The London School of Economics and Political Science

Why Did Fertility Decline?
An Analysis of the Individual Level Economic Correlates of the Nineteenth Century Fertility Transition in England and France

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Declaration

I certify that the thesis I have presented for examination for the PhD degree of the London School of Economics and Political Science is solely my own work other than where I have clearly indicated that it is the work of others (in which case the extent of any work carried out jointly by me and any other person is clearly identified in it).

Chapter 4A of this thesis is co-authored with Professor Greg Clark of the University of California at Davis. Professor Clark provided the pre 1800 data, and I provided the post-1800 data. The analysis is co-written. All other chapters are my sole work.

I warrant that this authorization does not, to the best of my belief, infringe the rights of any third party.

Abstract

The fertility transition in nineteenth century Europe is one of economic history's greatest puzzles. There is no consensus in the literature on the causes of this 'fertility revolution'. Following a critical review of the empirical and theoretical literature, this thesis re-examines the economic correlates of the fertility decline through the analysis of two new datasets from England and France. For the first time, the relationship between wealth and fertility can be studied over the period of the fertility transition. Clear patterns are discovered, namely a strong positive relationship pre-transition which switches to a strongly negative relationship during the onset of the transition. Family limitation is initiated by the richest segments of society. I then introduce a simple model which links fertility and social mobility to levels of economic inequality. I argue that parents are motivated by relative status concerns and the fertility transition is a response to changes in the environment for social mobility, where increased mobility becomes obtainable through fertility limitation. This hypothesis is tested with the new micro data in England and France. Fertility decline is strongly associated with decreased levels of inequality and increased levels of social mobility. The analysis finds strong support for the role of changes in inequality and the environment for social mobility as central factors in our understandings of Europe's fertility transition.

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Table of Contents

List of Tables

List of Figures

Chapter 1 - Introduction

Section 1.1: Background

Today's fertility levels are a small fraction of their potential maximum. Biologically, a healthy woman could give birth to more than 15 children if she married early enough and made no attempt to avoid pregnancy. Historically, human societies have never maximised fertility, but have restricted it through access to marriage[1]. However, within marriage, historical demographers have failed to find unambiguous evidence for significant fertility limitation before the demographic transition of the 18th and 19th centuries (Cleland and Wilson 1987 p.12). During the demographic transition, in conjunction with a decline in mortality, fertility within marriage fell sharply. For the first time, fertility control was practised on a wide scale. This process remains mysterious and poorly understood despite intense research over the past century. The demographic transition is "a phenomenon in need of an explanation" (Mace 2000 p.7). Why did fertility decline? This is the subject of this thesis. The dramatic change in reproductive behaviour from regimes of 'natural fertility' to the exercise of conscious control over family size has been justifiably termed "the fertility revolution" by Easterlin and Crimmins. They emphasise the importance of the analysis of this transition;

"Because of inadequate knowledge of the causes of the fertility revolution, it is not possible to predict the onset and pace of fertility' decline in today's developing countries or to formulate effective policies to slow population growth"
(1985 p.3).

Fertility is not only a personal choice. It has major macro economic impacts too. First, let us consider its influence on a country's population level. As of April 2009 the world's population stood at slightly over 6.7 billion people. By 2050, the UN estimates, this number will have increased by nearly 40% to 9.2 billion (U.S. Census Bureau (2009). However, the rate of growth between different regions of the world will vary greatly. Changes in the distribution of the world population will

[1] e.g Culture or traditions resulting in a high average age at marriage and a high proportion of the population never marrying, such as the European marriage pattern.

ultimately lead to dramatic swings in the locus of global political and economic power. The recent economic growth and rise of China to superpower status, and the relative decline of Western Europe can partially be attributed to the underlying population base. The three demographic constituents of population growth, mortality, fertility and net migration, will determine the growth rate and level of the population of different regions of the world. Of these constituents, it is fertility which has the greatest influence upon a country's population growth rate. The Population Reference Bureau states "small changes in childbearing trends today have huge implications for future population size" (2004 p.4). To illustrate empirically the importance of a country's fertility rate to its population size, I will compare the experience of England and France, 1850-1912.

