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Fertility transition in England and Wales: continuity and change *

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Abstract

The focus of this paper is whether the transition from high to low fertility reveals continuity or discontinuity with the past. Our analyses of districts of England and Wales over time reveal an overall picture of continuity. Specifically, we show that (1) a substantial proportion of districts experienced pretransition variations in marital fertility that were so large that they are suggestive of deliberate fertility control; (2) the changes over time in the distributions of marital fertility levels and the relative importance of marital fertility levels to the determination of overall fertility levels were gradual and smooth; (3) the proportion of districts dominated by marital fertiliity variation, as opposed to nuptiality variation, increased gradually over time, and both marital fertility and nuptiality variations were present in all periods considered; and (4) there are important relationships between changes over time in marital fertility and socio-economic variables in periods both before and after the transition. The last conclusion is based on our estimated equations from the pooled cross-sectional, time-series data. Moreover, these estimated equations reveal relationships between changes in specific explanatory variables and changes in marital fertility that are very similar both before and after the onset of the transition.

Continuity or discontinuity in processes of the fertility transition

Declines in fertility levels began in many west and northwest European countries during the last quarter of the nineteenth century. Classification of time into pre-transition and post-transition periods has become a common practice in many studies of fertility processes. This paper deals with the continuity or discontinuity of various aspects of fertility processes during pre-transition and post-transition periods. One interpretation of the term continuity, in the context of fertility transition processes, is that both marital fertility and nuptiality were important determinants of overall fertility before and after the onset of the fertility transition.

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In this introductory section, we discuss marital fertility and nuptiality in turn. Clearly, marital fertility control played an important role in post-transition fertility processes. However, there remains the controversial question of whether pre-transition populations practised marital fertility control to any significant degree. If populations exercised marital fertility control both before and after the transition, then one criterion for the continuity of fertility processes is met. If not, then the fertility transition can be described as a radical departure from traditional behaviour.

In addition to considering whether pre-transition populations practised marital fertility control, we reflect on the question of the continuing importance of nuptiality, after the transition. It is well established that nuptiality was an important factor affecting overall fertility in Europe before the transition to lower levels (Hajnal 1965; Smith 1981; Friedlander 1992). Did nuptiality remain an important determinant of overall fertility after the transition, or was its role usurped by marital fertility? If nuptiality remained an important determinant of overall fertility after the transition, then another criterion for the continuity of fertility processes is met.

Judith Blake (1985) argues that the processes of fertility transition are continuous, rather than discontinuous, in nature. Our interpretation of continuity implies that changes in fertility are gradual and smooth and that explanatory models of fertility reveal similar patterns before and after the transition. This aspect of continuity in the transition process can be considered and evaluated in several ways. Our focus on small geographic units, districts of England and Wales over time, allows us to consider changes in the cross-sectional distributions of levels of, and time-variations in, marital fertility and nuptiality, over the course of the fertility transition. For example, we ask whether the distributions of marital fertility and nuptiality across geographical units reveal a gradual shift to lower fertility levels over time, or whether changes in the distributions are abrupt. Is there a large degree of overlapping in the distributions in consecutive periods? We associate changes that are gradual and smooth with continuous fertility processes; changes that are abrupt are reflections of discontinuous processes.

Explaining fertility change

What kinds of explanatory variables are associated with the transition? The present analysis of explanatory models of fertility focuses only on models of marital fertility. Theories emphasizing the importance of socio-economic variables focus on the changing costs and benefits of children as the major cause of fertility decline. These costs and benefits are functions of the roles of children in the family under varying socio-economic and demographic conditions (e.g. Caldwell 1982). Traditional demographic transition theory can be viewed as one variant of these socio-economic explanations.

Ideational and cultural theories of marital fertility decline, on the other hand, often focus on the importance of the processes of secularization and individuation. One definition of secularization is the declining centrality of religion that engages in institutional regulation of conduct through assertion of norms that restrict individual behaviour (Lesthaeghe and Surkyn 1988). These ideational changes are, in turn, related to growing acceptability of fertility control within marriage (Cleland and Wilson 1987). The secularization of norms and the decline in religion parallel the rise of individual decision-making and the emphasis on individual responsibility.

Which of these two kinds of variables was dominant in the explanation of marital fertility patterns? It seems to us that theoretical considerations and empirical research suggest that a formulation of transition theory in terms of only one of these two alternative approaches is artificial. Even under situations of very rapid socio-economic change that conflicts with sustained high fertility, we would expect that transitional patterns would be affected also by ideational variables. Indeed, differentials in social and religious norms would certainly affect the pace and intensity of fertility changes. Similarly, it would be unrealistic to suppose that even in a society with deeply-rooted cultural norms related to fertility control, socio-economic differentials would not affect the patterns of fertility change. Hence, an appropriate formulation of transitional processes would be in terms of both ideational and socio-economic forces. We expect that culture operates in a socio-economic environment and vice versa.

