End of Award Report

Multilevel Multiprocess Models for Partnership and Childbearing Event Histories

1. Background

Event history data provide a longitudinal record of the timing of events such as partnership formation and dissolution, births, and changes in employment and housing. Typically outcomes of one process will influence the occurrence of events in another process. For example the presence of children, who constitute prior outcomes of the fertility process, is often found to be negatively associated with the risk of union dissolution. Previous researchers have explored the relationship between childbearing and dissolution by including the number of children as a covariate in a model for dissolution. This approach, however, ignores the possibility that decisions about childbearing and partnerships are subject to shared influences, some of which will be unobserved. In other words, fertility outcomes may be endogenous with respect to partnership transitions. Lillard and Waite (1993)[1] developed a simultaneous equations model to allow for the joint determination of marital stability and fertility in the US. Using this approach they found that some women were more likely than others to have unstable marriages (due to unmeasured time-invariant characteristics), and that such women were less likely to have children during marriage. Failure to take into account the simultaneity between processes led to biased estimates of the effects of having children on partnership transitions.

The aim of our project was to extend the work of Lillard and Waite to include both cohabiting and marital partnerships. The introduction of cohabitation adds complexity in two ways. First, we must now consider transitions from two partnership 'states', marriage and cohabitation, instead of one. Second, there are two possible transitions from cohabitation: separation or marriage (to the same partner), which can be viewed as 'competing risks'. We therefore developed a general model for the analysis of event history data, where there are correlated histories, multiple states and competing risks. Like Lillard and Waite, we also allow for the fact that some individuals will have more than one partner or birth over the observation period, and that the durations between repeated events may be correlated.

Our research contributes to the family demography literature in several ways. As noted above, we use a simultaneous equations model to adjust for selection on unobservables in estimating the effects of the presence of children on partnership transitions. We use a similar approach to model jointly the formation and dissolution of partnerships, which allows for selection when estimating the effects of previous partnership dissolution on future transitions. A second advance on previous research is our use of a multistate model to distinguish between marriage and cohabitation, while allowing for the effects of shared unobserved risk factors on transitions from each type of union. Finally, while most studies of partnership formation and dissolution focus on the first partnership, we consider all partnerships that began before age 42 for NCDS women, and age 30 for BCS70. Joint modelling of repeated

[1] Lillard, L. and Waite, L. (1993) "A joint model of marital childbearing and marital disruption", *Demography*, 30: 653-681.

transitions allows us to explore the effects of previous cohabitation and marriage on the formation and dissolution of future partnerships.

The substantive focus of this research project was the link between partnership transitions and childbearing. The same methods could be applied to study the interrelationship between any event history processes. For example, employment and childbearing decisions are likely to be jointly determined, as are decisions about employment and housing.

2. Objectives

The aims and objectives set out in the original proposal were pursued as follows:

(i) To develop methods for the analysis of event history data, where there are correlated histories, repeated events, multiple states and competing risks.

Steele et al. (2004)[2] developed a discrete-time event history model for handling repeated events, multiple states and competing risks. In that paper (completed under the current project) they show how this general model can be framed as a multilevel model for a mixture of binary and multinomial responses. Their approach was extended to incorporate correlated histories in Steele et al. (2005a). Further details are given in Section 3 of this report.

(ii) To provide macros/syntax for implementing the methodology in existing software.

A major advantage of the methods developed under the project is that they may be implemented in existing software. After structuring the data into a discrete-time, multivariate format, methods for analyzing multilevel binary and multinomial responses may be used. The required data format for estimation in MLwiN is described, with an example, in Steele et al. (2004, 2005a). Macros for setting up the data and model are provided among the workshop training materials. All of these materials are freely downloadable from the project web-site.

We had originally proposed to use aML in addition to MLwiN so that continuous-time and discrete-time methods could be compared. At an early stage in the project, we decided to focus on discrete-time methods as these are more flexible and can be estimated using existing procedures for discrete response data. We also felt that MLwiN was more flexible and user-friendly for fitting these models. However, an example of aML syntax for fitting continuous-time multiprocess models, with an example dataset, is provided on our web-site. Steele (2004) has also conducted an extensive review of the multilevel modelling capabilities of aML, which is available for download from the Software Review section of the Centre for Multilevel Modelling web-site. Further details of software are given in Section 3.

