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1. Introduction

This paper analyses the effects of women's education and aggregate unemployment rates on fertility in Britain. Education is widely regarded as a central factor in the trend to fewer and later births in developed economies. A higher level of education is associated with beginning child-bearing at a later age and with fewer children, on average, by the end of a woman's reproductive years. This can be explained very broadly in terms of the greater opportunity cost of foregone earnings which will be higher for well-educated women who have greater earning power. This would be a rationale for avoiding childbearing while still studying, as well as for deferring, if not avoiding, motherhood once on the labour market. However, education increases income, through own earnings and possibly through assortative mating, which could have a positive effect on fertility, reducing or outweighing the substitution effect especially at later ages and stages in the reproductive span (Gustaffson, 2001) In particular, higher earning power may make it easier to afford the costs of reducing foregone earnings through the purchase of childcare (Ermisch, 1989) and of owner occupied housing. Another route which connects low education to early and extended childbearing is that women who are (or will be) better educated are better equipped to avoid unintended births.

In Britain, as in other developed economies, successive cohorts of women have tended to wait longer before starting a family. The stylized facts are that, among women born in England and Wales in the 1950s, fewer than a quarter were still childless by age 30 but for women born in the early 1970s, about 40 per cent were still childless by the time they reached 30. In earlier cohorts, too, a higher proportion of women became mothers by the end of their reproductive lives. Around 13 per cent of women born in 1950 remained childless. This rose to 18 per cent of women born in 1960 and it is estimated that about the same proportion of those born in 1970 will not have children (ONS, 20007, Bray, 2008) The statistical association between education and the timing of first births is quite well-established. What is less clear is the more difficult question of whether education can be said to be having any causal link with birth hazards; the evidence on the direction of the relationship between education and higher-order births has also proved more mixed than that for first births.

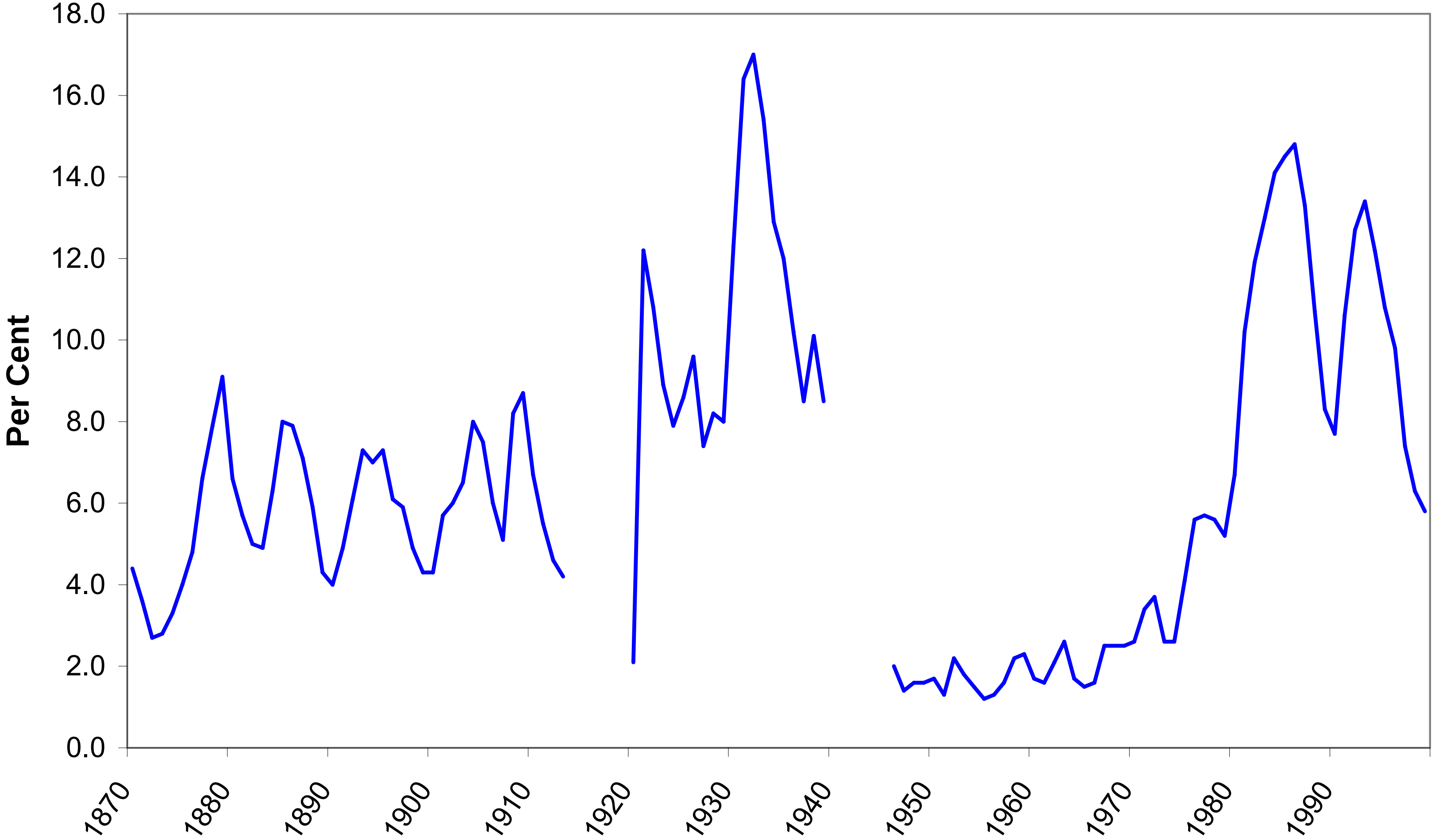
Cohorts reaching adulthood since the early 1970s have also experienced a labour market in which unemployment rates have been at times exceptionally high and in general volatile. This applies both in Britain and in many other European economies. In the case of Britain unemployment in the 1980s and early 1990s reached levels which had only previously been observed in the depressed decade of the 1930s (Crafts, 2007). Since the mid-1990s unemployment has fallen back to much lower levels. High unemployment might either deter or promote births, depending on whether the income effect of being able to afford a(nother) child dominates the substitution effect of the reduction in the mother's earning opportunity costs. Figure 1 graphs unemployment data over the long run to put recent labour market conditions into historical perspective, and reveals how high rates of unemployment experienced by recent cohorts have been and how sharp was the contrast with the preceding "Golden Age" of the 1950s and 1960s. It is also worth noting that the high unemployment of the interwar years was associated with very low birth rates and this provides a further rationale for analysing the links between fertility and labour market conditions in more recent times.

In this paper we combine micro-data on two cohorts who had different experience of education with macro-data on labour market conditions and examine how these factors impacted on the timing of births in Britain. We present results from hazard models estimated separately for each of two cohorts. The models analyse the timing of the first and second births, focusing on the associations of birth hazards with education level and a time-varying unemployment covariate. In addition we include in the models a range of other factors which may influence fertility behaviour and we utilise a method of controlling for unobserved heterogeneity in a robust fashion. In the next section we review literature which has considered the relationship between education and fertility, and also papers which look at how labour market conditions affect the timing of births. Section 3 of the paper describes in some detail the cohort datasets to be used in the paper while Section 4 discusses methodology, focussing in particular on the approach we adopt to deal with the problem of unobserved heterogeneity. In Section 5 we report the results of estimating the models and in Section 6 the implications for the timing of births are drawn out. Section 7 concludes the paper.

2. Literature Review

It is well-established in the demographic literature that a higher level of education is associated with later timing of the first birth (e.g. Gustaffson, 2001). The relationship between educational attainment and transition rates to higher order births remains less clear. The empirical evidence is mixed but several studies have reported that women with higher levels of education have made more rapid transitions to second and/or third births. Kravdal (1992) found a positive association between education and third births for Norway, while Kreyenfeld (2002) reported a similar association for second births in Germany. For Britain, Wright et al (1988), using data from the 1980 Women and Employment Survey, found no evidence that education exerted any influence on progression to third births in Britain.

Figure 1: Long run estimates of British Unemployment 1870 to 1999, measured on a consistent basis (source: Boyer/Hatton).



More recently, Rendall and Smallwood (2003) examined parity progression by education level using data from the ONS Longitudinal Study for women born between 1954 and 1958. They presented descriptive findings rather than model-based analyses but the results are, nonetheless interesting. Average age of entry to motherhood was some five years later for highly qualified women but, for any given age of childbearing highly qualified women were relatively more likely to have another child and tended to do so more quickly than less well educated mothers. In summary, there is overwhelming evidence that better educated women delay entry into motherhood. Some research has found that, once they begin childbearing, well-educated women proceed relatively quickly to second and higher-order births.