A distinction should be made between theoretical considerations and actual research limitations. In practice, research environments in which a reasonable selection of both kinds of variables is available to the investigator are extremely rare. Therefore, analyses that show the existence of significant socio-economic and/or ideational interrelationships with transitional processes, within a consistent theoretical framework, are the best that one can hope for. In this analysis of fertility transition in England and Wales, we are limited to a selection of socio-economic variables. It is important to keep this limitation in mind when interpreting empirical findings.

We believe that another important issue relates to continuity: is there stability in the interrelationships between marital fertility and explanatory variables, both socio-economic and ideational? Do the specific interrelationships between the changes in marital fertility and changes in each of the explanatory variables reveal relative stability before, during and after the transition? This approach to studying fertility transition was introduced by Richards (1977) who considered the changing relationships between marital fertility and explanatory variables during different stages of the transition in Germany.

The identification of ideational explanation with discontinuity and innovation

Many studies have made a theoretical connection between discontinuity in the trajectory of fertility decline and the characterization of fertility control as an innovation in human reproductive behaviour at the time of the fertility transition. It has been argued that 'the shift from natural fertility to family limitation and the resulting decline in marital fertility reflected a radical change in the reproductive behaviour of couples and societies' (van de Walle and Knodel 1980:27). In particular, the fertility transition was interpreted as an innovation in family limitation.[1] This innovative behaviour was understood to have been linked to ideational change. The identification of ideational change with discontinuity followed from this linkage.

Here, we challenge the identification of ideational change with discontinuity of fertility processes. Ideational change may be an important explanatory factor of fertility change, even if fertility control was practised, albeit to a more limited extent, before the onset of the transition. Ideational change may occur smoothly over time, leading to gradual changes in fertility behaviour.

Thus, while continuity of fertility processes is inconsistent with the theory of family limitation as an innovation in reproductive behaviour, a finding of continuity of fertility processes does not necessarily identify the causes of the fertility decline. It is likely that both sets of variables, socio-economic and ideational, may be associated with continuity of fertility decline.

Outline of this paper

In the next section, we describe our data and variables. In the third section we describe changes in the distributions of marital fertility and nuptiality over time, in an attempt to assess the continuity of fertility processes across different periods surrounding the onset of the fertility decline. In the fourth section we investigate the relationships between marital fertility change and changes in explanatory variables, in order to assess the importance of socio-

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[1] Conclusions concerning the occurrence of an innovation in marital fertility control in the form of parity-dependent control were largely based on the small magnitude of estimated Coale-Trussell *m* values for a limited number of pre-transitional populations. Criticisms of this line of research centre, among other things, on measurement problems associated with *m* (Okun 1994) and on other evidence that suggests that regulation of marital fertility was present in pre-transitional societies (Livi-Bacci 1968; Lee 1978; Blake 1985; David et al. 1988; Friedlander and Okun 1995; Santow 1995).

economic explanation of fertility change, and provide an evaluation of the continuity of these relationships over time. We end the paper with a summary and concluding remarks.

Data and variables

Our analyses of England and Wales are based on official census and vital registration data that were published regularly for each of over 600 registration districts from the middle of the nineteenth century. Marital fertility and overall fertility are measured in terms of Coale's standard Ig, and If indices (Coale and Treadway 1986). Given that births were not reported by age of mother until the 1930s, we cannot calculate more refined fertility measures. Nuptiality is measured by Coale's index Im, as well as by the proportion of women ever-married at ages 20-24.

Published volumes of seven censuses provided age, sex, marital status, and occupational status distributions for each district. Vital registration provided the intercensal numbers of births and deaths. Adjustment for underregistration of births in each district was performed using the same procedure applied by Teitelbaum (1974) to county data. Essentially, census reports on the size of the 0-9 age group were used to estimate the number of births during the preceding decade, by back projections. The estimation procedure was applied to each of the 600 registration districts of England and Wales, for each of the seven decades 1851-1911. The estimates from this first stage were then modified to allow for the annual rate of change in the number of births as well as for the rate of net migration. The estimated births obtained were compared to the registered births, and corrective factors were thus calculated. On average, our corrective factors were similar to those found by Teitelbaum, and did not change estimated numbers of births by more than seven per cent. Ig and If values are based on ten years of births from vital registration, thus adjusted. While Ig is an imperfect reflection of the changing behaviour associated with the marital fertility transition, it provides the basis for an examination of marital fertility and its relation to socio-economic conditions (Guinnane, Okun and Trussell 1994).