(iii) To apply these methods in a study of the interrelationships between transitions from cohabitation and marriage, and childbearing in Britain.

[2] All references are given in Section 6.

The methods developed in Steele et al. (2004, 2005a) have been implemented in three empirical studies, which are described in Section 4. These differ in two ways from the analyses anticipated in the proposal. First, we had planned to fit a full structural model which allowed estimation of not only the effects of childbearing outcomes on partnership stability, but also the effects of partnership stability on the probability of a birth. Although methods were developed to estimate this type of model, we were unable to apply them in practice because we could not find suitable instrumental variables. Full details on estimation of this model with discussion of the problems in its implementation are given in a research note (Steele 2005) which is available from the web-site. The model is also discussed in Steele et al. (2005a). The second change from the proposal was to restrict our analysis to women. A note, justifying this decision, was sent to the ESRC in February 2004; a summary of the main reasons is given in Section 4.

(iv) To provide social scientists with practical training in advanced event history analysis, through a workshop and web-based training materials.

A two-day workshop on multilevel event history analysis was held in February 2005. This provided 20 participants with face-to-face hands-on training in the use of advanced methods of event history analysis, focusing on methods developed under the project. The training materials were designed so that they could also be used for self-learning, and made available on the web-site. See Sections 5 and 6 for further details.

3. Methods

The statistical methods developed under the project are described in Steele et al. (2004, 2005a). We propose a discrete-time simultaneous equations model which allows for correlation between event histories (or 'processes'), while taking into account repeated events, multiple states and competing risks. In this section, we describe the methods in general terms. Specific applications are discussed in Section 4.

Discrete-time event history analysis

We focused on discrete-time models for several reasons. First, as is common in studies of human populations where event times are collected retrospectively, start and end dates of cohabitations and marriages are recorded to the nearest month. It is therefore natural to use a model which assumes measurement in discrete rather than continuous time. A second reason for favouring a discrete-time approach is that methods for discrete response data may be used; this is particularly important for facilitating model extensions to account for complexities such as repeated events, competing risks, and correlated histories. Other benefits of discrete-time models include straightforward inclusion of time-varying covariates and the possibility to allow for non-proportional hazards. One potential disadvantage of the discrete-time approach is the need to restructure each duration response to obtain a discrete response for each time interval. The expanded dataset may be very large, particularly if the width of the discrete time intervals is short relative to the observation period. One strategy to reduce the number of records generated is to group discrete time intervals and weight by the interval length. However, the storage overhead of large datasets is becoming less of a problem with the availability of cheap RAM and 64 bit processing.

Repeated events

Many kinds of event may be experienced more than once by an individual over the observation period. For example, in our application, an individual may have more than one partner or birth. The durations between repeated events may be correlated due to unobserved characteristics that affect the risk of *each* event occurrence. The standard way to analyse repeated events is to include in the model a random effect, representing unobserved individual-specific characteristics.

Correlated event histories

To allow for correlation between event histories, we use a simultaneous equations model, also called a multiprocess model. Using this approach, one or more equations are specified for each kind of event. In our applications, we consider two kinds of event: partnership transitions and conceptions which lead to a live birth. We allow for simultaneity between processes in two ways: (1) outcomes of one process (e.g. births) are included as explanatory variables in the other process (e.g. partnership stability), and (2) random effects, are permitted to be correlated across processes.

Multiple states

Over the course of the observation period, an individual may pass through different 'states'. In the case of partnership histories, we can distinguish between three states: unpartnered, (unmarried) cohabitation, and marriage. In previous research, it was usual to fit separate models for transitions from each state. Our approach has been to model transitions from different states simultaneously because this allows testing of the equality of covariate effects across states, and for correlation between the unmeasured determinants of transitions from different states. Multiple states can be handled straightforwardly by including dummy variables for each state as explanatory variables in the model. These dummies are interacted with explanatory variables to allow for state-specific covariate effects. State-specific random effects are fitted by allowing the coefficient of each state dummy to vary randomly across individuals. Further details are given in Steele et al. (2004).

Competing risks

In many research problems there will be more than one destination from a given state; individuals may exit a state in different ways or for different reasons. In the event history and survival analysis literature, different end events are referred to as 'competing risks'. Where there are multiple states, the type and number of end events will typically vary across states. In discrete time, competing risks may be handled by having, for each discrete time interval, a multinomial response which indicates whether an event has occurred, and the type of event. Methods for handling discrete responses, when the number of response categories may depend on the state, were developed in Steele et al. (2004).

