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by

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**Introduction**

What factors determine fertility and to what extent do we really understand the factors in the historical past that underpinned decisions on when to marry, when to start having children and how many children to have? In many ways, the posing of such questions may seem surprising given the now copious literature on the subject.[1] We argue that there is more to understand. In this paper we explore additional determinants and (hence employ new variables built from previously under-exploited primary source materials) and apply improved econometric modelling to build on previous work and thereby improve on our understanding of the determinants of the demand for children in early twentieth century England and Wales.

Standard economic theory tells us that the fertility is best explained in terms of the demand for children.[2] From this assumption, the Chicago-Columbian school explained fertility in terms of the demand for children.[3] This approach adopted a production function approach to explain the demand for children in terms of socio-economic development, namely increases in the relative price of children. Children, it is argued, require inputs of time and goods, and the price of children depends on the prices of these inputs. Price is related to the wife's time in childbearing and rearing and, as such, changes in the demand for children are related to increases in the opportunity costs of the wife's time. [4]

In contrast, the Pennsylvanian school has drawn our attention to supply side issues, namely the supply, cost and understanding of contraception and desired family size as well as the taste for children.[5] This approach stresses that the demand for children is not for births *per se* but *for surviving* children. As such, the supply side

school emphasises the influence of infant mortality rates on fertility. There is now a consensus in the literature based on substantive empirical research, that whilst supply side issues have dominated in pre-modern societies, demand then assumed importance as households shifted to a potential excess supply of children and the opportunity costs of women's time became important.

Whilst standard economic models may explain the determinants of fertility behaviour in pre- and post-modern societies, they do tend to ignore the issue of nuptiality. There is an implicit assumption in the economics literature that age of marriage was a factor in pre- but not postmodern societies. Yet there is a large historical literature relating fertility to the nuptiality decisions, with the latter being rooted in prevailing contemporary socio-economic conditions. From Malthus to Wrigley and Schofield, the argument is that in pre-modern societies, men and women determined the decision on when to marry according to prevailing economic conditions.[6] More recently, Szreter and Garrett have related nuptiality to class by finding evidence of a novel pattern of highly prudential, late marriage among the bourgeoisie in the course of the eighteenth and early nineteenth centuries. They also find evidence of an increased trend towards 'prudential' marriage throughout the population after 1816. [7] Nuptiality, in other words, is back on the research agenda: and hence forms an important part of our research agenda.

What, however, of conditions in early twentieth century England and Wales? How can we understand fertility behaviour amongst couples in a period when modernisation had indeed occurred, but when infant and child mortality (by modern standards) were still high, when women's opportunities for earned income were

limited, when 'modern' methods of contraception (i.e. 'the pill') were not available,[8] when household incomes were (in the main) determined by the earnings of the husband, prior to a welfare state which might provide support in times of economic distress (be it unemployment, pensions or health at the point of need)?

To date, much of the literature has attempted to explain the lagged timing of the transition[9] to low fertility rates to economic change. The notion that fertility behaviour varied according to social class in the early twentieth century was noted by an official at the Office of the Registrar General who supervised the analysis of the 1911 Census[10] and later became the subject of an investigation by Innes.[11] Subsequent analysis has spawned a large and scholarly literature. Social class[12] and/or urbanisation[13] have been used to 'proxy' improvements in the standard of living that may prompt the switch to low fertility regimes. All claim to find an important link between income (or wealth) proxied by occupational/social status or urbanisation of households and their propensity to control fertility. What is *missing* from this important work, we would argue, is any sense that families may have based their decisions on marriage and fertility on their anticipated life earnings: namely the number of years they could reasonably expect the husband to work – and thereby earn income.

To date, econometric modelling on the determinants of patterns of fertility in the early twentieth century has been constrained by data availability in terms of *explanatory* variables. Data on the dependent variable – namely births per women by age and duration of marriage – are, however, available.[14] The early twentieth century has provided scholars with an important dataset with which to examine fertility behaviour – namely the 1911 Fertility Census, which tabulates recorded fertility by

age at marriage, duration of marriage and occupational status of husband. That Census has prompted significant contributions to the literature, notably by Crafts, Haines and Szreter[15] who have demonstrated that opportunities for female work, infant mortality, social status and the wealth of households largely determined fertility behaviour.[16] A common, if understandable problem, in such models has been the propensity to develop aggregate models that may disguise, we would argue, differences in cause and effect mechanisms between different *occupational* groups. Equally, the need to use 'all embracing' proxies for explanatory variables has clouded our understanding of how and why different economic and social factors may influence the fertility decision.

Why then should we revisit the 1911 Census and the explanations for recorded fertility in England and Wales? The motivation for this paper is threefold: first in Section 1, we review recent developments in the wider economic and social history literature which suggest the need to improve on the explanatory variables. In so doing, we seek to encompass the Chicago-Columbian school's emphasis on the opportunity costs of the wife's time and on expected household earnings over the life-cycle, and on the Pennsylvanian school's emphasis on demand being for surviving children rather than births per se. Our work in this respect underlines the importance of exploring nuptiality and fertility by occupational status. In Section 1, therefore, we present our findings for new datasets, which build on prior work to improve on the explanatory variables determining fertility at this period of time. Second, in Section II, we argue that the timing of marriage and the decision to have children were *joint* decisions and as such should be modelled as a simultaneous equation system. In Section II, we discuss the dependent variables (and limitations which to date have

should been sufficiently flagged in the literature) and derive a theoretical model, which encompasses both the nuptiality and fertility decisions. Appendices 1 and 3 detail the source materials, variable definitions and data included in our model. Third, (in Section III), we present our findings of what really determined both the timing of marriage and the number of children had according to occupational status and presents our findings. Section IV concludes.

**I**

In this paper we argue that the decision on when to marry and how many children to have at the turn of the century in England and Wales was a *joint* decision. Those decisions were in turn a function of desired family size (defined as desired surviving children), predicted number of years of male (husband) household income and the opportunity costs of women's time (female earnings). In this section we explain our choice and estimation of explanatory variables (see Appendix 1 for data sources and estimations).

The Pennsylvanian school has made it clear that explanatory models should be couched not in terms of the demand for children *per se*, but for *surviving* children. At the turn of the century, and despite decreasing trends in child mortality from the childhood diseases of inter alia, measles, diphtheria and scarlet fever, parents still lost children to these diseases.[17] As such, the desired number of surviving children would be influenced not only by prevailing infant but also by childhood mortality levels. Childhood mortality, in other words, should be included in any model as an explanatory variable. To that extent, and given the fact that the 1911 Census includes observations on childhood mortality, by occupational group, age at and duration of

marriage it is surprising that this has not been incorporated into prior studies. We have therefore incorporated child mortality (that is children who died as a percentage of those born) to each occupational group by duration of marriage and age at marriage of the wife as one of our explanatory variables.

Our estimates reveal significant variations between occupational groups in terms of child mortality – and hence an on-going human tragedy experienced by couples faced with the certain 'knowledge' that any child born stood a high chance of dying (Table 1). That knowledge was experienced to an acute degree amongst married couples where the husband was employed as a shipyard labourer, a seaman, in iron manufacture, as a skilled and unskilled worker in iron foundries or as a dock and wharf labourer. Child mortality amongst these groups was the highest recorded amongst all couples married for all marriage durations in 1911. [18] By contrast, couples where the man was employed as an accountant, architect, civil engineer, author or journalist, banker, clergy, solicitor, or gamekeeper (standard professional middle class occupations) were spared (relatively) from the anguish of child mortality.[19] Prima facie, the empirical evidence suggests marked contrasts at the turn of the century between the professional and manual occupational groups in terms of the effects of child mortality on surviving children and hence fertility: thus the need to include explicitly child mortality as an explanatory variable in any model of the demand for children.