Time-series variations in district-level marital fertility are the basis of our analyses. The date of the onset of the marital fertility decline is estimated for each district. The date of the onset of decline in marital fertility is typically taken here as the year corresponding to the value of Ig which immediately precedes a sustained decline. The maximum likelihood procedure used for the estimation of the date of the onset of the transition — T1 — is presented in detail in Friedlander, Pollak and Schellekens (1993).

By defining the onset of the transition as the year corresponding to the maximum value of Ig before a sustained decline, rather than as the year in which Ig attains a value that is 10 per cent lower than its maximum value (as was done in the European Fertility Project), we maintain a stricter criterion for categorizing periods as pre-transitional. This definition is used in order to minimize misclassification of transitional periods as pre-transitional and vice versa. Since one of our main goals is to study relationships of Ig to socio-economic variables in pre-transition periods relative to relationships in transitional periods, it is important to distinguish between the two.

There is an added intricacy to our classification of periods as pre-transitional or transitional because our values for Ig refer to ten-year periods (see above), while the estimates of the time of the onset of the transition — T1 — is a single year. Thus, we define the decade during which the onset occurs as pre-transitional if the onset occurred more than half-way through the period; otherwise the period is categorized as transitional. In this way, we reduce as much as possible misclassification of the two types of periods.

District populations vary in size, with a median population of 20,000, a lower quartile of 14,000, and an upper quartile of 31,000 in 1861. One advantage of our analysis is that the district populations are much smaller and more homogeneous than the province-level populations used in the European Fertility Project. At the same time, the district populations are larger and subject to much less random variation than populations based on village reconstitutions (see for example Levine 1977).

Occupational distributions, compiled separately for men and women in 1861, 1871, and 1881, are derived from census returns. The aggregated occupational categories that are used in our analyses are tertiary (professional and commercial), industrial, domestic, and agricultural. Also, we have used information on the number of men and women engaged in teaching in order to compute a ratio of teachers to the adult population. We use the ratio of teachers to the adult population, rather than the ratio of teachers to the population of children, as an explanatory variable in our fertility equations in order to avoid statistical problems that arise from the fact that the number of children is closely related to the dependent variable. The ratio of teachers to the adult population provides a measure of the quality and quantity of children's education. Children's education is an important measure of the costs of children to parents (Caldwell 1982). Other explanatory variables which will be used in our analyses include the logarithm of population density, which is the ratio between the total population and the acreage of the area. Density is a measure of urbanization. For further details concerning the definition of most of these variables see Friedlander (1983).

The continuity and change in distributions of marital fertility

Changing distributions of marital fertility and comparisons to nuptiality

Figure 1a contains boxplot diagrams of Ig values across districts in periods from 1851 to 1911. Clearly, the distributions of Ig values begin moving to the left, to lower levels of marital fertility, from 1871. Although there are increases in marital fertility in some districts after 1871, there is an overall decline in marital fertility after this period. Indeed, it is well known that the decade 1871-1881 marks the beginning of the onset of the fertility transition for many English districts. More important for our argument here is the gradual change in the distributions: that is, in the process of decline. There is enormous overlap between distributions of Ig in consecutive decades. We interpret this gradual change as an indicator of the continuity of fertility processes.

Figure 1a
Ig values across districts in periods from 1851 to 1911

Figure 1b presents boxplot diagrams of the proportion of married women aged 20-24 in consecutive decades. We also observe declines in nuptiality, starting from the last quarter of the nineteenth century. There is a striking similarity between marital fertility change and nuptiality change in the pattern of overlapping and gradually shifting distributions. Despite the great similarity between the two sets of distributions, the change in marital fertility has often been described as abrupt, while no similar description has been applied to changes in nuptiality.

The contribution of marital fertility to maintaining low levels of overall fertility

It is well-established that overall levels of fertility in historical Europe, including England, were well below the biological capacity of childbearing. Low levels of nuptiality explain a large part of this low fertility (Coale and Watkins 1986). It is of interest to trace the continuity and change in the relative importance of marital fertility and nuptiality in maintaining low overall fertility, during the various stages of overall fertility decline. The innovation view of fertility transition suggests that the relative importance of marital fertility should increase abruptly at the time of the transition, while a view emphasizing continuity would suggest gradual change.

We calculate an index of the relative importance of marital fertility in maintaining a given level of overall fertility by computing the ratio of Im to Ig values in each period. The larger the ratio between Im and Ig, the larger the relative contribution of marital fertility in keeping the level of overall fertility low. Figure 2 presents the boxplot distributions of the values of these ratios in each decade, over the districts. We note that there is a movement to the right in these distributions; that is, there is an increase in the relative contribution of marital fertility over time. Note, however, that this shift to the right is very gradual, and takes place over several decades. Thus, Figure 2 suggests the appropriateness of the more continuous, long-term view of the changing importance of marital fertility control, rather than the argument about abrupt changes in fertility.