A number of papers have considered the relationship between unemployment and fertility. Ahn and Mira (2001) analyse the relationship between fertility and aggregate unemployment in Spain in the 1970s and 1980s. The Spanish (male) unemployment rate was below 5 per cent in the mid-1970s but climbed to around 20 per cent in the 1980s. The authors show that unemployment increased the average age at marriage. This higher age at marriage also reduced fertility (they consider the timing of the first three births) although the estimated effects of joblessness on birth hazards conditional on marriage were not statistically significant. Gutierrez-Domenech (2002) applied Cox hazard regression models to the timing of marriage and of births amongst two cohorts of Spanish women. The lagged unemployment rate was negatively and significantly related to the transition into marriage in both cohorts. The birth hazard models were fitted separately for each of the first three births and it was found that, after controlling for other factors, lagged unemployment was negatively associated to the hazard of each birth. This relationship was statistically significant for the first two births to the later cohort (born 1961-77) but was never significant for the earlier cohort (born 1945-60).

Studies of this topic for Scandinavian countries include Hoem (2000) who used data on Swedish women born in 1950 or later to analyse times to first birth in the 1980s and 1990s. It was found that the employment rate in the women's local municipality was positively associated with time to first birth in hazard regression models. Hoem used register data and so had few controls for the women's family background. Santow and Bracher (2001) drew on data from the 1992 Swedish Family Survey with a better range of controls. They also applied hazard regression models to the time of conceptions leading to first birth. The age-specific unemployment rate was negatively related to the time of first birth conception. The estimated unemployment effects were quite substantial: relative to the base case of unemployment below four per cent, when unemployment was between four and nine per cent first birth conception rates were reduced by a fifth and when unemployment exceeded 10 per cent first birth conception rates were lowered by two-fifths. Santow and Bracher also report that their results were largely unaffected by lagging the unemployment variable by one or two years. Kravdal (2002) estimated hazard models separately for first and higher-order births based on Norwegian register data for the period 1992 to 1998. All unemployment variables were lagged by 12 months and included individual unemployment as well as both male and female unemployment rates at municipal level. The woman's own unemployment raised the hazard of the first birth 12 months later but reduced the hazard of higher-order births. The municipal unemployment rates, both male and female, were associated with lower birth hazards for first and higher-order births. During the period studied unemployment in Norway varied only between a minimum of two per cent and a maximum of six per cent and so was quite low compared to many other European economies.

Other papers in this field include Kreyenfeld (2000) who used data from the German Socio-Economic Panel to study the relationship between unemployment and fertility in the former East Germany following unification. She focused on individual-level unemployment, i.e. whether the woman was herself unemployed at the time of conception, rather than the effect of aggregate unemployment. In a piecewise constant hazard model of first births it was found that unemployed women were more likely to conceive. The model included age and education level as controls, and the positive association with unemployment applied only to women educated below degree level and not to those with degrees. Dex et al (2005) fitted Cox hazard regression models to cohort data on time to first birth in Britain, Sweden and the US. Unemployment was measured as aggregate male unemployment rate. Higher unemployment was associated with a significantly lower hazard of motherhood in Sweden and the US but a significantly higher hazard in Britain. Del Bono (2001) explored whether unemployment affects fertility through its influence on expectations of the future condition of the labour market. A model was fitted to data on a cohort of British women all born in March 1958 who were followed up to the age of 33. It was shown that more favourable expected job opportunities raised the hazard of the first birth amongst these women.

3. Data

For the analysis of fertility we use data from two British birth cohorts: the National Child Development Study (NCDS), a cohort of individuals all born in the same week in March 1958 and the British Cohort Study (BCS) who were all born in a single week in April 1970. Members of each cohort have been surveyed at various points in their lives. For NCDS detailed birth histories were collected when cohort members were aged 33, in 2000, when they had reached the age of 42, and again in 2004 at the age of 46. For this project the data from the 2004 survey were combined with data from the 1991 and 2000 NCDS sweeps. Data on birth histories for BCS were also collected in 2000 and 2004 and information from these two sweeps was joined together. Some women with birth history data were omitted from the quantitative analysis, the main category being NCDS women who had left-censored birth histories: incomplete birth histories where we only know about births which occurred from age 33 but not before that age. For both cohorts cases where mothers had given birth to twins or triplets were also omitted. For NCDS the sample used for analysis consists of 5,631 women and there are 5,105 BCS women in our analyses. The information available is shown in Table 1. For over three-quarters of the NCDS women there is a full birth history up to age 46, while for a further 15 per cent there is a history up to age 42, and for the remaining nine per cent, a birth history which is truncated at age 33. For over four-fifths of the BCS women there is a full birth history up to age 34, while for the remaining 17.5 per cent, a birth history which is truncated at age 29 or 30.

Table 1: Information available on the sample of women

	N	*%*
NCDS women (1958 cohort)		
Complete birth history to age 33	*519*	*9.2*
Complete birth history to age 42	*840*	*14.9*
Complete birth history to age 46	*4,272*	*75.9*
TOTAL	*5,631*	*100.0*
BCS women (1970 cohort)		
Complete birth history to age 29/30	*892*	*17.5*
Complete birth history to age 34	*4,213*	*82.5*
TOTAL	*5,105*	*100.0*

Table 2: Number of live births for the women in sample

Number of births	N	%
NCDS WOMEN		
None	968	17.2
One	827	14.7
Two	2,412	42.8
Three	1,040	18.5
Four or more	384	6.8
TOTAL	5,631	100.0
BCS WOMEN		
None	1,663	32.6
One	1,185	23.2
Two	1,640	32.1
Three	479	9.4
Four or more	138	2.7
TOTAL	5,105	100.0

The number of live births recorded for the women is shown in Table 2. Among the NCDS cohort the most common number of children reported was two (42.8 per cent) while 17 per cent of the women had no children and nearly seven per cent had had four or more. As for BCS about a third of the women had no children, nearly a quarter had one child and a further third of the women had had two children. As not all women in the dataset are censored at the same point in time it may also be useful to report number of births by censoring point and this is done in Table 3.

Table 3: Number of Births by Age at which Censored

NCDS Women	**Censoring Point**					
	Age 33		*Age 42*		*Age 46*	
No of Births:	N	%	N	%	N	%
None	134	25.8	144	17.1	690	16.2
One	99	19.1	121	14.4	607	14.2
Two	157	30.2	342	40.7	1,913	44.8
Three	96	18.5	161	19.2	783	18.3
Four or more	33	6.4	72	8.6	279	6.5
TOTAL	519	100.0	840	100.0	4,272	100.0

BCS Women	**Censoring Point**			
	Age 29/30		*Age 34*	
No of Births:	N	%	N	%
None	391	43.8	1,272	30.2
One	202	22.7	983	23.3
Two	198	22.2	1,442	34.2
Three	83	9.3	396	9.4
Four	18	2.0	120	2.8
ALL	892	100.0	4,213	100.0

3.1 Explanatory variables:

Education is widely regarded as a key factor in understanding fertility behaviour and it was important to include it in the analysis. There are various ways of conceptualising education, each of which has some advantages and some disadvantages. We treat education as a fixed variable here based on years of completed education by age 30. An alternative (which we hope to explore in future work) would be to treat education as a time-varying covariate. In practice, relatively few women in our datasets substantially increased their years of completed education after their teens or early twenties. Also a fixed covariate simplifies the specification and effectively treats the destination education level as if it were anticipated. Education of the women in these cohorts was categorised as low, 11 years of completed education by age 30; medium, 12 or 13 years of education; and high, more than 13 years of education. Leaving school at age 16, the minimum school leaving age for this cohort would imply 11 years of education so the women in the low education category have no time spent in education beyond the minimum. Having 12 or 13 years of education would mean some secondary education beyond the minimum, but no tertiary education; those in the high education category have more than 13 years of education so would usually have some tertiary education. Descriptive statistics on the education levels of women in the two cohorts are shown in Table 4. Among the NCDS women over two-thirds were at low education level, approximately 17 per cent had medium education and 15 per cent had a high level of education. Higher proportions of BCS women were reported having education at the medium or high levels and this is what we would expect as more recent cohorts tend to stay in full-time education longer reflecting the secular increase in enrolment and attainment (Makepeace et al, 2003). Among the BCS cohort of women about half were classified as low education, of the remainder, slightly more were in the medium education category than the high education category.

Table 4: Education Levels of the NCDS and BCS women

Education Level	**NCDS WOMEN**		**BCS WOMEN**	
	N	%	N	%
Low	3,831	68.0	2,572	50.4
Medium	940	16.7	1,340	26.3
High	860	15.3	1,193	23.4
TOTAL	5,631	100.0	5,105	100.0

In Figures 2 to 5 Kaplan-Meier survival curves are plotted for the first two births among each cohort by education level to illustrate how the timing of births differs for women with differing amounts of education. For the first birth, measured from age 16, Figure 1 and Figure 2 both show very clear differences in survival profiles by education level, with the highly educated taking longer to have a first child than those with a medium level of education, who in turn tend to take longer to begin child-bearing than those whose education level was categorised as low. Comparing Figure 2 and Figure 3, the earlier cohort, NCDS, tend to make the transition to motherhood at an earlier age than those in the more recent cohort, BCS. For the second birth, measured in months since first birth, there is some indication that women with high education make a more rapid transition to second birth although the survival curves for each level of education are very close together (Figures 4 and 5).