In 1850 the population of France dwarfed that of her neighbour, England and Wales, holding almost exactly double the number of men, women and children. Over the following 62 years, the gap closed to a remarkable extent, where the population of England grew to 90% of that of France. Table 1.1 reports the constituent factors in the population growth rates for England and Wales, and France, 1850-1913

Table 1.1: The Determinants of Population Change, England and France, 1850-1913

	Crude Birth Rate	Crude Death Rate	Net Migration %	Population 1851	Population 1913	Change %
	(Average rate per year)			(Millions)	(Millions)	
England and Wales	32.15	19.65	-1.03	17.80	36.30	103.93%
France	23.99	22.24	0.40	35.60	39.70	11.52%

Source: Rothenbacher, 2002.

Despite losing an average of 1% of her population per annum through migration, the population level in England and Wales was expanding rapidly. In France, despite of a 0.4% gain in net migration per year, population is almost stagnant. Mortality differences were relatively negligible. The crucial constituent is fertility. The crude birth rate was 34% higher in England and Wales compared to France. Population growth in France was miniscule compared to the population explosion in England and Wales, whose percentage growth rate over the period was nearly 10 times that of France. These changes alter the economic, political and cultural power balances between countries.

Returning to today's world, the higher fertility rates of the developing nations will contribute most to world population growth over the next half century[2]. Fertility in the developed world is far lower, and many developed countries, particularly in Europe, have fertility rates below that necessary to replace the population. Without migration, these countries are shrinking. The executive summary of the European Population Forum pointed out that current low fertility trends, which will result in future population and labour force decline, "call into question sustainable development in Europe" (Macura et al. 2004 p.279).

The underlying demographic trends are resulting in a continuous rise in the dependency ratio[3] in Europe. As many European pension provisions are financed from current taxation, increases in the dependency ratio will mean that a greater proportion of governmental budgets are spent on these welfare transfers. Today, European governments face large, increasing and unsustainable commitments to their aging populations. There are three policy options available. Firstly, governments can introduce policies which stimulate the fertility rate. Secondly, governments can introduce policies to attract migrants of working age. If these options are not taken, the government must either act to cut welfare expenditure (e.g. raise the retirement age, cut payment amounts) or increase taxation (Population Reference Bureau 2004 p.28).

Europe's below replacement fertility rates have come as a surprise to most

[2] "It is almost certain that all future population growth will occur in the developing regions of the World" (Population Reference Bureau 2004 p.4).
[3] The ratio of the non-working to the working population. This ratio "is projected to rise sharply over the next 50 years" (Lee 2003 p.183).

demographers, many of whom expected fertility to level off at, or near to, replacement (Bongaarts 2002 p.419). On a global front, Europe's demographic share is expected to drop from 12% to 7%, a decline of 96 million, between 2000 and 2050 (Macura et al. 2005 p.279 (executive summary)). On current trends, Europe is vanishing. Adolphe Landry[4] attributed the declines of the Greek and Roman civilisations to depopulation (Kirk 1996 p.363). Caldwell's recent survey of ancient Roman demography concludes that population was stationary. However, he does point to evidence that the Roman upper classes "significantly" restricted their fertility, an ancient precedence to a modern phenomenon (Caldwell 2004 p.12).

Table 1.2: The Total Fertility Rate by the Level of Human Development, 2005

Level of Human Development	HDI	GDPpc PPP US$	e_0	Education Index[5]	Total Fertility Rate[6]	Net Reproduction Rate[7]
High	0.897	23,986	76.2	0.922	1.8	0.75
Medium	0.698	4,876	67.5	0.738	2.6	1.22
Low	0.436	1,112	48.5	0.515	6.0	1.83

Source: UNDB 2007/2008,

Table 1.2 reports the total fertility rate, and also the net reproduction rate, for the world, categorised by the level of human development. Countries are categorised as being having high, medium or low levels of human development based upon their relative ranking in terms of the human development index (HDI). The HDI score is calculated on income per capita, life expectancy and an education index. The component measures of HDI are also listed in table 1.2. The level of fertility is differentiated by the level of development on this global scale. Countries with high human development have low fertility; countries with low human development have high fertility. Countries with medium HDI levels have fertility rates in the middle range. What accounts for this variation in global fertility levels?

[4] An early proponent of demographic transition theory, which is discussed in section 1.3.
[5] This is the education component of the HDI. It is combination of adult literacy (2/3rds) and the combined general enrolment ratio.
[6] For 2000-2005.
[7] The net reproduction rates are sourced from UN 2008, and refer to level of development based upon income per capita alone.