Figure 1b
Proportion of married women aged 20-24 in consecutive decades

Short-term variations in marital fertility

Another aspect of fertility processes can be considered by examining changes in Coale's marital fertility and nuptiality indices over time in each district. To quantify the short-term variability of Ig, we compute the ratios of Ig values in different decades in each district, and multiply the ratios by 100. For example, if Ig in one district takes on the value of 0.80 in the decade 1851-1860, and the value 0.75 in the decade 1861-1870, we compute the change in Ig values between the consecutive decades as 100*(0.75/0.80)=94. Thus, values of less than 100 indicate a decrease in Ig between two decades; values greater than 100 indicate an increase between two decades.

In Figure 3, we portray the distributions of changes over time in marital fertility across districts, using boxplots. Each boxplot refers to the change between two consecutive decades; for example, the first distribution refers to changes in Ig values between the decades 1841-1850 and 1851-1860. There are three important points here. First, in each plot, including the plots that refer to the earlier periods, there is substantial variation across districts in the time-variability of Ig. Note that in every period, there are both increases and decreases in Ig. Over time, the balance between increases and decreases slowly moves towards greater decreases. This portrayal of fertility processes differs from previous research findings that show consistent stability in Ig values before the transition. Second, we see that over the decades 1841-1911, the boxplot slowly moves to the left, after an initial move to the right. This means that over the seven decades, the median change over time in Ig becomes increasingly large and negative. However, this change is not abrupt; rather we witness a gradual acceleration in median declines in Ig. Third, we note that there is very substantial overlap in the distribution of changes over time in Ig. The boxplot for each pair of consecutive decades overlaps to a large degree with the boxplot of the preceding and following pairs of decades. These three points are not consistent with a view of transition as an abrupt change.

Figure 2
Relative contribution (CONT) of Ig to reduction of IF

Figure 3
Decennial change in district Ig values, 1851-1911

Note: CHIG refers to 100* ratio of district values in consecutive decades, e.g. CHIG6151=100*lg1861/lg1851

Each boxplot in Figure 3 indicates that there was variation across consecutive decades in district-level Ig values. We now consider whether these variations were large enough to suggest non-random changes in Ig. Clearly, random variation in the ratios of Ig values will depend on population sizes in the relevant districts: larger districts will have less random variation. An estimate of the variance of the ratio of Ig values enables us to compute critical values of the ratios of Ig according to district population size. For example, we can calculate the proportion of district populations that experienced non-random variation in Ig values between the decades 1841-1850 and 1851-1860, at the five per cent significance level (see Friedlander and Okun 1995 for further details). Table 1 presents the cumulative proportions of districts in which non-random variations occurred. The cumulative proportion of districts that experienced non-random variation in Ig levels rises quickly over time, so that by the last period considered, all districts had experienced such change. If we disaggregate the districts into agricultural and non-agricultural groupings, we note that agricultural districts tend to experience less non-random change than non-agricultural districts, as may be expected.[2] Even in the earliest period, almost 50 per cent of the districts experienced non-random variation in Ig values between the decades 1841-1850 and 1851-1860. Earlier analyses suggest that in many instances, pre-transitional marital fertility variation over time was so large that it

[2] See Friedlander (1983) for details on the classification of districts into socio-economic types.

suggests changes in deliberate attempts to control marital fertility (Friedlander and Okun 1995).

The emerging dominance of marital fertility in short-term variations of overall fertility

Which demographic response, nuptiality or marital fertility, is dominant in its effect on changes in overall fertility? This question differs from the issue we discussed earlier, concerning the relative contribution of marital fertility and nuptiality in explaining the levels of overall fertility; here we attempt to disentangle the relative dominance of nuptiality and marital fertility with regard to changes in overall fertility.

Table 1
Cumulative percentage of districts experiencing non-random variation in marital fertility by time period and agricultural status

Date by which non-random variation occurs	All districts	Agricultural districts	Non-agricultural districts
1851-1860	48	36	58
1861-1870	71	63	79
1871-1880	83	77	88
1881-1890	93	90	97
1891-1900	98	97	100
1901-1910	100	100	100

Our definitions of short-term, time-series variations in nuptiality and overall fertility are analogous to our definition of time-series variation in marital fertility (see above); that is, variation in nuptiality and overall fertility is measured as 100 times the ratio of Im (and If) values from two different time periods. Suppose that in a given district, the nuptiality, marital fertility and overall fertility responses are 99, 91, and 90, respectively. Suppose that in another district these values are 93, 100, and 93. In the first example marital fertility dominates, while in the second example the nuptiality response dominates. In yet another example, these responses might be 105, 104, and 109. In this last example, the two effects are similar in their magnitude so that both contribute to the change in overall fertility. Clearly, in many cases there are no significant responses in overall fertility at all: for example when these values are 101, 101, and 102.

