found to be independently associated in only two of the four waves, and sex in none.

For the five variables consistently appearing for all waves, there was a good degree of consistency concerning which categories were associated with sample attrition. Table 2 gives the multiplying factors for the odds ratio for all categories with a consistent association with increasing attrition. Being in the younger age groups, between 18 and

29 (and especially 18 to 24), has a particularly strong effect, as does being in privately rented accommodation. Being single (*i.e.*, never married and not cohabiting) has a moderate association. There are no consistent associations with particular categories of economic activity or qualification level, except for a slight one with full-time, temporary employees. The effect of region is not consistent even for the two waves in which it appears.

Table 2
Multiplying factors for odds ratios -
categories associated with high attrition

Variable	Category	Multiplying factor for odds ratio			
		Wave 1	Wave 2	Wave 3	Wave 4
Age Group	18-19	1.89	2.56	2.86	1.92
	20-24	1.79	2.08	2.10	2.83
	25-29	1.17	1.30	1.44	1.55
Tenure	Privately rented	2.12	1.52	1.86	2.29
Marital Status	Single	1.25	(1.12)	1.27	1.49
Economic activity/status	Employee, full time, temp	(1.12)	(1.36)	(1.13)	1.75

Note: ( ) indicates coefficient is not significant at 5% level.

The logistic regression analysis performed did not allow for interactions between the variables, and to investigate this possibility a further analysis was performed, using the CHAID module of SPSS to produce a segmentation of the data set into groups which have as great a variation as possible with respect to the proportion of unlinked cases. The results of this were however very similar to those of the logistic regression analysis. Overall, the main characteristics independently associated with a high proportion of sample loss were the younger adult age groups (18 to 29, especially 18 to 24) and living in privately rented accommodation, with some relatively minor additional effects of being in temporary employment for the youngest age groups. Separate analyses of the characteristics of those sample members who had been lost through moving away, and those lost through non-contact (or, more rarely, refusal) produced similar results.

4. Compensating for attrition bias

The analysis so far has been directed at the biasing effect of sample attrition on the cross-sectional characteristics of the longitudinal sample, and has identified the characteristics independently associated with greater nonresponse. A possible approach to compensating for the bias arising from this is to incorporate tenure as well as age into the

weighting procedure for the longitudinal data. This is being explored, using a calibration approach with CALMAR software, and including prior weights derived from the work described above to compensate for differential nonresponse by tenure.

However, there may be a problem which would limit the effectiveness of this approach. The propensity to not respond may be directly dependent on the unobserved labour force status of the individual, and possibly independently of their observed characteristics. Non-response of this kind is an example of non-ignorable non-response (Rubin 1976), and its presence would imply that estimates of the important measures of labour force gross flows would be biased even after the application of a weighting process of the type being explored.

There are two indirect approaches which give some indication of whether non-ignorable nonresponse might be a problem for longitudinal LFS data. One is to investigate whether the proportion of the gross flows in the sample which are transitions between different economic activity states systematically decrease (or increase) from wave 1-2 to wave 4-5; if so, this would suggest that people changing from one state to another are more (or less) likely to be non-respondents than those in a stable state. However, Table 3 shows that there is no consistent systematic pattern across waves - though this does not exclude the possibility of other patterns of differential nonresponse by labour force flows category.

Table 3
Percentage of transitions between different economic activity states by wave for pairs of adjacent quarters

Data Set	Percentages			
	Wave 1-2	Wave 2-3	Wave 3-4	Wave 4-5
Summer/autumn 1995	8.0	7.3	7.3	7.1
Autumn 1995/ winter 1995-1996	7.2	6.7	6.5	6.5
Summer/autumn 1996	7.6	7.0	7.3	7.5
Autumn 1996/ winter 1996-1997	6.8	6.5	6.2	6.5

Another possibility is that people moving addresses (and thereby lost to the LFS sample) may have a different pattern of labour force flows than the rest of the population. We do not have any information on the people who have moved away, but we do know something about the people who have moved into the sample addresses from elsewhere. These movers-in can reasonably be taken to represent the movers-out, since they are equally samples from the same population of movers (ignoring the possible effects of the small proportion of international moves). Table 4 shows the distribution of the linked sample (all adults whose records

were able to be matched) and of the identifiable movers-in for a pair of adjacent quarters in 1995. (It should however be noted that the flows categories are not strictly comparable, since the previous economic activity state for the movers-in is obtained by retrospective reporting.) It is clear that the sample of movers does differ, with a lower proportion in stable inactivity, and a higher proportion in all the other flows categories, and in particular a greater proportion of people changing their economic activity state; but that the movers make up such a small proportion overall that the effect on the whole sample is negligible.