The perceived wisdom is that these countries are at different stages of their demographic transition. Fertility is lower in more developed countries because the fertility transition occurred for them earlier than anywhere else.

We still do not know why fertility declined in Europe. “The reduction in fertility accompanying modernisation poses a scientific puzzle that has yet to be solved” (Kaplan et al. 1995 p.326). This thesis asks “why did fertility decline?” To answer this, I will re-examine the economic explanations for the world’s first fertility transition by generating individual level fertility and economic data for two European countries, England and France.

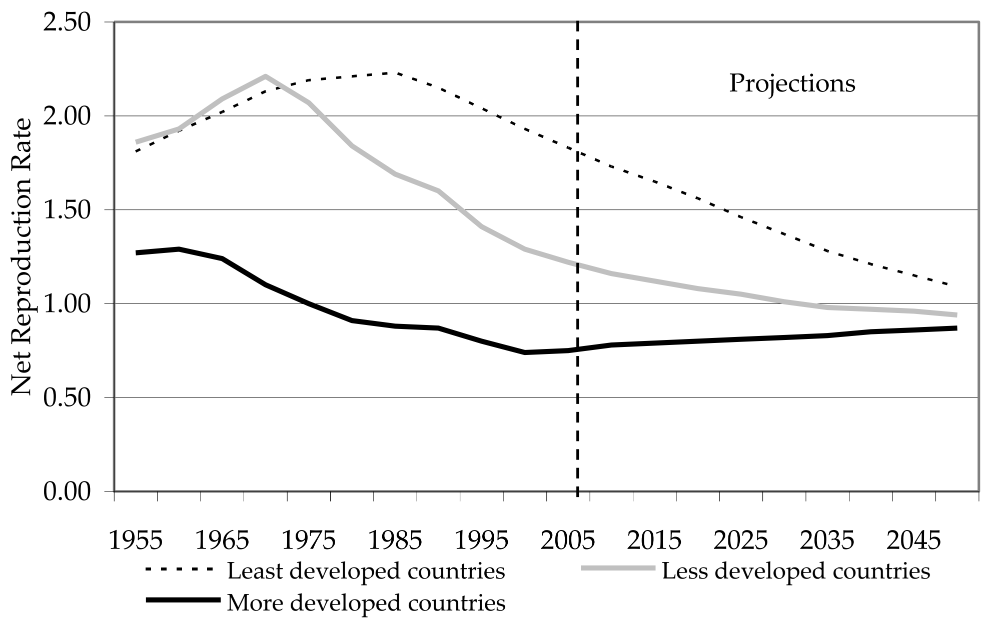
The rest of this chapter is comprised of five sections. Section 1.2 discusses the fertility transition pattern and reports some empirical evidence for the European case. Section 1.3 introduces and explores demographic transition theory. Section 1.4 reviews the findings of the European Fertility Project, the largest empirical study of the question and section 1.5 details the research questions and findings of each chapter in this thesis. Section 1.6 Concludes this chapter.

Section 1.2: The Fertility Transition

Figure 1.1 charts the development of the net reproduction rate for the World, by level of development, for 1950-2050. For the post 2000 years, the ‘medium variant’ projections are used. The net reproduction rate (NRR) is the average number of daughters that a hypothetical cohort of women would bear if they lived their lives generating the age specific fertility and mortality rates of a specific year. As the NRR is a fertility measure which factors in mortality, it must be considered the most realistic estimate of realized fertility. As stated in the last section, the principal reason for the contemporary variation in world fertility is that different groups of countries are at earlier or later stages of their fertility transitions.

The global historical record shows that regions typically experience a transition from high to low fertility levels, where a clear break from past trends is observed and fertility never returns to pre-transitional levels. Beginning in Europe in the 19th century[8], fertility transitions have been observed throughout the world over the past century, with many developing countries experiencing declining fertility more recently, as figure 1.1 illustrates. Some countries, mainly in sub-Saharan Africa, still have high fertility levels, but these are also projected to decline over the next few decades. The focus of explanations for fertility behaviour has been on these transitions. However, this process remains poorly understood and inadequately explained despite over 50 years of concentrated interest from demographers, economists and sociologists. Demography, as a discipline "consequently suffers from a sense of malaise caused by our apparent inability to explain one of the most important demographic phenomena in human history" (Hirschman as quoted by Mason 1997 p.446).