Estimation and software

The discrete-time model which takes into account the above features can be framed as a multilevel multivariate model. The model is multivariate because correlated events lead to multiple responses, and multilevel because of repeated events. The first step in the estimation procedure is to restructure the event history data into discrete-time, multivariate format. In the application to partnership transitions and childbearing, each partnership duration is represented by a sequence of discrete

responses, one for each time interval. After preliminary analysis, we decided to use six-month intervals, including the exposure time within each interval as a denominator (or weight). Then, for each time interval of a partnership, we define two responses: 1) a binary or multinomial response indicating the occurrence of a partnership transition, and 2) a binary response indicating a conception. After defining indicators for the partnership and conception responses and interacting these with duration and covariates, the model may be estimated using methods for mixtures of binary and multinomial responses (see Steele et al. 2005a).

Estimation was carried out using Monte Carlo Markov chain (MCMC) methods, as implemented in MLwiN v.2. A full description of the estimation algorithm is given in the appendix of Steele et al. (2004). The model may also be estimated using maximum likelihood methods, specifically numerical quadrature, in PROC NLMIXED in SAS. However, Steele's experience in using PROC NLMIXED for fitting multilevel event history models is that convergence problems are often encountered and estimation times are extremely long. Another approach is to use a continuous-time rather than discrete-time approach. Multilevel multiprocess models which assume measurement in continuous time can be estimated in aML, which like SAS uses numerical quadrature. The aML program was designed to fit multiprocess models to hierarchically-structured data. It can be used to model jointly any mixture of continuous, categorical or duration outcomes. A full review of the software is given in Steele (2004). An example of aML syntax for fitting the continuous-time analogue of the discrete-time model of Steele et al. (2005a) is given on the project web-site. We chose not to pursue aML further for two main reasons: 1) estimation times are very slow when there are a large number of correlated random effects, and 2) aML is a DOS program, has no data manipulation or graphical facilities and is therefore more suited to specialist users.

4. Results

Three empirical studies were carried out as part of the research, using data from the National Child Development Study (NCDS) and the 1970 British Cohort Study (BCS70). Our analysis is restricted to female cohort members for two reasons. First, previous research based on data from the BHPS has shown that men underreport births from previous relationships, particularly nonmarital births. Second, longitudinal information on the presence of stepchildren was not collected. Cross-sectional data on household composition show that the omission of stepchildren would be more severe for men than for women, which is as expected given that children usually remain with their mother after partnership dissolution. (See note sent to ESRC in February 2004 for further details.)

(i) *The effect of fertility outcomes on partnership dissolution and the move from cohabitation to marriage (among the 1958 birth cohort between the ages of 16 and 42)*

This was the first study of the project, which sets out the new methodology and applies it in a joint analysis of partnership transitions and childbearing among women of the 1958 birth cohort. The focus of the analysis is estimating the effects of the presence and characteristics of children and pregnancy on the risk that a marriage or cohabitation dissolves and the odds that cohabitation is converted to marriage. The results from two alternative modelling approaches are compared: a 'single process' model where partnership transitions and fertility are modelled as separate processes, and the multiprocess model in which we allow for cross-process correlation.

A large part of the first year of the project was devoted to preparing the NCDS data for this analysis. This involved linking the partnership histories collected at ages 33 and 42 to form a continuous history. Among the inconsistencies that needed to be resolved were disparities in the start and end dates reported for the same partnership at the different interviews, and overlapping partnerships (see Kallis (2005a) for further details). Another time-consuming data management task was the creation of time-varying fertility outcomes, indicating the number, age and parentage of children at the start of each six-month interval. Determining the parentage of each child involved comparing the partner identifier of the child's father with the identifiers of the mother's current and previous partners.

This study has been accepted for publication in *Demography* and will appear in the November 2005 issue. A press release based on the substantive findings was also prepared, which led to an article in the *Telegraph*.