***Table 1 about here***

Child mortality, we argue, was an important explanatory variable determining fertility amongst couples (defined in terms of the occupation of the husband) in early twentieth century England and Wales – but so was infant mortality (Table 1). Couples of all marriage durations recording the lowest levels of infant mortality were ones where the husband was employed as a civil servant, banker, architect, author and journalist, doctor, solicitor, civil engineer, clergy, shopkeeper and naval officer.[20] By contrast, infant mortality was highest amongst couples where the husband was employed as an unskilled foundry worker, a cutler, a shipyard labourer, an earthenware manufacturer, a dock or wharf labourer, and a worker in steel manufacture.[21]

What of changes over marriage durations? Our cross sectional data make it difficult to determine with any precision the implications of changes in infant and child mortality over time. What our data do show (Table 1), however, is that infant mortality was highest amongst couples of all occupations married between 15 and 20 years in 1911 [22] and was highest amongst couples where the husband worked as an unskilled foundry worker, a shipyard labourer, a dock or wharf labourer, and a worker in steel manufacture or as a costermonger/pedlar.[23] Crafts has already shown that in a cross section model over regions in 1911 that infant mortality had an important effect on the demand for children;[24] we would argue that it had an important effect on the decision processes of couples where the husband worked in different occupations.

Household income, and wealth, were determined not only by both the earned annual income of the male head of household but also by the number of years the male head of household might be expected to live and earn a livelihood. To this extent

we have built new datasets that estimate both earnings and the number of years of anticipated earnings as *separate* variables. To date, male income has not been included as an explanatory variable in work on the determinants of fertility at the turn of the century – a surprising, but understandable, omission given data availability problems. Yet the decisions of couples on when to marry (age of marriage) and how many children to have would have been determined in part by the anticipated earned income of the husband. Given the importance we attach to this calculation by couples at the turn of the century, a new dataset was created which assigned earned weekly wage estimates to different male occupations. This enabled us to estimate the effects of current earnings on the joint decisions on nuptiality and fertility. Our estimates of male wage rates were derived from both primary and secondary sources,[25] expressed in 1906 shillings per week per year.[26]

Our findings (Table 2) are suggestive of a very wide variation in male earnings: sufficient to explain why some couples, desirous of a given number of surviving children, would have reason to marry and have children at an early age. Not surprisingly, couples where the husband was employed in a professional middle class occupation were in receipt of the highest weekly and annual incomes. Some couples were in receipt of in excess of over 100s a week (£5) – namely solicitors, doctors, barristers, dentists, chemists, authors and journalists and army officers. At the opposite end of the income spectrum, families where the male earner was employed as a scavenger or dust collector, a dyer in textiles or a paviour received less than 23s a week (£1.15); those of a road labourer or porters less than 22s a week (£1.1); those of a porter less than 21s a week (£1.05), whilst those of a platelayer less than 21s, that of a factory labourer and shepherd less than 20s a week. At the very bottom of the

earned income hierarchy are the families where the male was employed as a horse-keeper or groom managed on 19s a week (£0.95) and those of an agricultural labourer 17.5 shillings (£0.88) a week. [27]

***Table 2 about here***

A noticeable (and crucial) omission from both the above theoretical and empirical work is an explicit and quantified acknowledgement and inclusion of income over the life cycle income. Life cycle income, however, is a function of how long one expects to be in paid employment, which, in turn, is function of prevailing levels of illness (morbidity) and of age of death (mortality). At the time, workers, local doctors and some in the higher echelons of the medical profession were well aware of the health risks associated with given occupations.[28] In recent years, the literature on occupational health has tabulated occupational morbidity and mortality in relation to given industries and occupations at the turn of the century.[29] To date, this growing literature has drawn our attention to the morbidity and mortality implications of, inter alia, working in coalmines and the textile industry.[30] The risks of losing the male bread-earner through a variety of occupational hazards have not figured in work on the fertility decision. Belated attention to the relationship between the determinants of the demand for children and occupational health risks amongst couples is an important omission from the literature to date and one which we seek to rectify.

Contemporaries were sufficiently concerned that the Registrar General, on a decennial basis, was required to tabulate mortality by occupation. That information includes data on the age distribution of deaths within given occupations. We have

therefore explicitly included variables that quantify the extent to which early mortality was 'the norm' in different occupational groups. Anticipated early death would prompt early marriage – and children – whilst longevity would encourage a later age at marriage and the postponement of child bearing. In these terms a couple marrying in a coal-mining district would marry early and have children early – whilst a 'clerical' couple would be under no such pressure to marry and start child bearing at an early age.

Examination of the returns revealed significant variation between occupations in the age of death (Table 3).[31] In 'extreme' cases (that is the differences between the longest and the shortest lived male occupations) the differences were in excess of twenty years. Given our argument that the risks of early death would encourage couples to marry early and to have children early in their marriage, the explanatory variable used to proxy the 'death risk' is the percentage of deaths in given occupations accounted for by deaths under the age of 35. In late nineteenth century England and Wales, the probability of dying before the age of 35 was extremely low amongst clergymen, coal-merchants, farmers, inn-keepers in agricultural districts, wheelwrights, and maltsters.[32] In contrast, there was a one in four risk of dying before the male worker reached the age of 35 if the man worked in glass manufacture, bookbinding, tin and tin plating, coal mining or in the Lancashire cotton mills.[33] The most hazardous occupations however were coal mining in South Wales, printing, railway driving, hairdressing and zinc working.[34] A couple desirous of a given number of surviving children would have good cause, dependent on the husband's occupation, to marry early – whilst in other occupations the absence of any such risk afforded the luxury of the choice to postpone marriage until a later age. The health

risk was such to have had a significant effect on the timing of nuptiality and of fertility.

***Table 3 about here***

The opportunity costs of women's time has figured prominently and been found to be statistically significant in econometric explanations of the demand for children. To date, this consideration has been modelled in terms of the labour force participation of *single* women and/or the returns to schooling for women which first encouraged women to obtain more education and thus facilitated a rise in women's wages relative to men's.[35] Yet secondary sources have contended with conviction that the demand for children was heavily influenced by the opportunity for work amongst married women.[36] We would argue that the decision to marry and to have children was determined not only by the availability of work for *married* women, but also by the wage they might receive. In essence, the timing of both nuptiality and fertility was a function of the income loss to the wife of giving up work.

To date, testing of such a hypothesis has been precluded by data availability. Given the importance we attach to this explanatory factor, we estimated new datasets that quantified the waged income of married women according to marital status and the occupation of husbands using a random sample of enumerators' returns from the 1901 Census. Previous work on fertility was constrained, of course, by lack of access to the enumerators' returns for this Census given the 100 Year Rule. The release of these documents in the recent past has allowed us to examine female working patterns – something that previous scholars have been unable to do. The released returns have

enabled us to sample primary materials, which detail the occupational status of married women: that is evidence on the opportunity costs of fertility for the wives of occupied married men. The enumerators' returns were used to provide an estimate of the occupations of married women; these were then linked to a range of primary and secondary sources to derive earned income of given 'female' occupations (Table 2) and hence the opportunity costs of married women's time.[37]

We find that the variation in women's wages was not as large as that of men; the highest (average) wages paid were 45 shillings (£ 2.25) per week for governesses and headmistresses, 40 shillings (£2) per week for head shop assistants and managers and 38 shillings (£ 1.90) per week to Civil Service telephone and telegraph operators. The lowest wages were all less than £0.50 per week: charwomen at 7.75 shillings (less than £0.4) per week; women's jobs in glass manufacture at 8.75 shillings (£0.44) per week; and women's work in agriculture and laundry at nearly 9.50 shillings (£0.48) per week[38]. Some occupations had a large enough concentration of married women to calculate an average for married women as well as for all women and girls. [39] Married women, among the working classes, seemed to be particularly prominent in occupations such as school caretakers (15 shillings per week), clerks (10-18 shillings per week), laundresses (9-12 shillings per week), clerks (10 – 18 shillings per week), and rope twisting, box making and making boot bottoms for 9 to 10 shillings per week. Cadbury et al state that a skilled French polisher was always welcomed back her former job as and when she wished and her household's needs required.[40]

Daughters (and widows) of middle-class professionals were most likely to work in the top levels of teaching, nursing, and clerking as Board-certified teachers,