Here we examine nuptiality, marital fertility and overall fertility changes over non-consecutive periods.[3] For example, we examine nuptiality, marital fertility, and overall fertility levels in the decade 1861-1870 relative to the corresponding levels in the decade 1841-1850. Likewise we examine analogous changes between the decades 1871-1880 and 1851-1860, 1881-1890 and 1861-1870, 1891-1900 and 1871-1880, and lastly, 1901-1911 and 1881-1890. In a small minority of the districts, there was no substantial change in If. In these cases, there is no need to explain changes in overall fertility; thus, we do not consider this section of the analysis.

Table 2 presents the frequency distribution of districts by dominance of marital fertility or nuptiality response. The first panel, which refers to all districts, shows that between 1841-

[3] We examine changes over two non-consecutive decades, rather than over two consecutive decades, because we recognize that Im is inherently sluggish relative to Ig; that is, Im generally does not change as rapidly over a short period of time. This is so because Im is a function of the marital status distribution of the population; unlike Ig, Im is not directly a function of vital events.

1850 and 1861-1870, 35 per cent of districts are characterized by a dominant marital fertility response, 36 per cent by a dominant nuptiality response, and 28 per cent by roughly equal nuptiality and marital fertility responses. In the later periods, the proportion of districts characterized by dominance of Ig response increases, while the proportions characterized by dominance of Im response or by roughly equal marital fertility and nuptiality responses declines. We note also that the second and third panels reveal that in industrial and urban-commercial districts, the marital fertility response is more likely to dominate than in agricultural districts (see footnote 2).

Although the fertility transition is characterized by large increases in the dominance of Ig over time, there remains a substantial minority of districts characterized by dominance in nuptiality response in all but the last period. In contrast to other views of the fertility transition which emphasize the sole importance of changes in Ig during the transition, the evidence presented here shows that changes in both Ig and Im were important in the process of overall fertility change before, during, and after the transition.

Table 2
Frequency distribution of changes in overall fertility by dominance of response by marital fertility or nuptiality

	1851-1870	1861-1880	1871-1890	1881-1900	1891-1911
All districts					
Dominance of I_g	0.35	0.38	0.53	0.58	0.86
Dominance of I_m	0.36	0.25	0.15	0.12	0.03
Equal responses	0.28	0.38	0.29	0.29	0.12
Industrial and urban/commercial districts					
Dominance of I_g	0.45	0.39	0.77	0.79	0.88
Dominance of I_m	0.35	0.30	0.09	0.06	0.06
Equal responses	0.20	0.30	0.13	0.15	0.06
Agricultural districts					
Dominance of I_g	0.36	0.38	0.46	0.51	0.89
Dominance of I_m	0.32	0.23	0.17	0.15	0.01
Equal responses	0.32	0.38	0.27	0.33	0.10

What lies behind the fertility processes?

We suggest above that marital fertility processes during the 70-year period under study are continuous in a descriptive sense. In the process of transition, we observe the gradual declines in marital fertility, and at the same time, a gradually increasing relative importance of marital fertility over nuptiality in determining both levels and changes in overall fertility. We now ask what were the socio-economic and demographic factors underlying these fertility processes. We consider whether socio-economic explanations of fertility change are continuous, in the following two ways. First, are explanations of cross-sectional differences in marital fertility similar to explanations of marital fertility change over time? Second, are explanations of marital fertility change over time similar in periods before and after the onset of the fertility transition?

We begin with an analysis of cross-sectional variation in marital fertility, and in the next section, we move on to cross-sectional and time-series analyses. Cross-sectional relationships between socio-economic variables and marital fertility levels at a point in time are indicative not only of structural relationships at that time; they are also suggestive of the kinds of relationships which existed before that time. For example, we suggest that variables, such as urbanization and education, that have significant and substantial explanatory power in the cross-section during the period 1851-1860 (see below), reflect relationships between these explanatory variables and fertility processes during even earlier periods, for which we lack data. If these same variables also explain variations in marital fertility over time in periods for which we do have data, then we have some support for the view of the continuity of fertility processes. On the other hand, if we find that cross-sectional marital fertility interrelationships bear little resemblance to time-series interrelationships that we observe in the data, then this would cast doubt upon the continuity of fertility processes. As we show below, both our cross-sectional and time-series analyses indicate that there are important relationships between marital fertility and specific socio-economic variables.

Consider the simplest type of cross-sectional model. We take values of Ig during the decade 1851-1860 as well as explanatory variables in 1861. The explanatory variables include the logarithm of density, the proportions of the male workforce engaged in industry, and the ratio of teachers to population aged 20+. We find relationships in the expected directions in all three cases (standardized regression coefficients presented in parentheses): marital fertility is negatively related to density (-0.42), proportions in industry (-0.08), and the ratio of teachers to population aged 20+ (-0.37). All of the explanatory variables are statistically significant at conventional levels, and the model has an R2 of 0.37.