Table 4
Gross flows for movers - in compared with linked sample

Activity states	Linked sample (%)	Movers-in (%)	Linked + movers (%)
EE	55.1	56.9	55.1
EU	0.8	1.5	0.8
EN	1.1	1.6	1.1
UE	1.0	1.7	1.0
UU	2.9	6.5	3.0
UN	0.7	1.1	0.7
NE	1.2	2.5	1.3
NU	1.0	2.3	1.1
NN	36.2	26.0	35.9
All transitions	5.9	10.6	6.0
TOTAL (no.)	80,664	1,790	82,454

Note: E represents in employment
U represents ILO unemployed
N represents economically inactive

hence EE represents in employment at both quarters
EU represents in employment then ILO unemployed *etc*.

These indirect approaches do not indicate any very strong effect of non-ignorable nonresponse, but they do not rule it out. This possibility is therefore being investigated by work involving the modelling of nonresponse in the LFS.

5. Response error and its biasing effects

All surveys in general, and household surveys in particular, are subject to response error, when the information given by the respondent is not an accurate reflection of the actuality. This may occur for a variety of reasons - the respondent may misunderstand the question; the interviewer may misunderstand or misrecord the response; the respondent may not know or remember the correct answer; or the respondent may knowingly give an incorrect answer for reasons of embarrassment, prestige, fear of breach of confidentiality or a wish to give the "expected" answer.

In the field of labour force surveys it has generally been found (for an overview see Lemaître 1994) that, for cross-sectional data, there is no particular tendency for the errors to be systematic, so that on average they tend to cancel out. However, for longitudinal data produced by linking together data collected on the same person at different points in time, this cancellation may not occur.

In particular, this is likely to be the case for data on gross flows between economic activity states. The numbers of people who move from one state (in employment, unemployed, economically inactive) to another during the relatively short period usually considered (a month, a quarter, or perhaps a year) are small compared with the numbers of people who remain in the same state. A response error at one point of time is much more likely to lead to an apparent change of state when the true situation is one of stability, than the reverse. Thus response errors are likely to have a very disproportionate effect in upwardly biasing flows between reported states. In the LFS, they may arise from the use of proxy respondents, where one person answers questions on behalf of someone else in the same household; and from respondent errors. We will consider these in turn.

6. The effect of proxy respondents

To investigate the effect of proxy respondents, we need to look at the distribution of activity states at the two quarters according to whether the first quarter's interview was in person or by proxy, and whether the second quarter's interview was in person or by proxy. Very young adults under 20 are both exceptionally likely to be represented by proxies and also likely to be particularly volatile in terms of their economic activity category, and so may distort any relationship between these two factors. Table 5 therefore shows the distribution of activity states at the two quarters, for men aged 20 to 64 and women aged 20 to 59. There is a higher proportion of transitions for personal followed by proxy interviews than for personal at both quarters, but proxy followed by personal interviews show only a very slightly higher proportion than personal at both quarters. Thus switching between proxy and personal interviews does not show a consistently greater proportion of transitions. Cases with both interviews by proxy have the lowest proportion of transitions of all, and the inclusion of these brings the overall proportion to a level consistent with that for personal interviews at both quarters. Thus there do appear to be differences between the various combinations of interview types, which merit further investigation, but in the LFS the use of proxy respondents does not of itself produce an exaggerated estimate of gross flows.

Table 5

Percentage of transitions by interview type

Interview type	Men (20-64)		Women (20-59)	
	Sample no.	% trans.	Sample no.	% trans.
Personal/personal	14,527	5.2	19,582	7.3
Personal/proxy	2,044	7.0	1,597	8.3
Proxy/personal	2,214	5.4	1,632	7.6
Proxy/proxy	8,602	4.7	4,206	5.4
All	27,387	5.2	27,017	7.1

7. Respondent errors

By their nature, respondent errors are impossible to identify directly, (except perhaps by re-interview, and even then there may be doubt about what is the correct answer). It is however sometimes possible to identify internal inconsistencies in the survey data, which may indicate response error. In the LFS, respondents who are in employment, and respondents who are unemployed, are asked how long they have been in that state. If the period is greater than three months, but they stated in the previous quarter that they were in a different state, there is an inconsistency which may indicate a false transition between economic activity states.