Matrons and Sisters or District nurses, Civil Service operatives (telephone and telegraph), clerk-typists, and "lady clerks". Sewing was an appropriate feminine activity which could be translated into paid work at many levels (dressmaking, needlework, embroidery, shrouds) by women of all social classes, and was frequently available as outwork.[41] The Census of 1901 shows large numbers of households having borders or lodgers, another common occupation for married women.[42]

Daughters of skilled manual labourers followed many of the same occupations as middle-class women, but at somewhat lower levels, and lower wage scales, becoming teachers in primary and publicly funded schools[43], nurses, shop assistants and typists. Daughters and wives of semi- and unskilled men often worked in the same industry as the male head-of-household. They, too, could move upward into teaching – training as pupil-teachers rather than in special programs; or nursing or various low levels of civil service clerks. For those with little education, laundry and cleaning were available.[44]

The empirical evidence discussed above demonstrates significant variations in crucial explanatory variables as defined in terms of the infant and child mortality experienced by different occupational groups and of occupational mortality. If we examine age at marriage and births per woman in terms of the occupational status of the husband we also find significant variations (Table 4): sufficient to suggest the need for an explanatory model couched in terms of the occupational status of the husband

***Table 4 about here***

**II**

Our approach is novel in terms of a methodological approach involving a simultaneous equation model that explores a) first the decision to marry and b) second the decision to have children. We have approached the demand for children as a system of two equations. We first estimate the demand for marriage. This is based on the proposition that if husband has a relatively short expected working life, the more it is likely that couples will marry young. We then estimate the demand for children. To some extent, our claim that couples faced a joint decision: to marry and have children at an early age, is not a new one. Friedlander, Haines and Schellekens et al[45] all noted the propensity of coal miners to marry early and to have children at an early age.[46] We would argue, however, that this observation is not limited to that of couples in coal mining communities. What is new is that we seek to build this observation into an econometric model that tests for joint decisions over *all* occupational groups in early twentieth century England and Wales. In this section we build on this observation and the above discussion on our explanatory variables to discuss the elaboration of our explanatory model.

We argue that the age at marriage and the number of children per couple (births per woman) in early twentieth century England and Wales were *jointly determined* based on the expected male wage and lifetime earnings, the female wage rate (her opportunity cost), expected child mortality (anticipated child survival) and the expected mortality of the male partner. We note that despite the absence of 'reliable' contraception, couples did practice birth control, that birth control was

practiced by couples from all social classes[47] and that parity-specific control was common. In this paper, whilst acknowledging that couples may indeed have made conscious decisions to terminate childbearing at a given age[48] and have 'spaced' their children,[49] we observe that the timing of marriage remained an important determinant of fertility

In essence, we argue that persons in occupations in which men were more likely to die young, leaving widows with small children, would have *more of* an incentive to marry at young ages than persons in occupations where men were more likely to live past age 55 or 60. Higher child mortality, we argue, would require more births per couple to reach the same level of children who survive to adulthood. Occupations with earlier ages at death were likely to wish to have more children survive to adulthood as insurance against disability and impoverished widows/mothers than would other occupations. As a result, we expect to find that occupations in which there is higher male mortality would have lower ages at marriage, and higher births per woman than will occupations in which the male is more likely to die at older ages. In addition, we would expect that occupations with high child mortality would have both lower ages at marriage and higher numbers of births per woman. The effect of wage rates in this period, however, may be ambiguous since higher wages allowed couples to afford more children (of any given level of quality), as well as more of all other goods, or fewer children of higher quality (more expensive inputs) or fewer children and more of other assets to insure income in old age or disability.

The dependent variables are a) the age of marriage of women by duration of marriage and occupation of the husband and b) the number of children by duration of marriage and occupation of the husband derived from the 1911 Census of Fertility. Table 6 details occupations where the age of marriage and the number of children were the lowest and highest.

There are, however, inherent sources of bias in the data from the Fertility Census of 1911. First, the data refer only to intact couples and, as such, omit widows. Second, the data refer only to current marriages and, as such ignore the families of prior marriages, that is those where one spouse has died young and the other has remarried – the children of the original marriage are not included in the Census returns because they are not defined as the offspring of the *current* marriage. Third, the returns ignore the extent of remarriage. This, we find, was particularly common amongst older brides, which leads to an upward bias on the mean age at marriage. The 1901 Census for Sheffield, for example, revealed a great deal of remarriages – dependents listed as 'step-son/daughter'; listed as 'son' but too old to be a child of the 'wife of head'; many women, with children, listed as 'living on own means'. Given that the occupational categories do not have the same number of couples (since the values of the variables are the averages for the occupation), the data are expected to be heteroskedastic.

We argue in this paper that the age at marriage and the number of children per couple (births per woman) were *jointly determined* based on the expected male wage and lifetime earnings, the female wage rate (her opportunity cost), expected child mortality and the expected mortality of the male partner. We therefore estimated a

model[50] based on a system of two equations, one for age at marriage, and one for births per woman, in which:

*age at marriage* = $ß_{10}$ + $ß_{11}$ births per woman + $ß_{12}$ child mortality + $ß_{13}$ female wage rate + $ß_{14}$ probability male dies before age 35 + $e_1$

*births per woman* = $ß_{20}$ + $ß_{21}$ age at marriage + $ß_{22}$ child mortality + $ß_{23}$ male wage rate + $ß_{24}$ male wage squared + $ß_{25}$ probability male dies before age 35 + $e_2$

Appendix 2 details the variables included in the explanatory model.

The model was estimated using a generalized method of moments estimator with White's heteroskedasticity consistent covariance matrix. The squares of both male and female wage rates were included as instruments due to the skewness in both endogenous variables. Including the square of the male wage in the fertility equation allows increases in the male wage to have a different response for high wage and low wage occupations. The square of the female wage rate was not significant in the age at marriage equation and was eliminated from the model. The female wage is included in the age of marriage equation as it is the best estimate of the foregone costs to a woman of marrying and having children. The male wage is included in the fertility equation as children are considered an asset to the couple and the level of asset holdings are best described a function of the family wealth, i.e. the male wage. As this is a system of simultaneous equations, both variables cannot be entered in both

equations as it would be impossible to identify the coefficients of the equations in that case.[51]

**III**

What then determined the joint decision of when to marry and how many children to have amongst occupational groups in early twentieth century England and Wales? First examining the demand for marriage and for fertility amongst marriage durations of all durations (that is, of 0 to 25 years (Table 5)), it is apparent that we are correct to argue that the decision was a joint decision. We find that age at marriage and the number of births per woman is indeed jointly determined. A Hausman test for endogeneity rejects the hypothesis that both age at marriage and births per woman are exogenous at a significance level of $p < 0.001$.

***Table 5 about here***

High child mortality and the probability that a man will die early act to lower the age at which women would choose to marry. Occupations with high probabilities of dying young, marry earlier than those with a lower likelihood of dying young, and that higher expected child mortality encourages earlier marriage. Both the high probabilities of dying young and high levels of child mortality lower the number of births per woman, probably due to the fact that the Fertility Census of 1911 only includes data on current, intact marriages, actual rather than desired fertility. Women may plan to accomplish the desired level of fertility by allowing for more than one

marriage, due to high levels of male mortality, therefore marrying at an earlier age to allow for the interruption of child-bearing due to their husbands' mortality.

Beginning with nuptiality, our model can explain 77% of the variation in age at marriage across occupations, which is high for a cross-section model. All variables are significant at better than five per cent significance level and have the predicted signs. A five percent increase (just over 1 standard deviation) in child mortality leads to a 0.6 year decrease in the average age at marriage independent of any other influences. A ten per cent increase (slightly more than one standard deviation) in the probability that the male will die before reaching age 35 leads to a 0.3 year decrease in the age at marriage. Both are non-trivial changes in the average age at marriage, especially given the number of women in each occupation. Female wage rates have a significant effect on the age at which a woman marries; a twelve shilling per week (just under one standard deviation) increase in a woman's wage leads to nearly a 0.2 year increase in the average age at marriage. This is, again, a non-trivial change.