Pooled cross-sectional time-series models

We now explore models of changes in Ig over time and across districts. We show in the following analyses that in periods both before and after the onset of the transition, changes over time in marital fertility can be explained in terms of changes in urbanization, occupational structure, and other socio-economic variables. We argue that marital fertility processes are continuous, because of their close connection to the same set of explanatory variables both before and after the onset of the transition. Our findings of continuity in fertility processes are consistent with the findings discussed earlier. We first provide a technical explanation of our analyses, and then move on to provide intuitive explanations and interpretations of our results. Readers less interested in the technical explanation may move directly to the Results section.

We estimate four models, using cross-sectional and time-series data on Ig and explanatory variables for 535 districts in three different time periods: 1861-1870, 1871-1880, and 1881-1890. In the first model, we have a pooled regression of 1605 (535*3) observations. In this model, we allow the intercept of the regression model to differ in periods before and after the onset of the marital fertility transition. That is, for each observation in each district, a dummy variable takes on the value zero for each observation which dates before the onset of the transition, and the value one otherwise. The statistical significance and importance of this dummy variable allows us to test, in a multivariate framework, whether there was an important, unexplained change in the level of Ig following the onset of the transition. In comparing this model with the cross-sectional models discussed above, we note that the time-series nature of this model allows us to test the significance of the 'before-after' effect, while this is clearly impossible in a purely cross-sectional model. We will refer to this model as the 'before-after' model. It has at least two disadvantages: it forces the relationship between Ig and the explanatory variables to remain constant over time; and it mixes together cross-sectional relationships (across districts) with time-series changes.

To address the first problem, in the second model, we generalize the 'before-after' model to allow the regression coefficients to differ between periods before the onset of the transition and periods after the onset of the transition. Specifically, we introduce interaction terms between the explanatory variables and the 'before-after' dummy variable. Thus, we allow the multivariate relationships to change following the onset of the transition. These interaction effects enable us to distinguish how, if at all, the relationships between marital fertility and the explanatory variables differed in the two periods. We will refer to this second model as the 'before-after model with interactions'.

Figure 4 presents three examples of changes in the relationships over time. For illustrative purposes, we focus here on the changing negative relationship between Ig and population density, before and after the onset of the fertility transition (at T_1). In the first panel of the figure, there is no change in the slope of the relationship between Ig and population density, but there is a negative change in the intercept: that is, the values of Ig are lower after T_1, for all levels of population density. In Panel B, we witness both a change in the intercept (as in Panel A), and an increase in the slope of the relationship. That is, in Panel B, the negative relation between Ig and population density becomes somewhat weaker after T_1, as compared to before T_1. In Panel C, the slope takes on a larger negative value after T_1 than before T_1, and there is a downward movement of the intercept. These three panels illustrate the types of changes in the relationships we see in the 'before-after' model (Panel A only) and the 'before-after model with interactions' (all three panels).

It is important to note that neither of these two models separates the cross-sectional effects from the time-series effects (the second problem noted above). The isolation of the time-series effects is important for the study of transition processes. We now introduce the third and the fourth models which focus on time-series changes. Only by controlling for the overall level of the dependent variables in each district can we analyse changes over time in the dependent variables. This is accomplished by introducing a fixed effect for each district. The fixed effects are simply dummy variables that capture the 'characteristic' level of marital fertility in each district. This 'characteristic' level is presumably determined by other important variables, which we do not have at our disposal. The dummy variables for each district help to control for these missing variables. In the third model, we build on the first model, the 'before-after model', by adding in fixed effects. In the fourth model, we build on the second model, the 'before-after model with interactions', by adding fixed effects. We refer to the third model as 'fixed effects model without interactions' and to the fourth model as 'fixed effects model with interactions'.

Results

Theory linking marital fertility with socio-economic and demographic variables suggests that there are negative relationships between marital fertility, on the one hand, and, on the other hand, socio-economic variables such as population density, proportion in tertiary occupations, proportion in domestic occupations, and the ratio of teachers to the adult population. These relationships have been shown to exist in this paper and elsewhere, primarily in cross-sectional studies (see e.g. Friedlander, Schellekens and Ben-Moshe 1991; for an opposing view, see Woods 1987). We show now that interrelationships among demographic and socio-economic variables that we observe in the patterns of change over time are similar to those in the cross-section. Moreover, the interrelationships which explain changes over time in the pre-transition period are similar to the interrelationships in the period following the onset of the transition. These analyses provide support to the view of transition as a continuous response to changing socio-economic circumstances.