Figure 2: Kaplan-Meier Survival Curve for First Birth by Education Level - NCDS

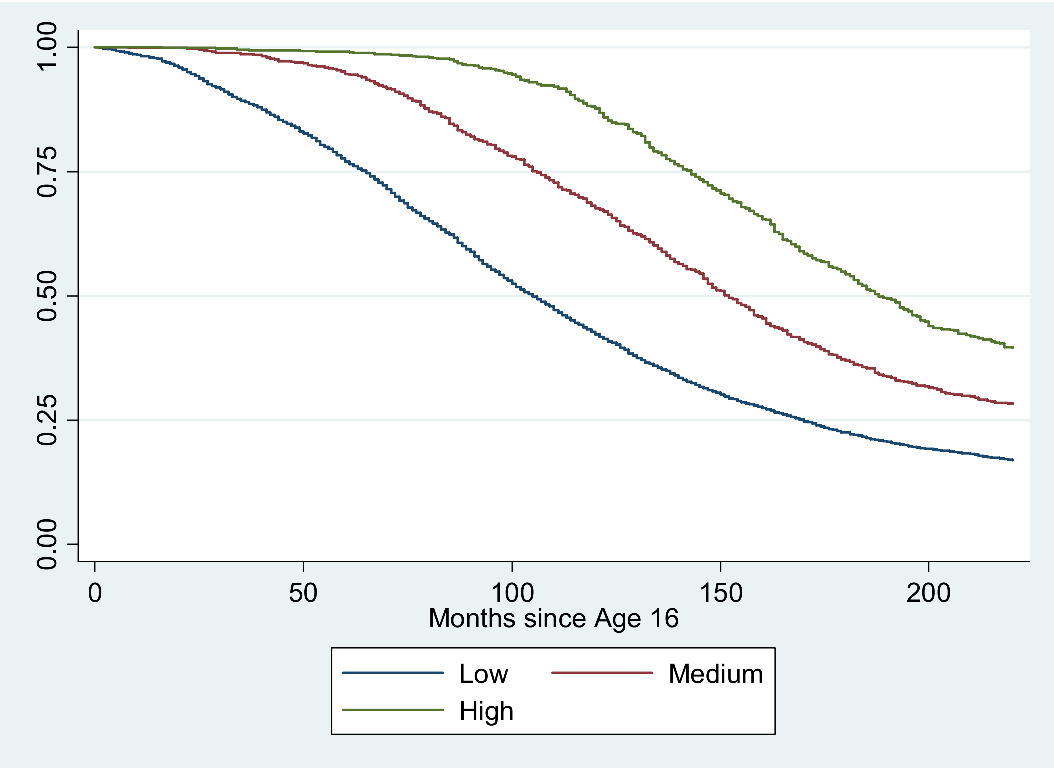


Figure 3: Kaplan-Meier Survival Curve for First Birth by Education Level - BCS

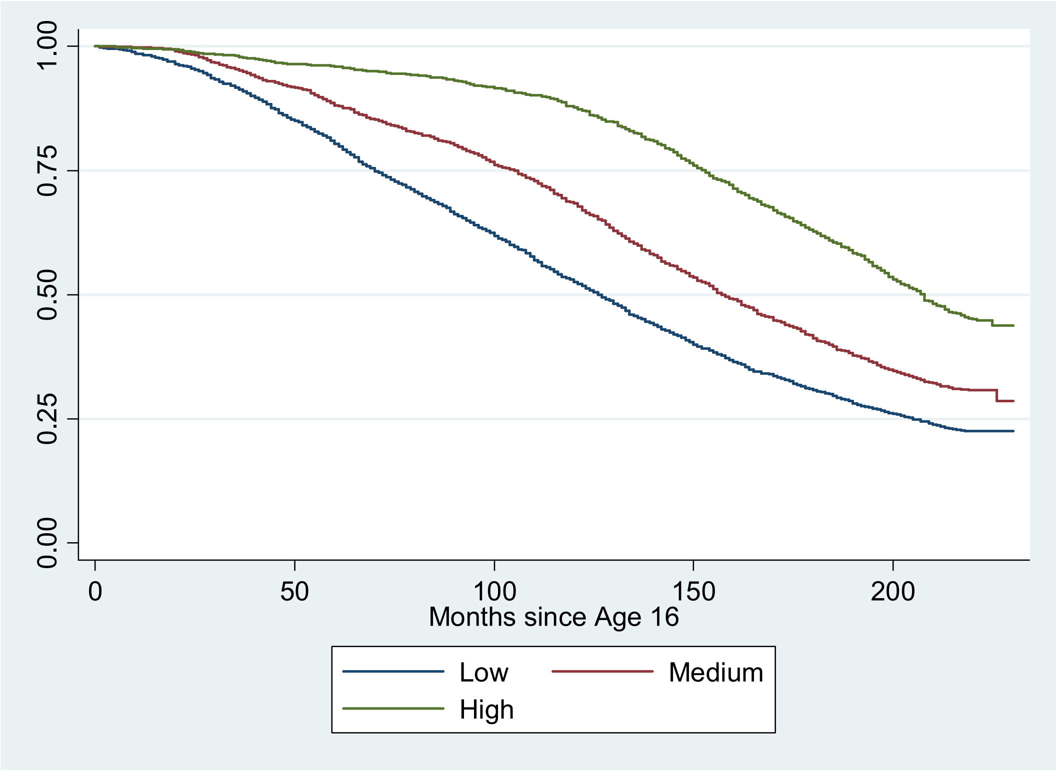


Figure 4: Kaplan-Meier Survival Curve for Second Birth by Education Level – NCDS

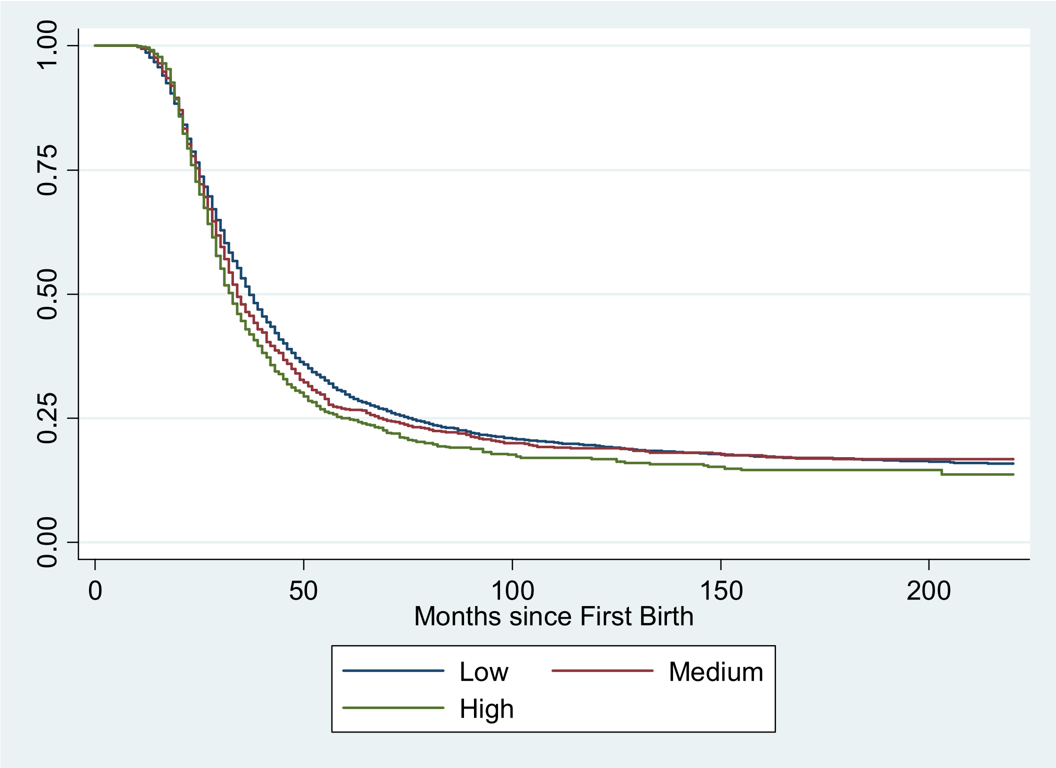
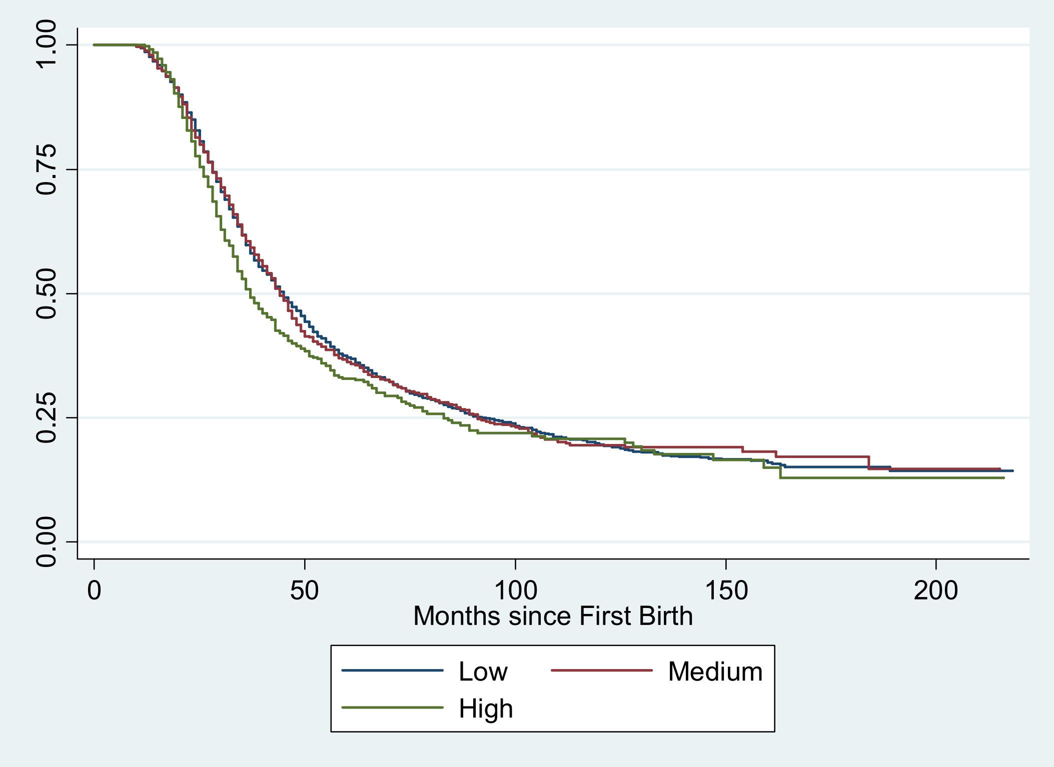
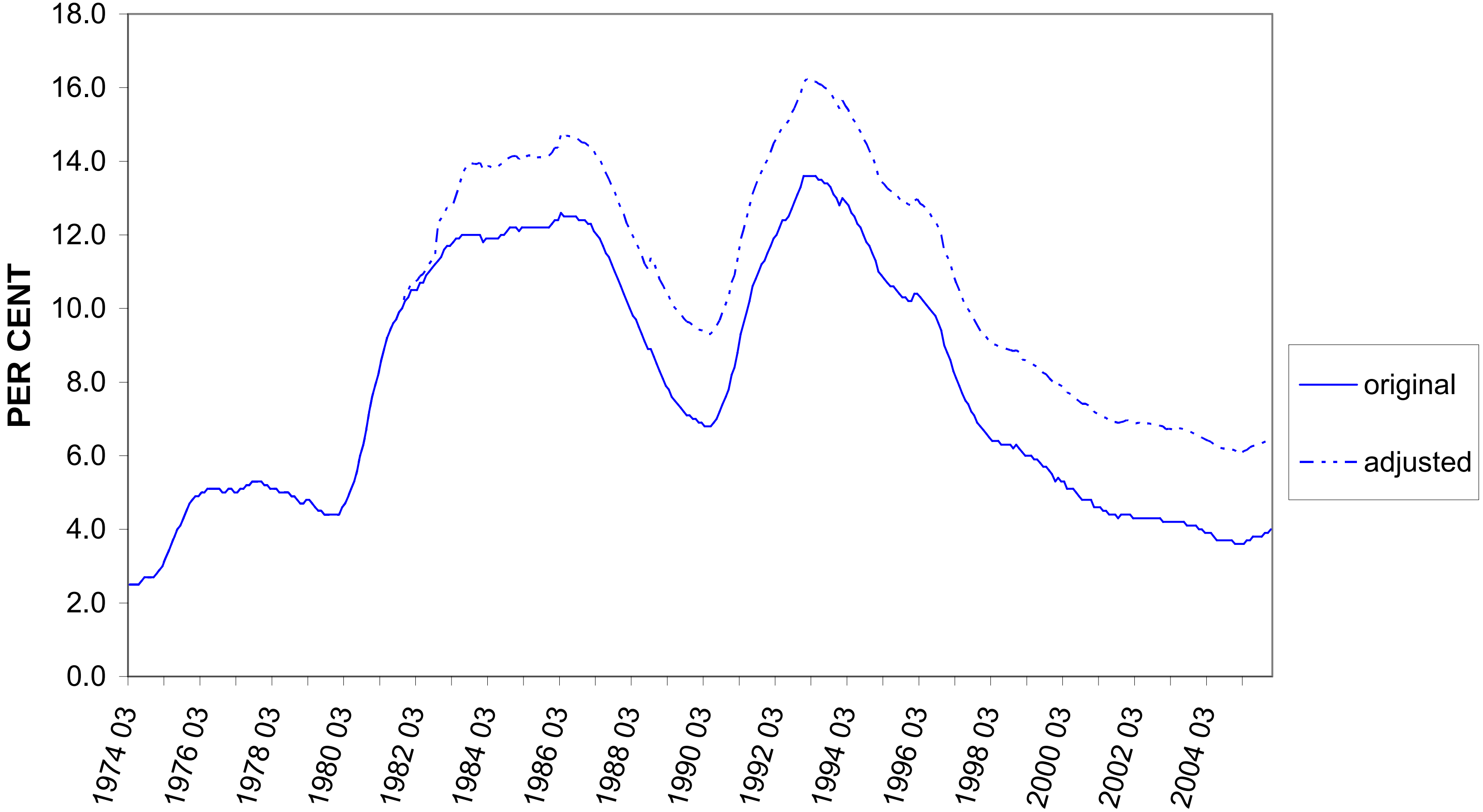


Figure 5: Kaplan-Meier Survival Curve for Second Birth by Education Level - BCS



We also utilised a measure of unemployment and here we faced some tricky data issues as for unemployment a *monthly* series is required which goes back to the early 1970s, when the 1958 cohort began to enter the labour market. The claimant count is the only series which meets these criteria. However, one serious problem with the claimant count is that it is affected by changes to the rules for eligibility to unemployment benefits. When unemployment was very high in the 1980s several changes were made to the eligibility rules. We have therefore adjusted the claimant count with the aim of constructing a series which is consistent through time. Information from Lawlor (1990) was used on how many people were removed from the claimant count during the 1980s by various rule changes and these numbers were added back in to create an adjusted claimant count series. As in Boyer and Hatton (2002), minor changes – those which altered the claimant count by 20,000 or less – were not incorporated in the adjusted series. We use the male claimant count rather than the female or all persons claimant count because long-term changes in the eligibility of women for unemployment benefits mean that the adjusted series for male claimants is a better indicator of the state of the labour market than a series which includes female claimants. The impact of the eligibility changes for male unemployment rates is apparent in Figure 6. Unemployment rates were exceptionally high for much of the 1980s and again in the early 1990s. By the year 2000 the adjusted series was around 6 per cent – approximately in line with estimates from the Labour Force Survey. The adjusted claimant count, then, should give a more realistic picture of conditions in the labour market than the raw claimant count and so it is the adjusted series which will be used in our modelling work.