What then of the fertility decision over all marriage durations? Tables 6 and 7 present our results for the nuptiality and fertility decisions by different marriage durations. Although the results are less robust than those for the nuptiality model, the $R^2$ results (0.45) are still respectable for a cross section model. In this equation, the male wage assumes importance. Increases in the male wage, our proxy for wealth and lifetime earnings, act to decrease the number of children the couple desires/has. The positive coefficient on the square of the male wage indicates that the effect of an increase in the wage increases as the wealth/wage increases. As wage rates, and wealth, increase couples may be choosing to have fewer children and invest more in

each child, the Becker quantity-quality trade-off.[52] Wealthier couples may be choosing assets other than children to insure against disability or early death of the male partner, or to save for their old age and retirement. The probability that a man dies before age 35 is significant in determining fertility, but has the opposite sign to what was expected. A 10% increase in the probability of dying young leads to a 0.2 decrease in the number of children per couple. The unexpected sign on the probability of dying young may be due to the fact that the Census of Fertility only includes current marriages and the data do not allow for remarriage. The lack of significance of child mortality may indicate that women/couples have already factored the expected mortality of their children into their plans for marriage and number of births, and do not "replace" lost children.

***Table 6 about here***

What then of the explanations for nuptiality and fertility over different marriage durations? It is clear (Tables 6 and 7) that no matter what the duration of marriage, the decision a) when to marry and b) how many to have was a joint one. Estimation by marriage duration did not change these findings. Durations of marriage of 0-2 years, 2-5 years, 5-10 years and 15-20 years were estimated separately. The same pattern of significance in the coefficients is apparent in all four regressions.

***Table 7 about here***

The probability that that the husband will die early is significant and negative in all four nuptiality equations and in three of four fertility equations. In the longest

durations, 15 to 20 years, child mortality lowers age of marriage but does not affect the number of children per woman, indicating that couples factor in their expected loss when determining how many children to have. Since child mortality is significant at shorter durations, couples are making lifelong plans which can be disrupted by the early death of one partner.[53] The negative (and significant) sign of the coefficient on the probability that the husband dies early may indicate that women who marry into occupations with high probabilities of men dying very young prefer to avoid being widowed with small children and allow for the formation of a "second family" with a possible second husband.

It is also apparent that the risks of dying early had a powerful effect on the timing of marriage. This finding applies whether couples had been married for less than two, for between two and five or between five and ten years. To that extent, recent work on occupational mortality is shown to have an important if not key effect on the timing of marriage. Where there was good reason to believe that the husband could die before he reached the age of 35, couples tended to marry early. The 'delayed' response of fertility behaviour to economic transition may reflect the truism that many men died early as a result of occupational disease and accidents.

Our results indicate that childhood mortality was an important explanation for the timing of marriage over all marriage durations. Despite the secular decline in mortality from common childhood illnesses, for example, measles, scarlet fever and diphtheria,[54] that decline was insufficient to persuade couples that children born were likely to survive. The 'knowledge' that children born stood a high risk of dying prompted many couples to marry and start having children early.

## IV Conclusion

This research has answered but also posed many questions. The approach pursued in this article has been to argue that recent work on the occupational costs of disease and of childhood illness needs to be incorporated into our understanding of nuptiality and fertility behaviour in early twentieth century England and Wales. The message is clear: occupational mortality and morbidity and childhood illnesses and death can no longer be assigned to specialist studies independent of their full demographic effects. To what extent changes in childhood and occupational mortality changed over time – and over cross section (occupation) in the twentieth century is a question only future researchers can answer.

As it is, our research suggests that in the early last millennium women faced a tortuous choice: if they wished to have any defined number of children and they wished to marry a man employed in certain occupations, they had little choice but to marry early and have their children as soon as possible. Such were the 'real-life' decisions faced by women nearly a hundred years ago. One wonders to what extent women in the developing nations, especially in the face of HIV/AIDS today, face similar choices – and decisions.

**Table 1: Child and Infant Mortality by Occupational Status of Male Parent**

| | **Child Mortality** All Marriage Durations | **Infant Mortality** 0-2 years of marriage | **Infant Mortality** 2-5 years of marriage | **Infant Mortality** 5 to 10 years of marriage |
|---|---|---|---|---|
| Mean | 0.171895 | 0.073308 | 0.098059 | 0.132838 |
| Median | 0.1714 | 0.072508 | 0.095668 | 0.132709 |
| Maximum | 0.4155 | 0.114583 | 0.157556 | 0.205147 |
| Minimum | 0.0548 | 0.022727 | 0.021834 | 0.048323 |
| Std. Dev. | 0.046952 | 0.019708 | 0.031077 | 0.036244 |
| Skewness | 1.303812 | -0.082846 | -0.232579 | -0.204248 |
| Kurtosis | 10.77831 | 2.987811 | 2.357626 | 2.607749 |
| Jarque-Bera | 227.1437 | 0.093159 | 2.122928 | 1.082461 |
| Probability | 0 | 0.954489 | 0.345949 | 0.582032 |
| Sum | 13.9235 | 5.937975 | 7.942761 | 10.75987 |
| Sum Sq. Dev. | 0.176358 | 0.031074 | 0.077261 | 0.105088 |
| Observations | 81 | 81 | 81 | 81 |

***Source:*** See Appendix 1.

**Table 2: Male and Female Earnings: 1900/1906**

| | **Male Waged/Salaried Income** | **Female Wages** |
|---|---|---|
| Mean | 44.36951 | 16.7121 |
| Median | 32.33 | 12.33 |
| Maximum | 400 | 100 |
| Minimum | 18.75 | 7.75 |
| Std. Dev. | 49.0508 | 12.55175 |
| Skewness | 5.36693 | 4.196924 |
| Kurtosis | 36.46954 | 25.68209 |
| Jarque-Bera | 4169.562 | 1974.153 |
| Probability | 0 | 0 |
| Sum | 3593.93 | 1353.68 |
| Sum Sq. Dev. | 192478.4 | 12603.72 |
| Observations | 81 | 81 |

***Source***: ***Source:*** See Appendix 1. Wages are a combination of 1906 Parliamentary/Board of Trade data. Data from years other than 1906 are deflated to 1906 levels.

**Table 3: Occupations with highest and lowest male life expectancies (average age of death, 1890/1900)**

**a) Highest**

| **Occupation** | **1890/2 mean age of death *occupied only*** | **1900/02 mean age of death *occupied only*** |
|---|---|---|
| Clergyman, priest, minister | 70 | 71 |
| Barrister | 62 | 62 |
| Farmer, grazier, farmer's son | 69 | 68 |
| Farm labourer, farm servant | 66 | 68 |
| Silk, satin, crape etc | 66 | 67 |

**b) Lowest**

| **Occupation** | **1890/2 mean age of death *occupied only*** | **1900/02 mean age of death *occupied only*** |
|---|---|---|
| Inn, hotel – servant | 39 | 38 |
| Commercial clerk, insurance service | 44 | 44 |
| Railway engine driver, stoker | 44 | 45 |
| Railway guard, porter, pointsman | 45 | 47 |
| Railway official, clerk | 45 | 47 |
| Printer | 45 | 46 |
| Law clerk | 46 | 46 |
| Domestic indoor servant | 47 | 46 |
| Draper, Manchester warehouseman | 47 | 48 |
| Brass, bronze-worker | 47 | 48 |

***Sources:***
Supplement to the 45th Report of the Registrar General, C-4564, Report by W.Ogle, PP 1884-5, Vol. XVII, C-4564, Table J, pp. xxv-xxvi; Supplement to the Registrar General's 55th Annual Report, PP1893-4, Vol. XXIV, Part II, pp. 124-130, PP 1905, Vol.XVIII, 6th Annual Report: Part 2: Cd. 2619, Table 2, pp cxxxiv-cxl.