Figure 4
Schematic view of 'before-after' models

a: Model with no significant interaction terms between time and explanatory variables

b: Model with positive interaction terms between time and explanatory variables

c: Model with negative interaction terms between time and explanatory variables

Table 3 presents the results of all four multivariate pooled regression models. As discussed above, while the first two models mix cross-sectional effects with time-series effects, the final two models present pure time-series effects. Broadly, the models fit the data well, and the main effects of our explanatory variables are consistent across the different models. For example, consider the main effects of the education variable, proportion of teachers in the adult population, on marital fertility. In each of the four models, we see a negative relationship between these two variables.

In the final models, the negative effect persists, and even becomes larger. This suggests that increases in education over time are associated with declining marital fertility: a finding that lends support to the view that the fertility transition was driven by changing socio-economic circumstances. Likewise, we note that reductions in marital fertility over time are associated with increases in urbanization, and the proportions of the male workforce employed in industrial, tertiary, and domestic occupations. The urbanization variable and the first two of the occupational variables are related to the degree of economic development in districts, while the proportion in domestic occupations may be positively associated with the level of economic and social status in a district. Thus the main effects of all five of these variables are consistent with an explanation of fertility decline that has an important socio-economic dimension. We also note that in both of the final 'fixed effects' models, the standardized regression coefficients (β) are largest for the urbanization and education variables. That is, marital fertility is most sensitive to changes in these explanatory variables.

By examining the results in models (2) and (4), we can determine whether the relationships between Ig and the explanatory variables differ significantly in periods before and after the onset of the fertility transition. The lower panel of Table 3 reports interaction effects of the explanatory variables with the before-after dummy variable. The interaction effects represent the differences in the relationships between Ig and the explanatory variables in the two different periods. We note that all of the interaction effects are small relative to the main effects. For example, the positive interaction effects of proportion of teachers and population density do not substantially change the overall negative effects of these variables on marital fertility. Thus, changes in education and urbanization in periods following the onset of the transition were associated with changes in marital fertility in much the same way as changes in education and urbanization were related to variations in marital fertility before the onset of the transition. A similar pattern of relations exists between marital fertility and the other socio-economic explanatory variables. Referring back to Figure 4, we observe that these findings fit the schematic depiction in the top two panels, in which the interaction effects were zero or slightly positive.

Table 3
Regression analyses of marital fertility using pooled data

	Models							
	Before-after		Before-after with interactions		Fixed effects without interactions		Fixed effects with interactions	
Explanatory Variables	(1)		(2)		(3)		(4)	
Main effects	B[a]	ß[b]	B[a]	ß[b]	B[a]	ß[b]	B[a]	ß[b]
% of teachers[c]	-5.8*	-0.25	-5.7*	-0.24	-9.5*	-0.40	-9.4*	-0.40
Log of pop. density	-1.5*	-0.35	-1.6*	-0.35	-2.7*	-0.61	-3.9*	-0.88
% of men in industrial occ.	-0.0	-0.02	-0.0	-0.02	-0.1	-0.10	-0.1**	-0.13
% of men in tertiary occ.[d]	-0.2*	-0.17	-0.2*	-0.18	-0.1**	-0.15	-0.1**	-0.15
% of men in domestic svc.	-0.0	-0.02	-0.0	-0.01	-0.3*	-0.11	-0.5*	-0.18

Before-after dummy	-3.1*	-0.28	-3.3*	-0.29	-2.8*	-0.25	-2.7*	-0.24
Interaction effects with before-after dummy								
% of teachers	NIM	NIM	0.9	0.02	NIM	NIM	1.9**	0.04
Log of pop. density	NIM	NIM	0.8*	0.09	NIM	NIM	0.6**	0.07
% of men in industrial occ.	NIM	NIM	-0.0	-0.02	NIM	NIM	0.0	0.00
% of men in tertiary occ.	NIM	NIM	-0.0	0.00	NIM	NIM	0.0	0.00
% of men in domestic svc.	NIM	NIM	0.1	0.02	NIM	NIM	0.2**	0.05
Adjusted R^2	44		.45		.75		.76	
Joint significance of explanatory variables	209.7*		116.8*		229.2*		133.5*	
Joint significance of fixed effects	NIM		NIM		4.7*		4.9*	

Notes: NIM: Not in Model, [a] (Regression coefficient) *100, [b] Standardized regression coefficient, [c] Ratio of male and female teachers to population aged 20+, [d] Men in commercial of professional occupations,
* Significant at 0.01 level, ** Significant at 0.05 level.