Key findings:

- The cross-process residual correlations provide some interesting insights. For example, after controlling for the effects of current fertility status, partnership history and background characteristics, we find positive residual correlation between the risk of partnership dissolution, for both marriage and cohabitation, and the odds of a cohabiting conception. This implies that women who are prone to unstable partnerships have an above average risk of conceiving during cohabitation. This correlation might be picking up a negative effect of getting pregnant during cohabitation on the dissolution risk of subsequent marriage, i.e. the instability of 'shotgun' marriages. However, allowing for these and other cross-process correlations has little impact on our conclusions about the effects of having children on partnership stability.
- From both the single and multi process models, we conclude that having preschool children with a partner reduces the odds of separating from that partner, for both married and cohabiting couples; the stabilising effect of children weakens as they get older. Having children from a previous union has no effect on the risk of dissolution, for either married or cohabiting women, or on the odds that a cohabiting union is converted into marriage.

(ii) *Changes in the relationship between the outcomes of cohabitation and fertility (a comparison of the 1958 and 1970 birth cohorts to age 30*)

In this study, we carried out a cross-cohort comparison of the effects of pregnancy and the presence of children on the odds that a cohabiting partnership is dissolved or that it is converted to marriage. The experience of cohabitation, and of having children within cohabitation, was more common for the later cohort. The outcomes of cohabiting partnerships are modelled simultaneously with the chance of a conception (leading to live birth) during cohabitation. The model is a special case of the model used in (i). In this comparative study, we decided to focus on cohabitation because we anticipated inter-cohort differences in the effects of having children on the outcomes of cohabiting unions, and particularly on the odds that a cohabiting couple marries.

Key findings:

- Allowing for residual correlation between partnership stability and fertility has little effect on estimates of the effects of being pregnant and the presence of children on the outcomes of cohabiting unions.
- There has been a decrease in the rate of 'shotgun' marriages. For both cohorts, however, the marriage rate, while high during pregnancy, declines once the child is born. Cohabiters born in 1970 experience a lower risk of dissolution in the first and third trimester of pregnancy, while pregnant members of the 1958 cohort are no more or less likely to separate than non-pregnant women.
- The presence of pre-school children with the current partner reduces the risk of dissolution for cohabiters born in 1970, but not among the much smaller group of women born in 1958 who were cohabiting before age 30.

The results from this study were presented at the Annual Meetings of the Population Association of American, Philadelphia, April 2005. A paper has been submitted to *Population Studies*.

(iii) *The formation and outcomes of cohabiting and marital partnerships among women of the 1970 birth cohort*

Studies (i) and (ii) focus on the link between childbearing and partnership stability, i.e. the outcomes of partnerships. Therefore, periods spent outside a partnership were excluded from the analyses. In this study, we consider both the formation and outcomes of marital and cohabiting partnerships, and model all transitions jointly to allow for shared unobserved risk factors. We focus on two key research questions: 1) the residual correlation between the formation and dissolution of partnerships, e.g. a positive correlation would suggest the presence of women who make quick transitions into and out of partnerships, and 2) the effects of previous partnership experience on the chances of future transitions. We also consider the effects of pregnancy and having children on partnerships transitions but, following the conclusions of (i) and (ii), we simplify the analysis by treating fertility outcomes as exogenous.

Key findings:

- There is a moderate positive residual correlation between the risk of marital separation and both the odds of entering into cohabitation and the odds of marrying a cohabiting partner. Thus women who cohabit quickly, and those who move quickly from cohabitation to marriage, also tend to have shorter marriages.
- Allowing for correlation between the unmeasured determinants of partnership formation and dissolution has a substantial impact on estimates of the effects of previous partnership experience on the probability of subsequent transitions, particularly on the risk of marital dissolution. For example, an apparently strong positive effect of previous cohabitation on the risk of marital dissolution disappears when we allow for the residual correlations noted above.

A paper based on this research has been submitted to the *Journal of the Royal Statistical Society*, *Series A*.

5. Activities

Conferences and seminars

The results of the research have been widely disseminated at conferences and seminars in the UK and overseas. The methodology and substantive findings have been presented to statisticians and social science audiences.