## Table 4: Occupations with the highest/best and lowest/worst values

| **Age at Marriage** | **Births per woman** | **Child Mortality** | **Die early (age < 35)** | **Die late (age > 55)** |
|---|---|---|---|---|
| | | | | |
| ***oldest*** | ***fewest*** | ***lowest*** | ***lowest*** | ***Highest*** |
| Clergy 29.4 | Doctors 1.1 | RR officers, clerks 5.5 | Clergy 5.1 | Clergy 78.1 |
| Gentlemen 28.6 | Actors 1.4 | Solicitors 7.5 | Gentlemen 5.1 | Gentlemen 78.1 |
| Doctors 28.1 | Gentlemen 1.5 | Clergy 7.6 | Bailiffs 6.2 | Bailiffs 75.3 |
| Domestic servants 28.0 | Domestic servants 1.6 | Authors, editors 9.2 | Market gardeners 7.8 | Wool spinners 72.5 |
| Solicitors 27.8 | Architects 1.8 | Architects 9.4 | Doctors 10.1 | Agricultural labourers 71.3 |
| Architects 27.4 | | Gentlemen 10.2 | Solicitors 10.3 | Solicitors 59.4<br>Doctors 59.3<br>Architects 50.9 |
| | | | | |
| | | | | |
| ***youngest*** | ***highest*** | ***highest*** | ***highest*** | ***Lowest*** |
| Coal miner 23.3 | RR officer, clerk 4.8 | Shipyard labour 41.6 | Inn, hotel servants 44.4 | Nurseryman 9.4 |
| Cutler 23.7 | Dock/wharf labourer 3.8 | Iron manufacture 31.6 | Commercial clerk 38.5 | Inn, hotel servants 13.2 |
| Glass manufacture 23.7 | Iron manufacture 3.7 | Dock, wharf labourer 25.1 | Insurance clerk 38.5 | Insurance clerks 26.4 |
| Shipyard labourer 23.7 | Brickmakers 3.7 | Iron foundry worker 23.8 | RR driver, stoker 38.2 | RR driver, stoker 26.9 |
| Brass manufacture 23.7 | Steel manufacture 3.7 | Cutler 23.5 | Printers 37.2 | Printers 28.4 |
| Boilermakers 23.8 | Coal miner 3.6 ($8^{th}$ highest) | Coal miner 23.4 | Coal miners 27.3 | |
| | | | | Coal miners 40.7 (high morbidity) |
| | | | | |

***Source:*** See Appendix 1.

**Table 5: Econometric Results: All Marriage Durations (that is couples married between 0 and 25 years)**

| | **Age at marriage** | **Births per woman** | **Age at Marriage** | **Births per woman** | ***Mean & std deviation*** |
|---|---|---|---|---|---|
| constant | 29.57<br>(36.57) | 15.10<br>(7.23) | 30.03<br>(31.01) | 17.56<br>(1.87) | |
| Age at marriage | | -0.436<br>(-6.62) | | -0.557<br>(-1.58) | 25.22 yr<br>(1.13) |
| Births per woman | -0.718<br>(-2.36) | | -0.895<br>(-2.90) | | 2.79<br>(0.619) |
| Childhood mortality | -12.08<br>(-5.72) | -3.09<br>(-1.57) | -12.71<br>(-6.48) | -4.68<br>(-0.87) | 17.2%<br>(4.7) |
| Female wage | 0.016<br>(2.56) | | 0.013<br>(2.05) | | 16.71 s/w<br>(12.55) |
| Male wage | | -0.010<br>(-3.29) | | 0.0010<br>(0.089) | 44.37 s/w<br>(49.05) |
| Male wage squared | | 0.00002<br>(2.88) | | -2.1E-06<br>(-0.09) | 3984.00<br>(16439.9) |
| Die early | -0.028<br>(-5.17) | -0.022<br>(-3.32) | -0.016<br>(-1.93) | | 19.71%<br>(8.01) |
| Die late | | | | 0.0013<br>(1.57) | 54.84<br>(83.37) |
| | | | | | |
| Determinant residual covariance (J-statistic) | 0.0334<br>0.1211 | | 0.0258<br>0.1488 | | |
| $R^2$ | 0.77 | 0.45 | 0.76 | 0.43 | |
| n | 79 | 79 | 79 | 80 | |

t-statistics in parentheses

s/w = shillings per week, 1906

## Table 6: Econometric Results: Different Marriage Durations: 0 to 2 years and 2 to 5 years

| | Durations 0 to 2 years | | | Duration 2 to 5 years | | |
|---|---|---|---|---|---|---|
| | **Age at marriage** | **Births per woman** | **Means & (std dev)** | **Age at Marriage** | **Births per woman** | **Means & (std dev)** |
| Constant | 32.65 (69.40) | 2.96 (25.50) | | 28.46 (36.02) | 0.55 (0.49) | |
| Age at marriage | | -0.091 (-22.26) | 26.27 yr (1.28) | | 0.005 (0.14) | 25.86 yr (1.26) |
| Births per woman | -11.04 (-22.77) | | 0.367 (0.074) | -0.054 (0.14) | | 1.20 (0.549) |
| Childhood mortality | -9.43 (-4.18) | -0.852 (-4.15) | 17.2% (4.7) | -15.95 (-4.99) | 3.19 (2.80) | 17.2% (4.7) |
| Female wage | -0.0006 (-0.22) | | 16.71 s/w (12.55) | 0.054 (3.99) | | 16.71 s/w (12.55) |
| Male wage | | -2.45E-5 (-0.01) | 44.37 s/w (49.05) | | -0.0008 (-0.87) | 44.37 s/w (49.05) |
| Male wage squared | | -2.32E-8 (-0.06) | 3984.00 (16439.9) | | -1.50E-07 (-0.08) | 3984.00 (16439.9) |
| Die early | -0.038 (-5.04) | -0.003 (-5.14) | 19.71% (8.01) | -0.034 (-3.55) | -0.002 (-0.64) | 19.71% (8.01) |
| Determinant residual covariance (J-statistic) | .0000267 0.1189 | | | 0.1677 0.0975 | | |
| $R^2$ | 0.66 | 0.16 | | 0.58 | 0.07 | |
| N | 79 | 80 | | 79 | 80 | |

## Table 7: Econometric Results: Different Marriage Durations: 5 to 10 and 15 to 20 years

| Table5 | Duration 5 – 10 years | | | Durations 15 – 20 years | | |
|---|---|---|---|---|---|---|
| | Age at marriage | Births per woman | Means & (std dev) | Age at marriage | Births per woman | Means & (std dev) |
| Constant | 31.89 (26.99) | 13.82 (9.66) | | 29.22 (39.71) | 23.96 (5.38) | |
| Age at marriage | | -0.42 (-8.45) | 26.27 yr (1.28) | | -0.788 (-5.19) | 24.83 yr (1.12) |
| Births per woman | -1.87 (-3.33) | | 0.367 (0.074) | -0.506 (-2.37) | | 3.87 (0.87) |
| Childhood mortality | -10.51 (-3.40) | -3.87 (-2.94) | 17.2% (4.7) | -12.42 (-3.28) | 0.99 (0.27) | 17.2% (4.7) |
| Female wage | 0.010 (1.21) | | 16.71 s/w (12.55) | 0.011 (1.82) | | 16.71 s/w (12.55) |
| Male wage | | -0.001 (-0.50) | 44.37 s/w (49.05) | | 0.0001 (0.19) | 44.37 s/w (49.05) |
| Male wage squared | | 3.02E-06 (0.51) | 3984.00 (16439.9) | | | 3984.00 (16439.9) |
| Die early | -0.037 (-4.12) | -0.019 (-4.91) | 19.71% (8.01) | -0.025 (-3.56) | -0.032 (-4.57) | 19.71% (8.01) |
| Determinant residual covariance (J-statistic) | 0.0095 0.0334 | | | 0.1354 0.1357 | | |
| $R^2$ | 0.70 | 0.48 | | 0.57 | 0.47 | |
| N | 89 | 85 | | 89 | 70 | |

t-statistics in parenthesis

**Appendix 1: Occupations and Fertility and Mortality**
**Variable Definitions and Sources**

| **Variables** | **Definition/Source** |
|---|---|
| Occupation | Occupational title/classification, 1871 Registrar General's Report, beginning page 450 |
| 1871 | Code number from the 1871 Registrar General's Report |
| census | Code number from the 1911 Fertility Census for the matching occupation |