Figure 1.1: Net Reproduction Rates for the World, by level of Development, 1950-2050[9]



Source: United Nations 2009.

[8] However, fertility decline in France preceded the rest of Europe by over a century (18th century).

[9] This graph is similar to one presented in Lee (2003 p.184), but uses the net reproduction rate rather than the total fertility rate.

The empirical character of the world's first demographic transition has been documented in great detail. In general, both birth and death rates declined from a range of 30–40 per thousand to less than 10, and life expectancy rose from a range of 25-35 to 75-80 (Livi-Bacci 1997 p.113). Fertility decline was near universal throughout Western Europe in the late 19th century, and as the European Fertility Project (EFP) revealed, there were a remarkable concentration of provinces in Europe experiencing an almost simultaneous onset of fertility transition. There were also huge outliers however, with Ireland experiencing much later decline (about 1929), and the anomaly of early French fertility decline (dated as 1800 by Knodel and van de Walle, but almost certainly earlier (Knodel and van de Walle 1986 p.394).

The decline in mortality, which started in North Western Europe about 1800, has been attributed to less frequent epidemics and famines, innovations in preventative medicine and improved personal hygiene (certainly related to the diffusion of the germ theory of disease) (Livi-Bacci 1997 p.94, Lee 2003 p.170, Kirk 1996 p.362). Public health measures such as better sanitation and drainage systems as well as improved welfare services also contributed significantly to the mortality decline, as did improvements in communications enabling greater dissemination of these advances to more remote regions. These were largely the result of the rapid rise of incomes in the period, and it was infant mortality which declined the most (Baines 1998 p.161). Income growth led to better fed populations, and in particular, improved nutrition during childhood. The empirical association of height and childhood nutrition suggests that this factor is important in lifelong susceptibility to disease (e.g. a stronger organ system) (Lee 2003 p.171). Another period of mortality decline began after World War II, linked to the discovery and use of sulpha drugs and anti-biotics (Schofield and Reher 1991 p.1).

In general terms, the decline of mortality in Europe was followed by the decline in fertility[10]. By 1900 most of Europe was experiencing fertility decline, or