Figure 6: Claimant Count Unemployment Rates - Males



Note: 1974 03 refers to March 1974 (the month NCDS cohort reached 16th birthday) and likewise for other years.

Table 5: Percentages with First Birth by Age 25 in NCDS and BCS Samples by Socio-Economic Characteristics

Education	Low	Medium	High			
NCDS	57.7	32.5	12.3			
BCS	47.4	31.6	12.3			
Age 10 or 11 ability test scores: quintiles	Lowest	Fourth	Third	Second	Highest	missing
NCDS	64.7	56.7	47.5	40.1	29.9	48.6
BCS	49.5	43.5	35.2	29.2	19.9	34.5
CM received Free School Meals	Yes	No				
NCDS	65.6	44.9				
BCS	52.6	32.7				
Father's social class	I	II	III	IV	V	missing
NCDS	18.9	30.5	48.6	56.1	67.5	55.9
BCS	12.8	23.2	38.5	40.5	62.1	38.5
CM's mother's age left f/t education	Before 15	15 to 16	16 to 17	17 or more		
NCDS	51.7	53.7	33.3	23.1		
CM's mother's years of f/t education	Less than ten	Ten	Eleven	Twelve plus		
BCS	40.8	40.5	24.7	22.1		
CM's Religion	None	Anglican	Catholic	Other Christian	Non-Christian	
NCDS	47.3	47.5	43.8	44.2	52.5	
BCS	35.4	37.3	33.5	31.6	35.9	
CM number of siblings	None	One	Two	Three	Four plus	Missing
NCDS	37.5	37.8	48.7	50.6	59.8	44.7
BCS	33.6	28.9	36.4	44.0	55.0	37.1

Further variables were chosen for their potential in explaining fertility behaviour. Variables were selected so that, as far as possible, they were similar for each cohort. Scores on ability tests taken in childhood are available at various ages for each cohort. We use information on age 11 test scores for NCDS and age 10 test scores for BCS. A range of variables which reflect aspects of the socio-economic background of the cohort members, such as their father's social class, mother's education level, their religion, number of siblings, and whether they experienced poverty as a child, measured by receipt of free school meals. Table 5 reports some descriptive statistics for these explanatory variables. We show the proportions having their first birth by age 25 in each cohort broken down by each potential explanatory variable. Overall 46.6 per cent of the NCDS women and 35.1 per cent of the BCS women had had a first birth by age 25.