**Nuptiality and Fertility Variables**

| | |
|---|---|
| Age m | average age at marriage; calculated from Tables 30, 35; 1911 Census<br>Ave m = {17.5*number of women married at ages 15 –19 +<br>22.5 * number of women married at ages 20 –24 +<br>27.5 * number of women married at ages 25 – 29 +<br>32.5 * number of women married at ages 30 – 34 +<br>40.0 * number of women married at ages 35 – 44} /<br>total number of women married for the given duration.<br>calculate by length of time married (duration) |
| age m02 | average age at marriage for women married 0 – 2 years |
| age m25 | average age at marriage for women married 2 – 5 years |
| age m510 | average age at marriage for women married 5 – 10 years |
| age m025 | still to be calculated: average at married for women married 0 – 24 years (< 25 years) |
| total child | total number of children born to women of a given duration. |
| Child 02 | total number of children born to women married 0-2 yr. |
| Child 25 | total number of children born to women married 2-5 yr. |
| Child 510 | total number of children born to women married 5-10 yr |
| Child 025 | Still to be calculated for women married < 25 yrs. |
| Women xy | total number of women married for x – y years, 1911 Fertility Census, tables 30 & 35; equals the sum of women married, by occupational category, at all ages for a given duration of marriage. |
| Women 02 | total number of women married 0 – 2 years, 1911 Census |
| Women 25 | total number of women married 2 –5 years, 1911 Census |
| Women 510 | total number of women married 5 – 10 years, 1911 Census |
| Women 025 | total number of women married < 25 years |
| B/W | births per woman for a given duration of marriage<br>B/W = total number of children born / total number of women of the given duration |
| B/W 02 | births per women married 0 – 2 years; = child 02 / women 02 |
| B/W 25 | births per woman married 2 – 5 years; = child 25 / women 25 |

B/W 510 births per woman married 5 – 10 yr; = child 510 / women 510
B/W 025 births per woman married < 25 years = child 025/women 025

**Infant and Child Mortality Variables**

Child die number of children of women of a given duration who died before the Census date.
Ch die02 number of children of women of duration 0-2 who died
Ch die25 number of children of women of duration 2-5 who died
Ch die510 number of children of women of duration 5-10 who died
Chi die 025 number of children of women married < 25 years who died

INF mort infant mortality; fraction of children born who died before the Census date.
INF mort = total child / child die
INF 02 fraction of children who die, born to women married 0-2 yr
INF 25 fraction of children who die, born to women married 2-5 yr.
INF 510 fraction of children who die, born to women married 5-10 yr.
INF 025 infant mortality for women married < 25 years.
CHILD Mort name used in EVIEWS data set for inf 025

**Mortality Variables**

Aged 71 average age at death for men over the aged 20 and older, by occupation, in the 1871 Registrar General's Report.
= (22.5 * number of men died aged 20 –25 +
30.0 * number of men died aged 25 – 35 +
40.0 * number of men died aged 35 - 45 +
50.0 * number of men died aged 45 – 55 +
60.0 * number of men died aged 55 – 65 +
70.0 * number of men aged 65 – 75 +
88 * number of men died aged 75 and older) / total number of men who died at ages 20 and above.

Model 71 modal age at death for men aged 20 and older, in the 1871 Registrar General's Report.

Aged 90 average age at death in 1890/1892, Registrar General's Report
Aged 00 average age at death in 1900/19002, Registrar General's Report

## APPENDIX 2: EVIEWS DATASET

| | |
|---|---|
| INF mort | INF 02 |
| CHILD mort | INF 025 |
| | |
| Aged 71 | average age at death, 1871 |
| Moded 71 | modal age at death, 1871 |
| Aged 90 | average age at death, 1890 |
| Aged 00 | average age at death, 1900 |
| | |
| Morbidity | percentage of men who die of lingering disease/disability<br>See list |
| Die early | proportion of men (by occupation) who die before age 35, 1890 |
| Die late | proportion of men (by occupation) who die after age 55, 1890 |
| | |
| Agem 025 | average at marriage for women married < 25 years, 1911 |
| | |
| Child 025 | number of children born to women married < 25 years |
| Ch die 025 | number of child born who died |
| | |
| Women | number of married women/couples, 1911 |
| BW xx | births per woman; number of children born/number of women |

I = occupation

**Wages**

| | |
|---|---|
| F wage female | wage rate, primarily BOT 1906, Holcombe 1973, Cadbury and Matheson 1909; weekly wages in 1906 shillings |
| M wage | male wage rate, primarily BOT 1906, Routh, 1980, Perkin 1989; weekly wages in 1906 shillings |
| Routh_w | wages from Routh, 1980; in 1906 pounds per year |
| | |
| Class | derived from Routh, social classification of occupations; 9 point, ordinal scale |

**REFERENCES**

***PRIMARY SOURCES***

Board of Trade, *Earnings and Hours Enquiry; Report of and Enquiry by the Board of Trade into the Earnings and Hours of Labour of Workpeople of the United Kingdom*. (1906). Volumes 1-8 (I. Textiles Trades, II. Clothing Trades, III. Building and Woodworking Trades, IV Public Utility Services, V. Agriculture, VI. Metal, Engineering and Ship Building Trades, VII Railway Service, VIII Paper, Printing & Trades; Pottery, Brick, Glass and Chemical Trades; Food, Drink and Tobacco Trades; and Miscellaneous Trades)

Labour Department of the Board of Trade, Abstract of Labour Statistics, Prices and Wages in the UK 1914-1920, p170

Report by W. Ogle, Registrar-General, 28 February 1885, in *Supplement to the 45th Annual Report of the Registrar-General*, Parliamentary Papers (PP) 1884-55, Vol. XVII.

Registrar General, *Supplement to the 45th Annual Report of the Registrar-General*, Parliamentary Papers (PP) 1884-55, Vol. XVII

Registrar General, *Supplement to the 55th Annual Report of the Registrar-General*, PP 1897, Vol. XXI

Registrar General, *Supplement to the 65th Annual Report of the Registrar-General*, PP 1905, Vol. XVIII, (Cd. 2619).

Report by John Tatham, Registrar-General, 27 May 1897, in *Supplement to the 55th Annual Report of the Registrar-General*, PP 1897, Vol. XXI

***SECONDARY SOURCES***

Arlidge, J.T. *The Hygiene, Diseases and Mortality of Occupations*. London: Percival & Co., 1892.

Becker, Gary S. "A theory of the allocation of time." *The Economic Journal* 75 (1965): 493-517.

Becker, Gary S. *A Treatise on the Family*. Cambridge, Mass: Harvard University Press, 1981.

Becker, Gary S. "Family economics and macro behaviour." *American Economic Review* 78, no. 1 (1988): 1-13.

Behrman, J.R. and Wolfe, B.L. "A more general approach to fertility determination in a developing country: the importance of biological supply considerations, endogenous tastes and unperceived jointness." *Economica* 51 (1984): 319-339.

Ben-Porath, Y. "The micro-economics of fertility." *International Social Science Journal* 26, no. 2 (1974): 302-314.

Ben-Porath, Y. "Economics and the family: match or mismatch? A review of Becker's 'A Treatise on the Family." *Journal of Economic Literature* 20 no. 1 (1982): 52-64.

Bowden, Sue and Tweedale, Geoff. "Poisoned by the Fluff; Compensation and Litigation for Byssinosis in the Lancashire Cotton Industry." *Journal of Law and Socie*ty 29, no. 4 (2002): 560-79.

Bowden, Sue and Tweedale, Geoff. "Mondays without Dread: The Trade Union Response to Byssinosis in the Lancashire Cotton Industry in the Twentieth Century." *Social History of Medicine* 16, no. 1 (2003): 79-95.