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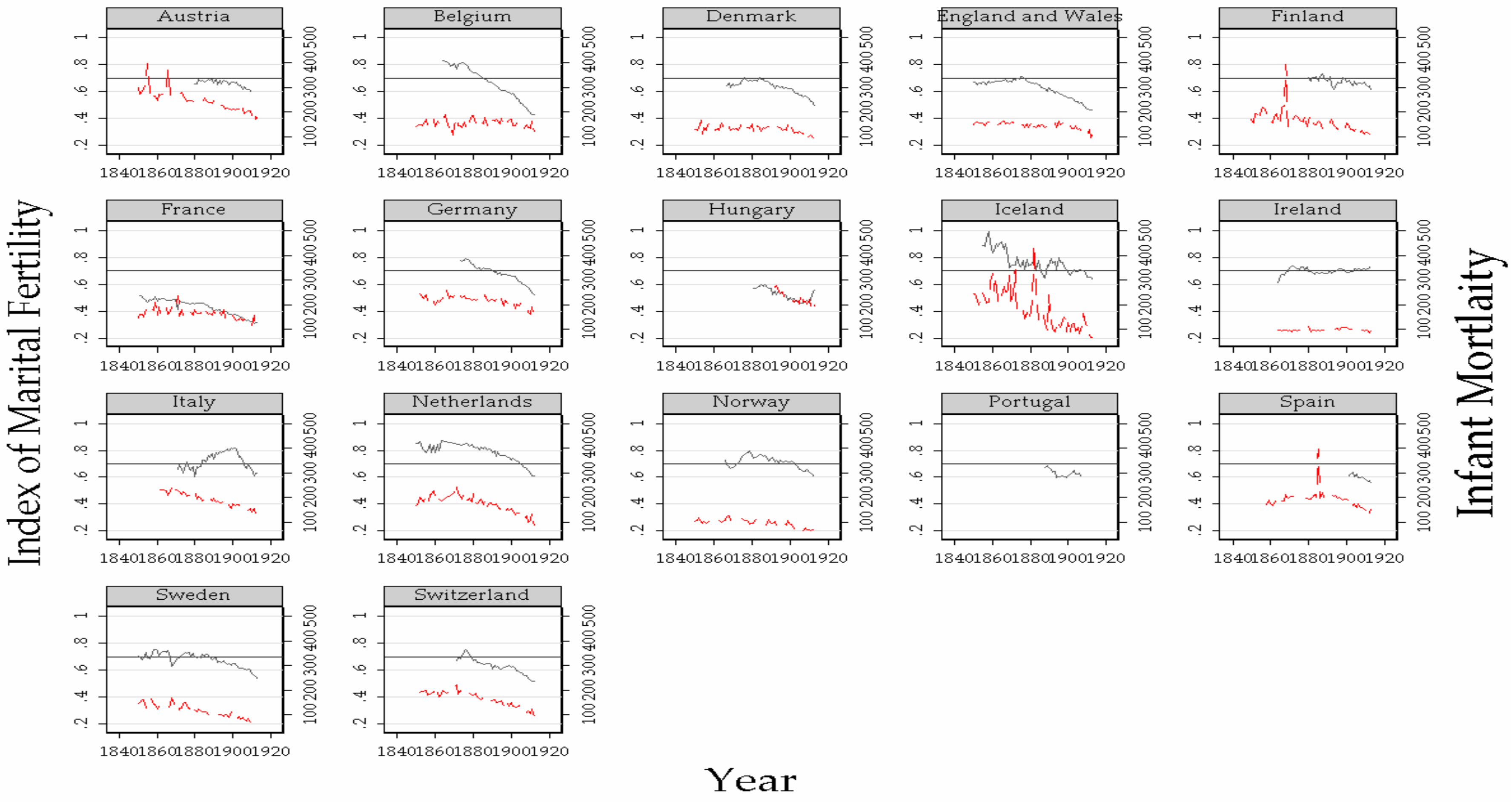
[10] Which came first is discussed later in this chapter.

about to. This was a "gradual and geographically varied process", where both levels and trends of decline were different across Europe (De Santis and Livi-Bacci 2001 p.100). The index of marital fertility (I_g) and the infant mortality rate (per 1000 births) is plotted for 17 European countries in figure 1.2. I_g is a standardised measure of fertility and is calculated a proportion of the maximum observed human fertility. The Hutterites, an Anabaptist group who married early and practised no form of birth control have an I_g equal to one. An I_g value greater than 0.7 is considered a rough threshold of a non fertility controlling population, and this threshold is represented in figure 1.2 by a solid horizontal line (Wetherell 2001 p.590). In practice this means that the population in question has recorded marital fertility levels which are 70% of the level we would expect of the Hutterites. In figure 1.2, I_g is represented by a solid line and is referenced by the left y axis, infant mortality by a dashed line (referenced by the right y axis). Infant mortality is the lower line in all graphs.

Figure 1.2 illustrates the decline in fertility of Austria, Belgium, Denmark, England and Wales, France, Germany, Hungary, the Netherlands, Norway, Sweden and Switzerland. All of these countries show a clear downward trend towards the end of the 19th century. In the French case, fertility has declined long before the start year of the graph, 1850. For Finland, Iceland, Ireland, and Italy, sustained decline in fertility does not occur before 1913, at least in this simple visual inspection. The exercise of plotting fertility against the infant mortality rate also reveals a variety of patterns in the countries of Europe. Level differences are enormous. Comparing Norway and Ireland with Germany and Italy, we see huge level differences in the index of marital fertility and the infant mortality rate. Further, for those countries where fertility decline has started, for instance Belgium, England and Wales and France, there is no downward trend in infant mortality.

As Alter put it, in regards to Europe's fertility decline "there is a mosaic of levels and trends" (1992 p.21).

Figure 1.2 : Fertility and Infant Mortality in Europe, 1840-1913



Source: Own calculations and Rothenbacher 2002.

Section 1.3: Why did fertility decline?