The percentage with a first birth by age 25 was inversely related to scores on ability tests in childhood. For the NCDS cohort nearly two-thirds of those in the lowest quintile on the ability test scores had had at least one child by age 25 compared to just 30 per cent for the highest quintile. For the BCS cohort this percentage fell from about half of those in the lowest quintile on the test scores to 30 per cent in the highest quintile. Women who had experienced poverty in childhood, measured by receipt of free school meals at age 10 (BCS) or 11 (NCDS) appeared to begin childbearing at younger ages. For example, among the NCDS women who were likely to have experienced poverty in childhood, almost two-thirds had a first birth by age 25 compared to only 45 per cent of those who had not received free school meals at age 11. Women whose fathers were in higher SES groups and women with more educated mothers were less likely to have had a first birth by age 25 and this applied across both cohorts.

As for religion, those women reporting that they were Anglican and those who said they belonged to a non-Christian religion had the highest likelihood of the birth of a first child by age 25. Generally, those cohort members who came from larger families also tended to start having children themselves at a younger age. However, for NCDS women there was little difference between those who had no siblings compared to those who had one, while for BCS women those with one sibling were somewhat less likely than those with no siblings to have their first child by 25. Overall, the descriptive statistics provide support for the notion that these characteristics have potential as explanatory variables and are worth including in our models.

4. Method

Not all women had had a birth by the time they were most recently observed in the data. In other words, some women's birth histories were censored. Duration modelling is now well-established as the appropriate technique to deal with the analysis of times to an event in the presence of censoring (Allison, 1984; Kiefer, 1988). The basic insight is rather than focusing on factors directly affecting occurrence of the event instead to look at factors which influence the risk of the event occurring (Newman and McCulloch, 1984). We apply duration models to our data on births. Here interest centres on the probability that a person who has occupied a state for a certain length of time t leaves it in the next short interval of time. Formally, the hazard is defined as:

$$h(t) = \lim_{dt \to 0} \frac{P(t \le T < t + dt \mid T \ge t)}{dt} \quad . \qquad (1)$$

We will estimate the hazard of a birth at time t given that it has not occurred prior to t. Letting f(t) be the probability density function and S(t) = 1 - F(t) the survivor function then the hazard function is also often written as:

$$h(t) = \frac{f(t)}{S(t)} \quad . \qquad (2)$$

Duration models were estimated separately for each of the two cohorts on which we have data. An exponentiated quadratic was used as the functional form for the baseline hazard. This is preferable to other commonly used functional forms for the hazard, such as the Weibull model, as the quadratic allows for the possibility of a non-monotonic hazard, which is plausible when modelling the hazard for births. We include in the models a range of explanatory variables including education, unemployment as a time-varying covariate and other explanatory variables which economic theory and the empirical research literature suggest may be important and which were described earlier in the data section of the paper.

One of the advantages of longitudinal data is that it should be possible to control for omitted variables and unobservables much more effectively than when using cross-sectional data (Davies, 1987). There has been considerable debate in the literature on duration models on the best way to take account of unobservables. It is well known that neglecting to control for the presence of unobserved heterogeneity can lead to mis-specification of the baseline hazard and that this could in turn bias the parameter estimates on explanatory variables (e.g. Blossfeld et al, 2007). A widely-used method for taking account of unobservable factors is to assume a parametric distribution for the heterogeneity and this distribution is usually chosen as some convenient functional form which will make the resulting mixing distribution analytically tractable (Lancaster, 1990). Unfortunately, empirical results can be sensitive to the functional form chosen for the parametric heterogeneity term (Heckman and Singer, 1984). They proposed a non-parametric maximum likelihood procedure in which the distribution of unobservables is approximated by a discrete distribution and both the probability masses and their locations are estimated from the data. We also adopt this non-parametric approach and write the jth conditional hazard, h_j, for the jth birth as:-

$$h_j = \exp \{\gamma_{0j} + \gamma_{1j} t_j + 0.5\gamma_{2j} t_j^2 + Z\beta_j + f_j \theta_j \} \qquad (3)$$

where t_j is the length of the jth spell; Z is a vector of covariates, which may include time-varying covariates; θ_j is the transition-specific unobserved heterogeneity component; and the γ, β, and f terms are transition-specific parameters to be estimated. The first spell begins at age 16; subsequent spells begin at the time of previous birth plus nine months.

As the θ_j term is unobservable we estimate its distribution using Heckman and Singer's (1984) non-parametric maximum likelihood procedure. Here θ_j is assumed to have a one-factor structure such that

$$\theta_j = f_j \theta, \; j = 1,2\ldots,C \qquad (4)$$

where $E(\theta) = 0$ and C is the number of births. The unobservable for spell j is $f_j\theta$ and the covariance between $f_i\theta$ and $f_k\theta$ is $f_i f_k Var(\theta)$. By modelling the unobservables in this fashion we allow for the unobserved heterogeneity to be correlated across spells. To obtain the estimates of the non-parametric distribution we began by estimating the location and weights to be placed on just two mass points and continue to add mass points until two converge on the same location.

5. Results

The estimated hazard models are reported in Table 6 for the NCDS cohort and in Table 7 for the BCS cohort. In each of these tables model A does not control for unobserved heterogeneity, while model B is more complex and specifies non-parametric heterogeneity terms. All models were estimated in CTM (Yi et al, 1987). We estimated the models for as many transitions as was feasible. In practice this was the first three births for each cohort. However, for the later cohort (BCS) only a small proportion of women had already had a third birth by their early to mid-thirties and such women may not be very typical, so we focus mainly on comparisons of the first two births.

There was a negative association between education level and the hazard of the first birth for women in the NCDS cohort and in the BCS cohort. The coefficients on the education variables became much larger in absolute value once unobserved characteristics of the women were taken into account. The absolute size of the estimated education coefficients was larger for the older cohort. The base category for education was low, i.e. no education beyond compulsory schooling and, after controlling for unobservables, the coefficients on the education variables for the NCDS cohort were approximately -1.2 for the medium level of education and -2.0 for the high level of education, while for the BCS women they were -0.4 for the medium level and -1.3 for the high level of education. As for the hazard of second births, there was some evidence of a positive association with higher levels of education for the NCDS women, but this effect disappeared once controls for unobservable factors were incorporated into the models. There was no evidence of any statistically significant associations between education and hazards of second births among BCS women. Overall, since our results show later timing of the first birth for more educated women and no evidence of faster entry to higher order births, the implication is that more educated women would have fewer children, on average, over the lifecourse.

The unemployment rate (adjusted as described earlier to allow for changes in eligibility rules) was lagged by 12 months and was entered into the models as a time-varying covariate. For NCDS women there was a negative association between the lagged unemployment rate and the hazard of first births, but this was not statistically significant. There was a positive association between lagged unemployment and the hazard of second births and this became much larger and strongly significant after controlling for unobserved heterogeneity. Results for the third birth to NCDS women were similar. For the BCS women there was also a negative association of the unemployment variable and the hazard of first births; this was statistically significant and little affected by whether or not controls for unobservables were included in the model. The hazard of second birth was also negatively related to the lagged unemployment rate and was significant, at least in models which included controls for unobserved heterogeneity. There were, then, quite considerable differences between the two cohorts in the relationships between the lagged unemployment rate and birth hazards.