Bowley, A.L. *Wages and Income in the United Kingdom since 1860*. Cambridge: Cambridge University Press, 1937.

Boyer, George R. and Jeffrey G. Williamson. "A quantitative assessment of the fertility transition in England, 1851-199." *Research in Economic History* 12 (1989): 93-117.

Brown, John C. and Timothy W. Guinane. "The Fertility Transition in Bavaria2. Yale University, Economic Growth Canter. Center Discussion Paper No. 821, April (2001).

Cadbury, E., M.C. Matheson and G. Shann. *Women's Work and Wages*, London: T. Fisher Unwin, 1909.

Coale, A.J. and S. Cotts Watkins. (eds.), *The Decline of Fertility in Europe,* Princeton, 1986.

Crafts, N.F.R. "A time series study of fertility in England and Wales,1877-1938." This JOURNAL 13 (1984): 571-590.

Crafts, N.F.R. "Duration of marriage, fertility and women's employment opportunities in England and Wales in 1911." *Population Studies* 43 (1989): 325-335.

Friedlander, D. "Demographic patterns and socio-economic characteristics of the coal mining population in England and Wales in the nineteenth century." *Economic Development and Cultural Change* 22 (1973): 359-381.

Guiannane, Timothy W., Carolyn Moehling and Cormac O'Grada."Fertility in South Dublin a Century Ago: A First Look." Yale University Economic Growth Center, November 2001, Discussion Paper No. 838.

Guiannane, Timothy W., Carolyn Moehling and Cormac O'Grada. "The Fertility of the Irish in America in 1910".Yale University Economic Growth Center, Discussion Paper No. 848, October 2002.

Haines, M.R. "Fertility, nuptiality and occupation: a study of coal mining populations and regions in England and Wales." *Journal of Interdisciplinary History* 8 (1977): 245-80.

Haines, Michael R. "Social class differentials during fertility decline: England and Wales Revisited." *Population Studies*, 43 (1989): 305-323.

Hardy, Anne. *The Epidemic Streets; Infectious Disease and the Rise of Preventive Medicine, 1856-1900*. Oxford: Clarendon Press, 1993.

Hewitt, M. *Wives and Mothers in Victorian Industry*. London, 1958.

Holcombe, Lee. *Victorian Ladies at work: middle class working women in England and Wales*. Newton Abbot, UK: David and Charles, 1973.

Innes, J.W. *Class Fertility Differentials in England and Wales, 1876-1934*. Princeton, New Jersey, 1938.

Johnston, R. and McIvor, A. *Lethal Work: A History of the Asbestos Tragedy in Scotland.*, Glasgow: Tuckwell, 2000.

Keeley, M. "A comment on 'An interpretation of the Economic Theory of Fertility." *Journal of Economic Literature* 13 no.2 (1975): 461-7.

Lancaster, K.J. Consumer Demand: A New Approach. New York: Columbia University Press (1971)

Leibenstein, H. *Economic Backwardness and Economic Growth* New York: John Wiley. 1957.

Leibenstein, H. "An interpretation of the economic theory of fertility - promising path or blind alley." *Journal of Economic Literature* 12, no. 2 (1974): 457-79.

Leibenstein, H. "The economic theory of fertility decline." *Quarterly Journal of Economics* 89, no. 1 (1975): 1-31.

Malthus, T.R. *An Essay on the Principle of Population*, 1803, 2nd. Edn., Reprinted with an introduction by T. Hollingsworth, London: Dent, 1973.

Mincer, J. "Market prices, opportunity costs and income effects" in *Measurement in Economics*, ed. C, Christ *et. al*., Stanford: Stanford University Press, 1963.

Nerlove, M. "Household and economy: toward a new theory of population and economic growth." *Journal of Political Economy* 82, no. 2, Part II (1974): S200 S218.

Oliver, T. *Dangerous Trades: The Historical, Social and Legal Aspects of Industrial Occupations as Affecting Health, by a Number of Experts* London: John Murray, 1902.

Perkin, H. *The Rise of Professional Society, England since 1880*. London: Routledge, 1989.

Pollard, Sidney. *A History of Labour in Sheffield*. Liverpool: Liverpool University Press, 1959.

Pindyck, R.S. and D.L. Rubinfeld. *Econometric Models and Economic Forecasts, 4th edition*, Boston MA, USA: Irwin McGraw-Hill, 1998.

Roberts, Elizabeth. "Working wives and their families" in T.C. Barker and M. Drake (eds.), *Population and Society in Britain, 1850-1980*, London, 1982.

Roberts, Elizabeth. *Women's work, 1840–1940*, Cambridge: Cambridge University Press, 1988.

Routh, Guy. *Occupation and Pay in Great Britain 1906-1979*. London: Macmillan Press Ltd, 1980.

Sanderson, W.C. "On two schools of the economics of fertility." *Population and Development Review* 2, no. 4 (1976): 469-77.

Sanderson, W.C. "Comment" in *Population and Economic Change in Developing Countries*, ed. R.A. Easterlin, Chicago: University of Chicago Press, 1980.

Schellekens, J.. E. Ben-Moshi, A. Keysar. "Socio-Economic Characteristics and Life Expectancies in Nineteenth Century England: A District Analysis." *Population Studies* 39, no. 1 (1985): 137-151.

Schultz, T.W.(ed.), *The Economics of the Family*. Chicago: University of Chicago Press, 1974.

Schultz, T. *Economics of Population*. Reading, Mass: Addison-Wesley, 1981.

Schultz, T. Paul. "The Fertility Transition: Economic Explanations", Yale University, Economic Growth Center, Center Discussion Paper No. 833, August (2001).

Seecombe, Wally. "Starting to stop: working-class fertility decline in Britain." *Past and Present* 126 (1990): 151-188.

Stevenson, T.H.C. "The fertility of various social classes in England and Wales from the middle of the nineteenth century to 1911." *Journal of the Royal Statistical Society* 83, no. 3 (1920): 401-444.

Szreter, Simon. "The Idea of Demographic Transition and the Study of Fertility Change: A Critical Intellectual History." *Population and Development Review* 19, no. 4 (1993): 659-701

Szreter, Simon. *Fertility, Class and Gender in Britain, 1860-1940, Cambridge Studies in Population, Economy and Society in Past Time,* Cambridge: CUP, 1996.

Szreter, Simon and Eilidh Garrett. "Reproduction, Compositional Demography, and Economic Growth: Family Planning in England Long Before the Fertility Decline." *Population and Development Review* 26, no. 1 (2000): 45-80

Szreter, Simon and Anne Hardy. "Urban Fertility and Mortality Patterns" in Martin Daunton (ed.), *The Cambridge Urban History of Britain, Volume 3, 1840-1950*. Cambridge: Cambridge University Press: 629-72, 2000.

Teitelbaum, M.S. *The British Fertility Decline,* Princeton: Princeton University Press, 1984.

Thackrah, C. T. *The Effects of Arts, Trades, and Professions*, London: Longman, 2nd edition, 1832.

Tweedale, G. *Magic Mineral to Killer Dust: Turner & Newall and the Asbestos Hazard*, Oxford, 2nd edition, 2001.

Watkins, S. Cotts. 'Conclusions' in A.J. Coale and S. Cotts Watkins (eds.), *The Decline of Fertility in Europe*, Princeton, pp. 420-449, 1986.

Willis, R.J. "A new approach to the economic theory of fertility behaviour." *Journal of Political Economy* 81 no. 2 Part II, (1973): S14 S64.

Women's Co-operative Guild (The). *Maternity, Letters from Working-Women,* (1915) Reprinted London: Virago Ltd. (1978).

Woods, R.I. "Approaches to the fertility transition in Victorian England." *Population Studies* 41, (1987): 283-311.

Woods, R. and Nicola Shelton., *An Atlas of Victorian Mortality.* Liverpool: Liverpool University Press, 1997.

Woods, R. and C.W. Smith. "The decline of marital fertility in the late Nineteenth century: the case of England and Wales." *Population Studies* 37 (1983): 207-225.