UK

11 June 2004: Seminar, Bedford Group for Lifecourse and Statistical Studies, Institute of Education

2 July 2004: Invited presentation in session on "Statistics: Understanding Family Processes", Research Methods Festival, Oxford

27 August 2004: Invited presentation at workshop on "Theory and Practice in the Analysis of Longitudinal Data", Quantitative Methods in the Social Sciences (QMSS) programme for young European researchers, University of Southampton

7-10 September 2004: Session on "Complex Interactions", Royal Statistical Society Conference, Manchester

19 October 2004: Invited presentation at a meeting on "New Advances in Multilevel Modelling", organised by the Social Statistics and General Applications Sections of the Royal Statistical Society

9 May 2005: Seminar, Institute for Social and Economic Research (ISER), University of Essex

20 May 2005: Seminar, Department of Statistics, University of Bristol

International

1 June 2004: Invited presentation in a session on "Multilevel Modelling", Annual Meeting of the Statistical Society of Canada, Montréal

16-20 August 2004: Contributed paper, RC 33 Conference on Social Science Methodology, Amsterdam

7 December 2005: Seminar, Max Planck Institute for Demographic Research, Rostock, Germany

31 March–2 April 2005: Contributed paper in session on "International Perspectives on Cohabitation", Annual Meetings of the Population Association of America, Philadelphia

Workshop

A free two-day workshop on multilevel discrete-time event history analysis was held on 10-11 February 2005 at the Institute of Education. As the target audience for the workshop was quantitative social scientists, rather than statisticians, we began with an introduction to traditional methods of event history analysis before moving to the more advanced methods developed under the project. Participants were guided through the processes of data preparation, analysis and interpretation of results, starting with simple event history analysis, and gradually building up to multiprocess models for correlated histories. The emphasis was on applying these methods in practice and interpreting the results.

The workshop was attended by 20 participants from a range of disciplines (epidemiology, public health, demography, social policy, sociology, geography, economics, and medicine) and countries (UK, Poland, Norway, Sweden, and Belgium). From the eighteen participants who completed evaluation forms, the feedback was extremely positive. In an overall assessment of the course, on a scale of 1 (very poor) to 10 (excellent), 8 was the minimum rating given and half the participants gave the maximum rating of 10.

Following the success of this workshop, it will be repeated in March 2006 at the University of Bristol.

All materials from the workshop – slides, computer exercises, MLwiN macros, and datasets (via the Data Archive) – are available for download from the project web-site.

Collaborations

We have collaborated with colleagues from the Centre for Longitudinal Studies on the preparation of the partnership history data for analysis. Feedback from CLS staff has been taken into account in preparing the documentation which accompanies the archived data (Kallis 2005a, 2005b). We have also shared our cleaned, linked NCDS dataset with colleagues (Shirley Dex, Andrew Jenkins and Heather Joshi and their international collaborators) for use in a study on female labour supply[3].

Steele has applied multiprocess methods similar to those developed under this project in a study of the effect of school resources on pupil attainment. The multilevel analysis was part of a DfES-funded study led by colleagues at the Institute of Education, Ros Levačić and Anna Vignoles. A paper is in preparation and we expect to submit this to the *Journal of the Royal Statistical Society*, *Series A*, in autumn 2005.

Steele has been invited by Prof Hans-Peter Blossfeld, University of Bamberg, to co-author a book on new developments in event history analysis. Prof Blossfeld has published widely on this topic, including several books. The new book, which we plan to start writing in September 2005, will include the methods developed under this project.

Steele will build on the research of this project as part of her involvement in the new ESRC NCRM node at the University of Bristol (LEMMA). She will collaborate with Prof Kelvyn Jones in a project concerned with the analysis of the duration of episodes spent in hospital. The new project will require extension of the methods developed here to allow for cross-classified and multiple membership structures.

6. Outputs

Publications

[3] Dex, S., Gustafsson, S., Jenkins, A., JOSHI, H., Kenjoh, E., Killingsworth, M.R. (2005) "Mothers' Changing Labour Supply in Britain, the US, and Sweden" in R. Goméz-Salvador, A. Lamo, B. Petrongolo, M. Ward and E. Wasmer E., *Labour Supply and Incentives to Work in Europe*, Edward Elgar: Cheltenham, UK. Northhampton, MA, USA, ISBN 1 84542 129 9, pp 115 – 150.

Published articles

Steele, F., Goldstein, H. and Browne, W. (2004) "A general multistate competing risks model for event history data, with an application to the study of contraceptive use dynamics", *Statistical Modelling*, 4: 145-159.

Steele, F., Kallis, C., Goldstein, H. and Joshi, H. (2005a) "The relationship between childbearing and transitions from marriage and cohabitation in Britain", *Demography*, 42 (to appear in November issue).

Submitted articles

Steele, F., Joshi, H., Kallis, C. and Goldstein, H. (2005b) "Changes in the relationship between the outcomes of cohabiting partnerships and fertility among young British women: evidence from the 1958 and 1970 birth cohort studies" (submitted to *Population Studies*).