Table 6 Hazard Model for Timing of First Three Births: NCDS Results

	MODEL A				MODEL B		
	Without controls for unobserved heterogeneity				*Including controls for unobserved heterogeneity*		
	Coeff	Std err	t-stat		Coeff	Std err	t-stat
First Birth							
Intercept	0.235	0.093	2.523		-5.310	0.706	7.52
Gamma_1	3.054	0.133	22.92		4.955	0.259	19.15
Gamma_2	-2.012	0.077	26.09		-1.936	0.117	16.49
Education (base, low)							
Medium	-0.381	0.046	8.356		-1.175	0.105	11.16
High	-0.618	0.059	10.52		-1.999	0.150	13.34
Free School Meals (FSM) at age 11	0.236	0.050	4.671		0.448	0.111	4.03
Father's SES							
SES I	-0.222	0.094	2.368		-0.512	0.180	2.84
SES II	-0.177	0.056	3.18		-0.482	0.115	4.19
SES III	-0.100	0.040	2.477		-0.228	0.086	2.64
SES IV	-0.052	0.049	1.052		-0.056	0.107	0.52
SES data missing	-0.130	0.077	1.679		-0.138	0.163	0.84
Mother's Education (base, left school before age 15)							
Mother left school aged 15 to 16	0.057	0.037	1.547		0.161	0.079	2.04
Mother left school aged 16 to 17	-0.072	0.059	1.211		-0.114	0.124	0.92
Mother left school aged 17 or more	-0.047	0.067	0.705		-0.126	0.126	1.00
Ability Test Score Age 11 (base, lowest quintile)							
Highest quintile	-0.256	0.053	4.846		-0.846	0.118	7.16
Second quintile	-0.208	0.048	4.296		-0.805	0.108	7.44
Third quintile	-0.172	0.048	3.577		-0.709	0.110	6.42
Fourth quintile	-0.091	0.046	1.964		-0.391	0.102	3.82
Ability test: missing data	-0.202	0.054	3.762		-0.569	0.119	4.80
Religion (base, no religion)							
Anglican	0.057	0.033	1.73		0.064	0.069	0.93
Roman Catholic	-0.065	0.049	1.32		-0.294	0.098	2.99
Other Christian	0.035	0.047	0.738		0.005	0.094	0.06
Non-Christian religion	0.328	0.161	2.04		0.377	0.300	1.25
Number of Siblings (age 16, base one sibling)							
No Siblings	-0.007	0.079	0.086		-0.080	0.150	0.53
Two siblings	0.153	0.047	3.258		0.294	0.095	3.08
Three Siblings	0.112	0.051	2.191		0.428	0.108	3.97
Four or more siblings	0.256	0.049	5.224		0.672	0.109	6.14
Siblings: missing data	0.040	0.048	0.831		0.203	0.095	2.14
Unemployment (lagged)	-0.012	0.007	1.666		-0.003	0.008	0.37
Factor Loading					8.904	0.788	11.29
Second Birth							
Intercept	-0.485	0.112	4.318		-3.138	0.321	9.79
Gamma_1	0.501	0.134	3.752		0.749	0.136	5.50

	MODEL A				MODEL B		
	Without controls for unobserved heterogeneity				*Including controls for unobserved heterogeneity*		
	Coeff	**Std err**	**t-stat**		**Coeff**	**Std err**	**t-stat**
Gamma_2	-3.207	0.162	19.8		-3.429	0.163	21.09
Education (base, low)							
Medium	0.027	0.047	0.569		-0.108	0.055	1.96
High	0.117	0.056	2.074		-0.059	0.066	0.89
Free School Meals (FSM) at age 11	-0.130	0.066	1.964		-0.098	0.074	1.34
Father's SES							
SES I	0.104	0.094	1.109		0.085	0.111	0.77
SES II	0.048	0.059	0.807		0.015	0.068	0.22
SES III	-0.002	0.048	0.047		-0.019	0.054	0.35
SES IV	-0.049	0.060	0.814		-0.049	0.068	0.72
SES data missing	0.052	0.093	0.562		0.054	0.107	0.51
Mother's Education (base, left school before age 15)							
Mother left school aged 15 to 16	-0.015	0.043	0.35		-0.016	0.049	0.33
Mother left school aged 16 to 17	-0.015	0.065	0.23		-0.026	0.075	0.35
Mother left school aged 17 or more	-0.042	0.068	0.626		-0.035	0.079	0.44
Ability Test Score Age 11 (base, lowest quintile)							
Highest quintile	-0.043	0.062	0.695		-0.112	0.072	1.57
Second quintile	-0.069	0.058	1.173		-0.136	0.066	2.05
Third quintile	-0.088	0.060	1.459		-0.166	0.069	2.42
Fourth quintile	-0.059	0.059	0.99		-0.097	0.066	1.46
Ability test: missing data	-0.010	0.067	0.155		-0.060	0.075	0.80
Religion (base, no religion)							
Anglican	0.111	0.039	2.873		0.144	0.044	3.30
Roman Catholic	0.065	0.056	1.153		0.037	0.063	0.58
Other Christian	0.025	0.053	0.475		0.046	0.060	0.77
Non-Christian religion	0.164	0.171	0.962		0.250	0.194	1.29
Number of Siblings (age 16, base one sibling)							
No Siblings	-0.033	0.082	0.405		0.002	0.095	0.02
Two siblings	0.076	0.051	1.488		0.121	0.059	2.05
Three Siblings	0.124	0.059	2.099		0.184	0.067	2.74
Four or more siblings	0.140	0.057	2.436		0.229	0.066	3.47
Siblings: missing data	-0.021	0.054	0.391		0.009	0.061	0.15
Unemployment (lagged)	0.008	0.005	1.572		0.054	0.007	8.33
Factor Loading					3.031	0.335	9.06
Third Birth							
Intercept	-1.721	0.183	9.426		-6.539	0.642	10.19
Gamma_1	-0.350	0.230	1.524		-0.032	0.234	0.14
Gamma_2	-2.188	0.304	7.206		-2.450	0.306	8.02
Education (base, low)							
Medium	-0.309	0.086	3.594		-0.454	0.097	4.66
High	-0.217	0.098	2.222		-0.380	0.110	3.44

	MODEL A			MODEL B		
	Without controls for unobserved heterogeneity			***Including controls for unobserved heterogeneity***		
	Coeff	**Std err**	**t-stat**	**Coeff**	**Std err**	**t-stat**
Free School Meals (FSM) at age 11	0.383	0.094	4.063	0.443	0.109	4.07
Father's SES						
SES I	0.111	0.155	0.721	0.125	0.178	0.70
SES II	-0.218	0.103	2.117	-0.260	0.118	2.20
SES III	-0.104	0.076	1.373	-0.126	0.088	1.43
SES IV	-0.149	0.094	1.577	-0.166	0.109	1.52
SES data missing	-0.320	0.154	2.082	-0.329	0.172	1.91
Mother's Education (base, left school before age 15)						
Mother left school aged 15 to 16	0.009	0.071	0.131	0.011	0.081	0.13
Mother left school aged 16 to 17	0.217	0.106	2.046	0.241	0.121	1.99
Mother left school aged 17 or more	0.289	0.114	2.528	0.321	0.131	2.46
Ability Test Score Age 11 (base, lowest quintile)						
Highest quintile	-0.313	0.104	3.01	-0.377	0.119	3.17
Second quintile	-0.218	0.093	2.337	-0.256	0.107	2.39
Third quintile	-0.296	0.097	3.055	-0.346	0.112	3.09
Fourth quintile	-0.136	0.091	1.501	-0.139	0.105	1.33
Ability test: missing data	-0.073	0.102	0.711	-0.109	0.119	0.92
Religion (base, no religion)						
Anglican	0.036	0.064	0.561	0.089	0.073	1.21
Roman Catholic	0.187	0.088	2.14	0.227	0.100	2.26
Other Christian	0.010	0.090	0.108	0.040	0.102	0.39
Non-Christian religion	0.409	0.222	1.841	0.667	0.259	2.58
Number of Siblings (age 16, base one sibling)						
No Siblings	-0.079	0.152	0.517	-0.093	0.167	0.56
Two siblings	0.165	0.088	1.885	0.174	0.099	1.76
Three Siblings	0.194	0.097	2	0.204	0.111	1.85
Four or more siblings	0.324	0.092	3.525	0.411	0.106	3.87
Siblings: missing data	0.122	0.090	1.36	0.115	0.101	1.14
Unemployment (lagged)	0.001	0.010	0.066	0.028	0.011	2.62
Factor Loading				5.664	0.671	8.45
Log likelihood	-10,339.32			-9,740.96		