Almost all theories and explanations of Europe's fertility decline can be categorised as being either 'innovation diffusion' or 'adaptation'[11]. The 'innovation diffusion' hypothesis states that declining fertility rates represent a new behaviour, a result of new knowledge (about contraception, for example) or changes in culture or attitudes that make fertility control acceptable on moral grounds. The 'adaptation' hypothesis states that fertility control is primarily influenced by couples' reactions to changes in economic and social circumstances (for example rising incomes and declining infant mortality rates) (Bonneuil 1997 p.2). Through this, high pre-transitional fertility is seen as couples' rational response to economic and social conditions, just as falling fertility is seen to reflect couples rational assessment of the changing costs and benefits of having children.

Perhaps the most influential theory of the interaction of the economy and the population is that forwarded by the Reverend T.R. Malthus in his "Essay on the Principle of Population" (first published in 1798). Malthus' ideas are still highly controversial today. Essentially, Malthus argued that the growth rate of the population was dependent on the food supply, and this relationship was kept in equilibrium via the preventative check, which acted through fertility, and the positive check, which acted through mortality. Using annual variations in grain prices as a proxy for variations in the real wage (and therefore the standard of living), Galloway states "fertility was highly sensitive to grain price fluctuations in most of pre-industrial Europe" (1988 p.298). For England and France, Weir found "evidence of a connection between the economy and marital fertility" for the period 1740-1789 (Weir 1984a p.39). More recently, Anderson and Lee, using statistical methods which factor in the endogenity of population dynamics and the economy, have found that their estimates of the effect of wage variation on fertility, for 1540 to 1870, were "substantially stronger" than previous estimates (2002 p.212). However, this is a short run relationship, Anderson and Lee state "very little of the long-term

[11] A categorisation first forwarded by Carlson (1966).

variation in either fertility or mortality appears to be explained by variations in wages" (2002 p.212)[12].

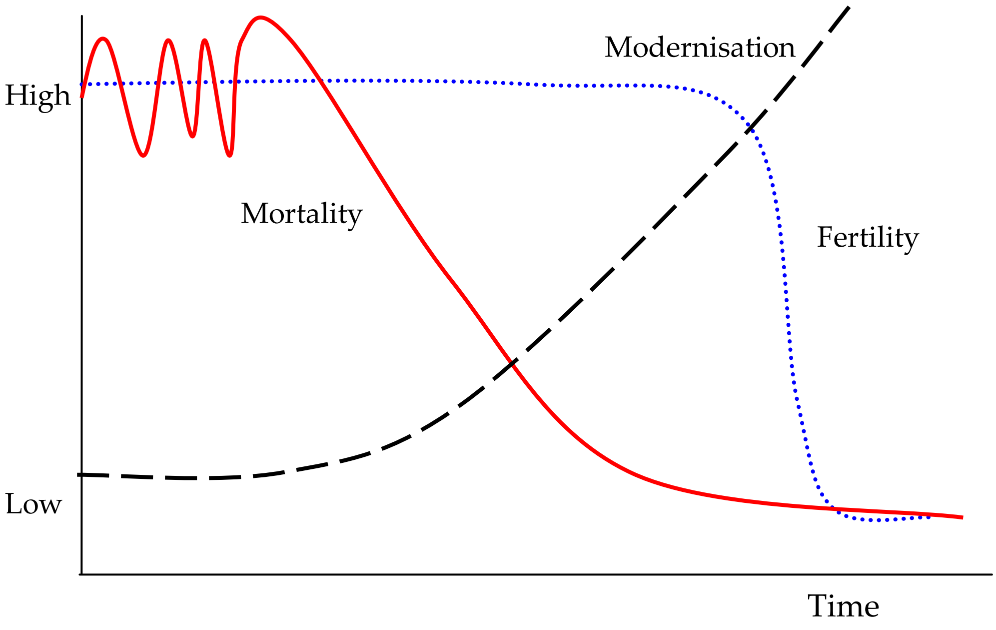
However, Malthusian theory offers no explanation for the systematic decline of European fertility in the late 19th century, and the demographic transition is often characterised as the escape of Europe from the 'Malthusian trap'. Without the fertility transition, the material gains from the industrial revolution would have been dissipated, and population would have grown extraordinarily large. Something fundamental in people's fertility preferences changed. This new behaviour, the practice of deliberate family limitation within marriage, was not foreseen by Malthus.