Table 6 shows the percentage of inconsistencies for various kinds of transitions - these are high throughout. Transitions from economic inactivity produce the highest percentages, especially when the transition is into unemployment. (There are no large or consistent differences between the different subcategories of the inactive.) Separating those in employment into part-time and full-time shows that there is a consistent pattern of a greater proportion of inconsistencies for part time employment, and similar but less pronounced results were found for the self-employed.

Table 6

Percentage of inconsistencies by transition type

Transition Type	Percentage of inconsistencies		
	All (%)	Full time (%)	Part time (%)
Unempl. to Employment	8.7	7.8	12.2
Inactive to Employment	26.2	18.1	30.4
Employment to Unemployment	18.7	14.7	23.3
Inactive to Unemployment	49.5		
All	23.9		

It is possible that the inconsistencies may have arisen through errors in the reported length of time in the economic activity state at the second quarter, rather than in the initial state at the first quarter. The distribution of the length of time does not however show heaping at around four to five months (as would be expected in the case of errors in the duration data). Also, the duration data reported in consecutive quarters for people in a stable state were found to be very consistent. These findings tend to suggest, though the evidence is indirect and by no means conclusive, that the errors are more likely to be in the reporting of economic activity at one or other of the interviews. This is not the only possibility - for example, it may be that some respondents have correct transition data, but incorrect duration data through using an interpretation of their past economic activity which is not consistent with the standard definitions applied to the reporting of their current state - but the findings so far suggest that it is likely to be the most common.

Some light on which of the inconsistent categories is correct may emerge by looking at the pattern of responses over three interviews. Table 7 shows the proportions of each group of inconsistent transitions from one quarter to the next which are followed by each economic activity category in the third quarter. (All relevant waves are combined in order to obtain reasonable sample sizes.) It is clear that of the transitions into employment in the second quarter, the great majority remain in that category in the third quarter. The transitions into unemployment show a much more mixed pattern, with a little over half remaining in unemployment, but a substantial group of about 30 to 40 per cent reverting to the state reported in the first quarter. It is noteworthy that scarcely any of the transitions from the second to the third quarter for this group were found to have a repeated inconsistency between the transition and the reported duration data. The results so far suggest that, in the case of an inconsistent transition into employment, that is likely to be the correct state, but more investigation is needed to achieve further clarification.

Table 7
Percentages of inconsistent transitions
by economic activity at following quarter

Transition type	Total inconsistent	Activity state in next quarter		
		Employed (%)	Unempl. (%)	Inactive (%)
Unempl. to Employment	60	90	7	3
Inactive to Employment	159	79	4	17
Employment to Unempl.	87	39	53	8
Inactive to Unempl.	229	17	55	28

8. Adjusting for response error bias

It is clear from the above that there is likely to be a substantial level of response error affecting the raw data on gross flows. Work on adjusting for such errors has so far been largely confined to the USA and Canada. A review of three methods proposed for USA data is given by Flaim and Hogue (1985), and a later proposal for Canadian data is given in Singh and Rao (1995), but to date, to the author's knowledge no official adjusted gross flows data are being published, though several countries are publishing unadjusted data while drawing attention to their limitations. The adjustment methods so far proposed all rely on assumptions about the nature of the errors which seem unlikely to be met in practice - either full independence of the classification errors or very limited departures from that assumption. (See Lemaitre 1994 for a review of problems with these adjustment methods.)

It seems worthwhile to explore different routes to the development of methods of adjustment or compensation for response error bias. As a first stage, work is continuing on the investigation of the characteristics and circumstances of cases of inconsistency, and of other possible ways of identifying false transitions. It is also proposed to investigate the circumstances of people giving inconsistent responses of the kind analysed above, by means of more detailed follow-up interviews. This should provide better indications of the extent to which the inconsistencies do represent response error, and may provide results useful for both reducing, and adjusting for, response error. Both these strands will provide inputs to a third element of the forward programme, in which it is proposed to develop models of classification error in reporting economic activity.

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