Table 7 Hazard Model for Timing of First Three Births: BCS Results

	MODEL A				MODEL B		
	Without controls for unobserved heterogeneity				*Including controls for unobserved heterogeneity*		
	Coeff	**Std err**	**t-stat**		**Coeff**	**Std err**	**t-stat**
First Birth							
Intercept	0.481	0.172	2.79		-1.512	0.254	5.96
Gamma_1	2.456	0.150	16.37		2.367	0.168	14.11
Gamma_2	-1.535	0.141	10.86		-0.620	0.169	3.66
Education (base, low)							
Medium	-0.273	0.040	6.82		-0.442	0.060	7.39
High	-0.695	0.054	12.87		-1.281	0.077	16.54
Free School Meals (FSM) at age 10	0.293	0.050	5.89		0.550	0.073	7.51
FSM data missing	0.153	0.074	2.07		0.069	0.107	0.65
Father's SES							
SES I	-0.420	0.129	3.27		-0.509	0.189	2.69
SES II	-0.387	0.097	3.99		-0.495	0.150	3.31
SES III	-0.288	0.088	3.28		-0.316	0.137	2.32
SES IV	-0.331	0.097	3.40		-0.263	0.150	1.75
SES data missing	-0.314	0.097	3.25		-0.231	0.151	1.53
Mother's Education (base, less than 10 yrs f/t education)							
10 yrs of f/t education	0.081	0.076	1.07		0.103	0.108	0.95
11 yrs of f/t education	-0.118	0.088	1.35		-0.063	0.124	0.51
12 or more yrs of f/t education	-0.017	0.089	0.19		-0.032	0.128	0.25
Mother's education data missing	0.066	0.080	0.83		0.108	0.115	0.94
Ability Test Score Age 10 (base, lowest quintile)							
Highest quintile	-0.291	0.065	4.45		-0.555	0.095	5.85
Second quintile	-0.218	0.059	3.68		-0.520	0.085	6.11
Third quintile	-0.218	0.057	3.84		-0.333	0.084	3.94
Fourth quintile	-0.062	0.054	1.14		-0.154	0.080	1.91
Ability test: missing data	-0.242	0.057	4.27		-0.406	0.082	4.94
Religion (base, no religion)							
Anglican	0.117	0.045	2.59		0.004	0.065	0.05
Roman Catholic	-0.040	0.062	0.64		-0.159	0.088	1.81
Other Christian	0.000	0.051	0.00		-0.086	0.073	1.17
Non-Christian religion	0.104	0.104	1.00		0.129	0.148	0.87
Number of Siblings (age 16, base one sibling)							
No Siblings	0.083	0.056	1.49		0.171	0.082	2.07
Two siblings	0.150	0.053	2.81		0.210	0.078	2.70
Three Siblings	0.260	0.073	3.54		0.320	0.107	2.98
Four or more siblings	0.505	0.085	5.97		0.612	0.124	4.93
Siblings: missing data	0.077	0.045	1.71		0.150	0.065	2.33
Unemployment (lagged)	-0.043	0.009	4.59		-0.048	0.009	5.12
Factor Loading					3.690	0.178	20.78
Intercept	-0.473	0.194	2.44		-2.779	0.438	6.34

	MODEL A				MODEL B		
	Without controls for unobserved heterogeneity				*Including controls for unobserved heterogeneity*		
	Coeff	**Std err**	**t-stat**		**Coeff**	**Std err**	**t-stat**
Gamma_1	2.628	0.228	11.53		3.213	0.245	13.12
Gamma_2	-5.994	0.396	15.13		-6.737	0.409	16.48
Education (base, low)							
Medium	-0.030	0.051	0.59		-0.088	0.059	1.49
High	0.045	0.065	0.68		-0.115	0.077	1.49
Free School Meals (FSM) at age 10	-0.024	0.068	0.35		0.054	0.078	0.69
FSM data missing	0.141	0.098	1.43		0.177	0.108	1.64
Father's SES							
SES I	0.424	0.173	2.46		0.398	0.201	1.99
SES II	0.290	0.134	2.16		0.287	0.152	1.89
SES III	0.087	0.125	0.69		0.069	0.141	0.49
SES IV	0.133	0.137	0.97		0.109	0.155	0.70
SES data missing	-0.026	0.136	0.19		-0.048	0.154	0.31
Mother's Education (base, less than 10 yrs f/t education)							
10 yrs of f/t education	0.099	0.099	1.00		0.149	0.113	1.32
11 yrs of f/t education	0.296	0.112	2.66		0.375	0.128	2.92
12 or more yrs of f/t education	0.107	0.115	0.92		0.155	0.132	1.17
Mother's education data missing	0.145	0.106	1.37		0.184	0.120	1.53
Ability Test Score Age 10 (base, lowest quintile)							
Highest quintile	0.041	0.081	0.50		-0.022	0.096	0.23
Second quintile	-0.066	0.075	0.88		-0.162	0.087	1.87
Third quintile	-0.053	0.074	0.72		-0.114	0.085	1.33
Fourth quintile	-0.089	0.072	1.24		-0.144	0.084	1.72
Ability test: missing data	-0.063	0.073	0.86		-0.149	0.084	1.76
Religion (base, no religion)							
Anglican	0.142	0.057	2.46		0.181	0.066	2.75
Roman Catholic	-0.111	0.080	1.39		-0.141	0.091	1.55
Other Christian	0.083	0.066	1.26		0.105	0.076	1.39
Non-Christian religion	0.120	0.128	0.94		0.129	0.147	0.88
Number of Siblings (age 16, base one sibling)							
No Siblings	-0.211	0.072	2.93		-0.206	0.081	2.53
Two siblings	0.081	0.065	1.24		0.141	0.077	1.83
Three Siblings	0.052	0.094	0.56		0.063	0.108	0.58
Four or more siblings	-0.057	0.119	0.48		-0.004	0.137	0.03
Siblings: missing data	-0.142	0.056	2.52		-0.124	0.064	1.92
Unemployment (lagged)	0.008	0.007	1.04		-0.032	0.009	3.49
Factor Loading					3.670	0.456	8.05
Intercept	-2.328	0.332	7.00		-12.377	1.611	7.68
Gamma_1	2.233	0.475	4.70		4.844	0.664	7.29
Gamma_2	-4.230	0.888	4.76		-5.943	1.104	5.38
Education (base, low)							

	MODEL A				MODEL B		
	Without controls for unobserved heterogeneity				*Including controls for unobserved heterogeneity*		
	Coeff	**Std err**	**t-stat**		**Coeff**	**Std err**	**t-stat**
Medium	-0.024	0.101	0.24		-0.154	0.158	0.97
High	0.331	0.147	2.25		0.045	0.224	0.20
Free School Meals (FSM) at age 10	0.346	0.113	3.06		1.058	0.194	5.46
FSM data missing	-0.042	0.172	0.24		0.410	0.281	1.46
Father's SES							
SES I	0.097	0.355	0.27		-0.050	0.512	0.10
SES II	0.037	0.242	0.15		-0.140	0.352	0.40
SES III	0.080	0.215	0.37		-0.221	0.310	0.71
SES IV	0.225	0.232	0.97		0.203	0.336	0.60
SES data missing	-0.044	0.237	0.19		-0.375	0.346	1.08
Mother's Education (base, less than 10 yrs f/t education)							
10 yrs of f/t education	-0.332	0.157	2.11		-0.181	0.246	0.74
11 yrs of f/t education	-0.416	0.197	2.11		-0.251	0.310	0.81
12 or more yrs of f/t education	-0.660	0.212	3.12		-0.696	0.325	2.14
Mother's education data missing	-0.288	0.170	1.69		-0.306	0.269	1.14
Ability Test Score Age 10 (base, lowest quintile)							
Highest quintile	0.167	0.174	0.96		-0.202	0.251	0.80
Second quintile	0.354	0.147	2.40		0.254	0.231	1.10
Third quintile	-0.007	0.149	0.05		-0.369	0.232	1.59
Fourth quintile	0.091	0.136	0.67		-0.270	0.209	1.29
Ability test: missing data	0.413	0.130	3.18		0.234	0.202	1.16
Religion (base, no religion)							
Anglican	0.196	0.112	1.74		0.339	0.170	2.00
Roman Catholic	0.039	0.167	0.24		-0.028	0.257	0.11
Other Christian	0.153	0.131	1.17		0.354	0.199	1.78
Non-Christian religion	0.458	0.204	2.24		0.758	0.332	2.28
Number of Siblings (age 16, base one sibling)							
No Siblings	0.023	0.147	0.15		-0.162	0.222	0.73
Two siblings	0.250	0.129	1.94		0.248	0.203	1.23
Three Siblings	0.274	0.171	1.60		0.504	0.273	1.85
Four or more siblings	0.258	0.189	1.36		0.474	0.284	1.67
Siblings: missing data	0.018	0.115	0.16		-0.049	0.173	0.28
Unemployment (lagged)	0.133	0.015	9.08		0.027	0.025	1.09
Factor Loading					14.115	1.655	8.53
Log Likelihood	-7214.04				-7055.63		

There was a strong, positive relationship between the experience of poverty in childhood (as measured by receipt of free school meals) and the hazard of the first birth. This applied to both cohorts and regardless of whether the model specification controlled for unobserved heterogeneity. The size of estimated coefficients was similar for NCDS and BCS samples. There was little evidence of any relationship of childhood poverty with the hazard of the second birth for either cohort. For NCDS women the free school meals variable was marginally significant in models which did not control for unobservables, but this effect disappeared once controls for unobserved heterogeneity were included.