Wrigley, E.A. and R.S. Schofield. *The Population History of England, 1541-1871* Cambridge: Cambridge University Press, 1981.

## *Footnote References*

[1] See, for example, Boyer and Williamson, "Quantitative Assessment"; Coale and Watkins, *Decline of Fertility*; Crafts, "Time Series" and "Duration of Marriage"; Haines, "Social class"; Szreter, *Fertility, Class and Gender*; Teitelbaum, *British Fertility*; Woods and Smith, "Decline of Marital".

[2] Leibenstein, "Economic theory"; Becker, *A Treatise* and "Family Economics".

[3] Mincer, "Market prices"; Nerlove, "Household and economy".

[4] For a survey of this approach see Ben-Porath, "Economics and the Family."

[5] Ben-Porath, "First generation effects"; Leibenstein, "The economic theory"; Anderson, "On Two Schools" and "Comment"; Behrman and Wolfe, "General Approach".

[6] That is, up to about 1870 in England and Wales. Malthus, *Essay on Principle*; Wrigley and Schofield, *Population History*.

[7] Szreter and Garrett, "Reproduction".

[8] We note that in a recent analysis of the determinants of fertility in Bavaria in the nineteenth century, Brown and Guinnane have found an important role for the adoption of new ideas about contraception rather than adaptation to changing economic and social conditions. Bavaria was a mainly Catholic country which industrialised later than the rest of Europe – neither of which conditions apply to our study. Brown and Guinnane, "Fertility Transition". For the effects of the teaching of the Roman Catholic Church on fertility at the turn of the century see also Guinnane et al "Fertility of Irish".

[9] Although we should note that Szreter has argued that notions of an economic transition can be unhelpful in our understanding of fertility behaviour over time. Ibid.

[10] Stevenson, "Fertility".

[11] Innes, *Class Fertility*.

[12] Banks, 1981; Haines, "Social class"; Woods and Smith, "Decline of".

[13] Boyer and Williamson, "Quantitative Assessment"; Teitelbaum, *British Fertility*; Szreter and Hardy, "Urban Fertility".

[14] Although, as we argue below, these data are not without their problems.

[15] Crafts "Duration of Marriage"; Haines "Social Class Differentials" and Szreter, *Fertility, Class and Gender*.

[16] See also Szreter, *Fertility, Class and Gender*.

[17] In 1884 the death rate per million of children under 14 in England and Wales from Scarlet Fever was 473; by 1900 it had risen to 856 but fallen by 1909 to 462; the equivalent figures for Diphtheria was 646 (1889), 340 (1900) and 273 (1909), and for measles, 419 (1884), 394 (1900) and 356 (1909). Source: Annual Report of the Registrar General.

[18] Child mortality (fatalities per child born) were 0.42 in the children of male shipyard labourers, 0.34 of seamen, 0.32 of those employed in iron manufacture; 0.29 and 0.24 amongst skilled and unskilled workers in iron foundries respectively and 0.25 amongst dock and wharf labourers. Source: 1911 Fertility Census, Tables 30 and 35. See also Guinnane et al., *Fertility in South Dublin" who find a role for social effects in the explanations of the determinants of fertility in Dublin at this time.

[19] Child mortality (fatalities per child born) were 0.1 in the children of accountants, architects, civil engineers and authors/journalists; 0.08 amongst bankers and clergy, 0.07 amongst solicitors and 0.06 amongst gamekeepers. . Source: 1911 Fertility Census, Tables 30 and 35

[20] Infant mortality rates amongst civil servants and bankers were 0.05; amongst architects and authors/journals 0.047; amongst doctors 0.04; amongst solicitors 0.036; amongst civil engineers and the clergy 0.35; amongst shopkeepers and naval officers 0.02.Source: 1911 Fertility Census Tables 30 and 35

[21] Infant mortality rates amongst couples where the husband was employed as an unskilled foundry worker were 0.17; amongst cutler and scissors makers 0.16; amongst iron manufacture workers and shipyard labourers, 0.15; amongst workers in earthenware manufacture 0.15; amongst costermongers and workers in glass and bronze manufacture and dock labourers 0.14. Source: 1911 Fertility Census, Tables 30 and 35

[22] Median and mean infant mortality rates of 0.187 and 0.185 respectively, compared with median and mean infant mortality rates for couples married over all durations of 0.094 and 0.095 respectively.

[23] Infant mortality rates for couples married between 5 to 10 years where the husband was employed as a shipyard labourer were 0.205; as a dock or wharf labourer and unskilled iron foundry worker 0.0199, as a steel manufacturing worker 0.194 and as a costermonger/pedlar 0.193.

[24] Crafts "Duration of marriage".

[25] The data were derived primarily from Board of Trade, Enquiry into Earnings and Hours Report (1906) supplemented by data from Routh, *Occupation and Pay* and Perkin *Rise of Professional.*

[26] From Routh, *Occupation and Pay* in 1906 pounds per year

[27] The data recorded here, we should note, make no allowance for hardship incurred as a result of the lqbour rationing which occurred at this time. Short time working, temporary stoppages as well as unemployment applied to many industries. See Whiteside.

[28] Arlidge, *The Hygiene*; Ogle, 1885; Oliver, *Dangerous Trades*; Thackrah, *Effects of Arts* 1832; Thatham, 1897

[29] Rosen; Tweedale, *Magic Mineral*

[30] Bowden and Tweedale, "Poisoned" and "Mondays"; Johnston and McIvor, *Lethal Work* .

[31] In 1890, the mean age of death of a clergyman was 70. By 1900 this had risen to 71. By contrast, a brass or bronze worker had an average age of death of 47 in 1890, rising to only 48 in 1900. Registrar General, *Supplement to the 55th Annual Reportl.*

[32] Less than 10 per cent of deaths recorded in these occupations were of men who died before the age of 35. Registrar General, *Supplement to the 55th Annual Report*.

[33] Just over 25 per cent per cent of deaths recorded in these occupations were of men who died before the age of 35. Registrar General, *Supplement to the 55th Annual Report.*

[34] The relevant percentages of deaths under 35 as a percentage of all deaths in these occupations were Coal-miner in South Wales (35%), Hairdresser (34%), Zinc Worker (30%), Railway Driver (38%) and Printer (37%).

[35] Crafts, "Duration of marriage"; Schultz, "Fertility Transition"; Willis, "New approach".

[36] Hewitt, *Wives and Mothers*; Roberts," Working wives".

[37] Wages are a combination of 1906 Parliamentary/Board of Trade data and estimates from Holcombe, *Victorian Ladies*; Cadbury et. al., *Women's Work*, Routh , *Occupation and P*ay and Perkin *Rise of Professional*). Data from years other than 1906 are deflated to 1906 levels.

[38] Board of Trade Enquiry into Earnings and Hours, 1907; Roberts, 1988.

[39] Cadbury et al., *Women's Work*.

[40] Cadbury, *Women's Work*

[41] Roberts, *Women's work*; Cadbury, *Women's Work*; Mattheson and Shann, 1909.

[42] 1901 census

[43] That is schools funded by the local city or county council .

[44] 1901 census.

[45] Friedlander, "Demographic" Haines, "Fertility" (1977) and Schellekens et al., "Socio-Economic Characteristics".

[46] Occupational differences were also noted by Pollard. See Pollard, *History of Labour.*

[47] Seecombe, "Starting to stop".

[48] Watkins, "Conclusions"; Woods, "Approaches to Fertility".

[49] Crafts, "Duration of marriage"; Roberts, "Working Wives" and *Women's Work*.

[50] We used a generalized method of moments to test the above, which was robust under a wide range of distributional assumptions.

[51] Pindyke and Rubinfeld, *Econometric Models.*

[52] Becker

[53] The number of observations for duration 15- 20 years is different due to the change in instruments used to estimate the system. The square of the male wage is insignificant and was eliminated.

[54] Hardy, *Epidemic Streets*; Woods and Shelton, *Atlas of Victorian.*