Steele, F., Kallis, C. and Joshi, H. (2005c) "The formation and outcomes of cohabiting and marital partnerships in early adulthood: the role of previous partnership experience" (submitted to *Journal of the Royal Statistical Society, Series A*).

Other

Kallis, C. (2005a) "NCDS5 and NCDS6 Partnership Histories". Data Note, Centre for Longitudinal Studies, Institute of Education, University of London.

Kallis, C. (2005b) "BCS70 Partnership Histories". Data Note, Centre for Longitudinal Studies, Institute of Education, University of London.

Steele, F. (2004) "A Review of aML (Release 2)". Software Review, Centre for Multilevel Modelling, Institute of Education. Download from www.mlwin.com/softrev/

Steele, F., Kallis, C., and Goldstein, H. (2004) "Multilevel multiprocess modelling of partnership and childbearing event histories", *Multilevel Modelling Newsletter*, 16(1): 4-12.

Steele, F. (2005) "A multiprocess model for correlated event histories with multiple states, competing risks, and structural effects of one hazard on another", Research note, Centre for Multilevel Modelling.

In preparation

Steele, F. (2005) "Event history analysis", a briefing paper commissioned by the National Centre for Research Methods.

Steele, F. and Joshi, H. (2005) "The risk of parental separation by union status at birth, for children born to women of the 1958 and 1970 British birth cohorts".

Training materials

Materials from the two-day workshop on multilevel discrete-time event history analysis are available for download from the project web-site. These materials include slides from the lectures, computer exercises in SPSS and MLwiN, datasets, and recommended reading. The lecture notes and exercises were designed to be a self-contained guide to discrete-time event history analysis. Researchers with knowledge of logistic regression and some familiarity of MLwiN should be able to work through the materials on their own. It is hoped that other trainers will adapt the materials for use in their own teaching.

Website

A project webpage has been set up on the Centre for Multilevel Modelling website (www.mlwin.com/team/mmmpceh.html). Research papers and training materials are available for download.

Datasets with documentation

The following datasets have been submitted to the Archive, with documentation (Kallis 2005a, 2005b):

- Cleaned, linked partnership histories for NCDS women, ages 16-42
- Cleaned linked partnership histories for BCS70 women, ages 16-30

7. Impacts

We expect that our dissemination activities (publications and presentations), together with the training materials, will lead to wider use of advanced techniques of event history analysis in social research. In addition, the fact that they can be implemented in the MLwiN software makes these methods accessible to social scientists. As part of the Bristol ESRC NCRM Node, LEMMA, MLwiN will shortly be free to UK researchers, which will further improve the accessibility of the methods.

One potential obstacle in the use of event history data is the often considerable amount of work needed to manipulate the data from the form in which they were collected into a form suitable for analysis. Not all social scientists have the data management skills to do this. By making available the cleaned NCDS and BCS70 partnership histories to other researchers, we hope to promote further use of event history data collected in the cohort studies.

8. Future Research Priorities

<u>Substantive research</u>

Steele and Joshi are continuing the research (unfunded) in a study which compares the risk of experiencing parental separation for children born to cohabiting and married parents. An event history analysis of the duration between a child's birth and parental separation will be carried out for all children born to women of the 1958 and 1970 cohorts during a co-residential union. We will investigate whether children born to cohabiting parents experience a greater risk of parental separation, and whether the effect of union status at birth varies by cohort and the child's date of birth. A crude event history analysis, including only union status, cohort and their interaction, reveals that children born to a cohabiting couple are more likely to experience the

dissolution of their parents' union. However, this effect may be due to selection. For example, it is possible that women with a high propensity to have a child during cohabitation also have a low propensity to stay with their partner for the sake of their child in the event that a relationship breaks down. Such selection effects may be stronger in the 1958 birth cohort where cohabiting births were rare events and likely to be among a highly select group of women, perhaps with more liberal attitudes towards marriage and family. To allow for this type of selection, we will model a woman's decision to have a child during cohabitation (as opposed to marriage) jointly with the duration from birth of that child to separation, using a multilevel multiprocess model.

Development of methods for event history analysis of data with complex structure

As noted in Section 5, Steele will extend the methods developed under this project to handle data with non-hierarchical structure. This research will be carried out under the new ESRC NCRM node at the University of Bristol (LEMMA).