The hazard of the first birth tended to be higher for those cohort members whose fathers were in lower SES categories. This finding applied to both cohorts. As for the second birth, father's SES variables were largely non-significant, but for the younger cohort there was some evidence of higher hazards of second births for women whose fathers were in higher SES groups. On the whole, the education level of the cohort member's own mother appeared to have little association with birth hazards. Exceptions were that the cohort member's mothers leaving school at age 15 or 16 was associated with higher hazard of first birth for NCDS while 11 years of mother's completed schooling was associated with a higher hazard of second birth for the BCS cohort. Certain coefficients were statistically significant, but there was no clear pattern to these results.

Those cohort members who scored highly on general ability tests in childhood tended to have a reduced hazard for first births. The magnitude of this association increased once controls for unobservables were included in the models, and it was larger for NCDS women than for BCS women. There was less evidence that hazards of the second birth were associated with the ability test scores, but for NCDS it seemed that those in the second or third quintiles of attainment tended to have a higher second birth hazard.

The models also included measures of the religion of cohort members. The hazard of first births was lower for Roman Catholics in both cohorts and was statistically significant for the NCDS women, but not quite so for the BCS women. Those who were Church of England also had an increased hazard for the second birth in both cohorts. It may also be worth noting that third birth hazards were higher for Roman Catholic and those of non-Christian religion, which was perhaps more in line with prior expectations.
NCDS and BCS cohort members who had a large number of siblings also had a significantly higher hazard for the first birth. The number of siblings was also positively associated with the second birth for NCDS; this finding did not apply consistently for BCS women but those with no siblings had a significantly lower hazard than those with one sibling.

It may also be of interest to report some information about the non-parametric heterogeneity distributions estimated in the models for NCDS and BCS, and this is done in Table 8. The procedure here was that two of the mass points were fixed at zero and one and other mass points and all associated probabilities were freely estimated. We began by estimating a distribution with just two mass points and increased the number of points until two converged on the same location. The outcome of this process was different for NCDS and BCS. In the case of the models for NCDS a distribution with six mass points could be estimated, while for BCS there were just three mass points.

Table 8: Estimated Mass Points and Probabilities

NCDS			
Location	SD	Cumulative Probability	SD
0.00000	0.00000	0.13258	0.00989
0.46785	0.04192	0.25559	0.07704
0.59949	0.07893	0.39177	0.09280
0.74234	0.06201	0.63190	0.17446
0.85187	0.03583	0.89496	0.04325
1.00000	0.00000	1.00000	0.00000
BCS			
0.00000	0.00000	0.33621	0.01462
0.75971	0.02120	0.87491	0.01242
1.00000	0.00000	1.00000	0.00000
See Tables 6 and 7 for details of the estimated model			

6. Discussion

Probably the most important findings of this research are that education is negatively related to the timing of the first birth and that this effect is still observed – in fact becomes stronger – in models which allow for unobserved heterogeneity. Since the estimates control for unobserved heterogeneity, the results are consistent with an interpretation which sees education as having a causal effect on fertility rather than there just being an association with education.[1] The explanation for this would be that not only is childbearing avoided during studies, but once a woman is on the labour market earnings reach higher levels than those which might be achieved if first childbearing is not delayed. Women who attain higher levels of education have higher earning potential and so a larger opportunity cost in terms of lost earnings of if time is spent out of the paid labour force giving birth to, and looking after, children. Once controls for unobservables were included, there was no evidence of any relationship between education and the hazard of second births.

The relationship between fertility and labour market conditions, as measured by an aggregate, time-varying series for the unemployment rate was also an important part of our research agenda. The main findings were that unemployment was negatively related to the hazard of the first birth, but this was only statistically significant among the later, BCS, cohort while, for higher order births, there was evidence of a positive relationship of birth hazards with unemployment for the earlier, NCDS, cohort. In the paper by Dex et al (2005), in which all the current research team were involved, some evidence was found of a positive relationship between the hazard of the first birth and unemployment. This earlier paper may be regarded as a preliminary exploration of the effect of labour market conditions on the timing of births. The same two cohorts were used but with data only up to the year 2000, when the younger cohort were aged 30, used unadjusted unemployment data and the models estimated were simple Cox models with few covariates and no controls for unobservables. The present paper supercedes our earlier work for Britain and suggests a rather different pattern of results. It was also the case that the positive association between unemployment and higher order births only emerged as significant once we estimate three transitions, but was not significant when the model was estimated only for the first two births. Results for unemployment, then, do seem to be sensitive to the dataset used and the way that the model is specified.

As to why the relationship of birth hazards and unemployment might differ between the two cohorts, the most likely explanation is the differing labour market conditions which they encountered. The earlier cohort, NCDS, were born in 1958 and so reached the minimum school-leaving age of 16 in 1974 when the unemployment rate was still quite low. It steepled upwards in 1979-80 when this cohort were in their early twenties and remained high for much of the 1980s. The younger cohort, BCS, became 16 in 1986

[1] Controlling robustly for heterogeneity allows us to be much more confident that education is having an effect on fertility behaviour. However, it is possible to think of circumstances in which such results would be consistent with education not being causally linked to fertility. For example, if there are unanticipated shocks which impact on education and hence on fertility.

when unemployment was high, but on a downward trend; they experienced rising unemployment between the ages of roughly 20 to 23 and labour market conditions improved steadily thereafter. In other words, in the teenage years when the vast majority of both cohorts were still at risk for their first birth the 1958 cohort faced much lower levels of unemployment than the 1970 cohort who continued to face relatively high unemployment into their mid-twenties. Moreover, the 1958 cohort did not face the highest rates of unemployment until they were in their thirties, by which time most of them had had their first birth. In addition, an important caveat is that we only observe the later cohort until the age of 34, in 2004, so that it will be some time and several further sweeps of data collection before their complete birth histories will be available for analysis.

The effects of other covariates in the models appeared to be broadly similar across the two cohorts. For example, NCDS and BCS cohort members who had a large number of siblings also had a significantly higher hazard for the first birth. There was also a positive relationship between the experience of poverty in childhood (as measured by receipt of free school meals) and the hazard of the first birth for both cohorts. This confirms that in Britain women from disadvantaged backgrounds tend to be more likely to make an early entry into motherhood. While the findings in this paper refer to cohorts of women born in 1958 and 1970, Hawkes (2009) shows that it also holds in a survey of more recent origin, the Millennium Cohort Study.

In demographic research, and more generally in the literature on duration analysis, there has been debate on the best way to control for heterogeneity. Heckman and co-authors have advocated a robust, non-parametric approach and this method has been utilised in some studies of fertility (although not previously for UK data). Heckman and Walker (1990) analysed data on the first three births for four cohorts of Swedish women and actually found that unobserved heterogeneity terms were not statistically significant, concluding that “unobservables correlated across spells are not an important feature of modern Swedish fertility data”. In contrast Merrigan and St-Pierre (1998) conducted a very similar analysis (in terms of explanatory variables and modelling strategy) on Canadian birth history data and found non-parametric heterogeneity to be important. We have also utilised Heckman and Singer’s non-parametric method to control for unobservables. Controlling for heterogeneity improved the fit of the models in that the likelihood was increased and the factor loading terms in our models were highly significant for all transitions. Moreover, controlling for unobserved heterogeneity made a considerable difference to substantive research findings. In models which did not allow for unobservables it appeared that there was a positive association between education and the hazard of second birth for the NCDS cohort. Also, unemployment did not appear to be related to the timing of higher-order births. Once controls for unobservables were incorporated into the models education was no longer significantly related to second birth hazards, while it became apparent that there was a positive association between unemployment and the hazards of second and third births for the NCDS cohort. These results affirm the importance of including robust controls for unobservables when modelling the timing of births.

7. Conclusion

In this paper we have presented analyses of the effects of women's education and aggregate unemployment rates on the hazards of first and higher-order births among British cohorts. Essentially the objectives of the research were to discern the impact on fertility of the long-term trend towards more education among younger cohorts and also to test whether labour market conditions have tended to mitigate or to exacerbate such trends. Much of the previous literature on aggregate unemployment has focused only on the first birth and often rather sparse models with few covariates as controls have been estimated due to data limitations. We contribute to research in this field by estimating models for times to first and higher order births, by allowing for unobservables to be correlated across spells and by utilising rich cohort datasets which allow us to include controls for a range of family background variables. Our main finding is that the hazard of first birth was negatively related to higher levels of education. Moreover, since we control robustly for unobserved heterogeneity we argue that our results are consistent with education having a causal effect on fertility, rather than there merely being an association between these variables. Once controls for unobservables were included, there was no evidence of any relationship between education and the hazard of second births. The unemployment rate was also negatively related to the hazard of first birth, but this was only statistically significant among the more recent, BCS, cohort while for higher order births there was evidence of a positive association of birth hazards with unemployment among the earlier, NCDS, cohort. Controls for unobserved heterogeneity improved the fit of estimated models and also made a difference to substantive results, highlighting the importance of incorporating robust controls for unobservables into the modelling of birth hazards.

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