A conspicuous and important variable in Table 3 is the 'before-after' dummy variable, which differentiates periods before and after the onset of the transition. This dummy variable represents the difference in Ig levels between periods before and after the onset of the transition, after controlling for changes in other explanatory variables. We note that in all models, this variable is associated with a negative coefficient. Obviously, if we were to look at simple averages of marital fertility levels, we would expect periods following the onset of the transition to have lower levels of marital fertility than periods before the transition. Regression results not presented here show steadily declining values (down to 50 per cent) of the estimated coefficient on the before-after dummy variable when additional explanatory socio-economic variables are successively included in the model. However, the significance of the before-after dummy variable, even after inclusion of all available variables, indicates that there remains an unexplained component of the reduction in fertility. In order to get an indication of the importance of the before-after dummy variable, we estimate its contribution to the predicted change in Ig values from periods before the onset of the transition to periods after the onset. Based on the full model (model 4) presented in Table 3, we conclude that the before-after dummy variable accounts for 44 per cent of the explained change in Ig values, while the socio-economic variables account for 56 per cent of the explained change.

The coefficient on the before-after dummy variable can be understood in at least three different ways. First, there may be changes in the qualitative nature of the explanatory variables included in the model; these qualitative changes may affect the levels of marital fertility, at all levels of the explanatory variables. For example, there may be changes in the nature of work, particularly women's work, or education, which have implications for the level of childbearing, at all levels of the explanatory variables. Second, the change in the intercept may be due to missing variables. For example, the labour-force participation of women is omitted from our analyses here through lack of data. In addition, other potentially important socio-economic variables are unavailable for our analysis. Likewise, we have no measures of ideational change, which may be related to an increased use of family limitation in the transitional period. Third, there may have been a discontinuity in fertility patterns, consistent with innovation in fertility control at the time of the transition. While it is impossible to determine what part of the coefficient on the before-after dummy variable is due to each of these three causes, our analysis suggests that it is unwise to attribute the entire coefficient to innovation. Indeed, it would be very unlikely that any regression model would be able to explain most of the fertility decline, so that the before-after dummy variable would have a coefficient close to zero.

Concluding observations

One analytic issue concerning the transition from high to low marital fertility revolves around the question of whether the change reveals continuity or discontinuity with the past. A perspective of discontinuity has been adopted in studies of the European Fertility Project. It has been argued in these studies that the idea and the practice of family limitation was an innovation, that marital fertility control was virtually unknown in the past, and that the control of overall fertility before the transition was through variations in nuptiality. It was concluded that the use of family limitation was a revolutionary, abrupt change occurring virtually simultaneously in the different provinces of Europe. It was argued that these processes were independent of socio-economic conditions.

The acceptance of this formulation should reveal discontinuity in the empirical analysis of the patterns of change in marital fertility levels as well as in interrelationships between marital fertility and socio-economic variables. Specifically, discontinuity implies an absence of marital fertility control in the pre-transition period; abrupt shifts over time in the cross-sectional distributions of marital fertility levels and the relative importance of marital fertility levels in the determination of overall fertility levels ; a sudden change in the form of dominant control of changes in overall fertility, from nuptiality to marital fertility; and an absence of relationships between changes over time in marital fertility and socio-economic variables, in periods both before and after the onset of the transition.

Contrary to the discontinuity perspective, our analyses reveal an overall picture of continuity in the process of marital fertility decline. In this and earlier analyses, we have shown that (1) a substantial proportion of districts experienced pre-transition variations in marital fertility that were so large that they are suggestive of deliberate fertility control. Moreover, other Western European countries experienced pre-transition variations of a similar nature, so that England and Wales is not unique in this sense. (2) The changes over time in the distributions of marital fertility levels and the relative importance of marital fertility levels to the determination of overall fertility levels were gradual and smooth; (3) the proportion of districts dominated by marital fertility variation, as opposed to nuptiality variation, increased gradually over time, and both marital fertility and nuptiality variations were present in all periods considered; and (4) there are important relationships between changes over time in marital fertility and socio-economic variables in periods both before and after the transition. The last conclusion is based on our estimated equations from the pooled cross-sectional, time-series data. Moreover, these estimated equations reveal relationships between changes in specific explanatory variables and changes in marital fertility that are very similar both before and after the onset of the transition.

There is, however, one estimated parameter in the same set of equations which does not support the continuity perspective. Our analyses suggest that after controlling for all available explanatory variables, there remains an important unexplained component of change in Ig values between periods before and after the onset of the transition. Most likely this estimated parameter (the coefficient on the before-after dummy variable) results from the fact that important socio-economic and ideational explanatory variables are missing from our data, and that there may have been changes in the qualitative nature of some of the included variables.

Despite the importance of the before-after dummy variable, our analyses provide strong support for the continuity perspective.

Continuity in the process of changing patterns of fertility means that marital fertility control has always been an important feature of the family, even if it has not always been used extensively and effectively. In the context of late age-at-marriage, in which the family is the dominant institution in which individuals are active socially or economically, and where child mortality is high, the widespread use of marital fertility control was unnecessary. But, as in later periods, the extent of marital fertility control depended on socio-economic conditions. Changes in marital fertility have occurred continuously over time, as fertility control within marriage has always been of critical importance to society.

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