In the first half of the 20th century, demographers such as Thompson (1929), Landry (1934) and Notestein (1945), and others developed 'demographic transition theory'. Notestein (1945) categorised countries into three stages of demographic transition based upon the growth rate of the population – a high growth potential (where both birth and death rates are high), a transitional growth regime (where mortality decline precedes fertility decline) and an incipient decline regime (where both mortality and fertility have declined) (pp.42-48). Underlying demographic transition theory is the hypothesis that prosperity, urbanisation and modernisation are the causal agents of the decline of fertility in Europe. The reduction of heavy mortality, and in particular, infant mortality, coupled with drastic changes in the social and economic climate through modernisation, significantly altered peoples' motives and tendencies regarding family size. The ubiquitous demographic transition theory schema is illustrated in figure 1.3.

Figure 1.3 illustrates the time trend of the three demographic transition theory variables: fertility, mortality and 'modernisation'. High and erratic pre-

[12] There is a rich literature on the validity of Malthus' ideas. The field is controversial and is still, two centuries later debated furiously. Some recent studies include Crafts (2009), Mokyr and Voth (2009) and Clark (2007). An earlier but fascinating analysis of homeostasis in human population is that of Lee (1985).

Figure 1.3: Demographic Transition Theory



transition mortality rates (and by extension infant mortality rates) require societies to maximise their fertility in order to survive. Health and welfare improvements, induced by modernisation, have an immediate impact upon mortality. However, fertility remains high, and the society experiences a high rate of population growth. Eventually, fertility falls into equilibrium with mortality, as demand for children adjusts with a lag to the sudden increase in supply. The theory is still a major teaching tool in many demography textbooks. It is intuitive, and appears to make sense. However, not only is it regularly attacked for not being a proper theory, it has also failed to match the empirical record.

Demographic transitions theory's inherent vagueness means that there very few testable hypotheses. One of these is the hypothesis that infant mortality decline will always predate fertility decline. Inspecting the mosaic of patterns in figure 1.2, the relationship is less than obvious. Amazingly, taking Europe as a single entity and correlating the infant mortality and fertility data used in figure 1.2, yields a surprisingly low correlation coefficient of 0.054. This suggests strongly that the causal mechanism emphasised by DT theory sheds little light on intra European demographic differentials.

In order to provide an empirical confirmation of demographic transition theory at a more disaggregated level than the national level series, Ansley Coale initiated the Princeton Project on the history of European Population (also known as the European Fertility Project (EFP). The EFP published eight books and seven summary journal articles between 1968 and 1986, with the oft cited summary volume '*The Decline of Fertility in Europe*' concluding the series[13]. The initial spark for the project came from the PhD thesis of William Leasure, who had discovered that the fertility decline in Spain did not fit the description of demographic transition theory (Coale and Watkins 1986 preface). Along with his collaborators, Coale's objective was to investigate Europe's fertility decline through the collection and analysis of fertility measures at the level of 'provinces' – the many hundreds of counties, departments, and cantons in Europe. The study is regarded by many as the "definitive study" of Europe's fertility transition (Kirk 1996 p.366).

Regarding the description of the fertility transition, the central findings of the project were that (1) Marital fertility decline was the predominant influence on the fall in overall fertility from 1870-1930, (2) Once the decline started (as signified by a 10% drop in marital fertility), it continued to decline and (3) Excluding France, 59% of the provinces of Europe began their fertility transition during the decades of 1890–1920 (Watkins 1986 p.431-43). The EFP was also able to confirm and document the "marriage boom" in Western Europe (as observed by Hajnal in 1953). The proportion married rose significantly and rapidly between 1870 and 1960 (Watkins 1986 p.335). Malthus viewed access to marriage as the primary determinant of fertility and the fertility transition can be interpreted as "a shift in the mechanism of population control from restriction of marriage to limitation of childbearing within marriage" (Alter 1992 p.14).

[13] The references, with the country under study in parentheses, are: Books: Livi Bacci 1971 and 1977 (Portugal and Italy respectively), Knodel 1974 (Germany), van de Walle 1974 (France), Lesthaeghe 1977 (Belgium), Coale and Anderson 1979 (Russia), Teitelbaum 1984 (Great Britain and Ireland) and Coale and Watkins 1986 (summary volume). Papers: Livi Bacci 1968 (Spain), Siampos and Valaoras 1971 (Greece), Demeny 1972 (Austria-Hungary), Forrest 1975 (Austria), Mosk 1978 (Denmark), van de Walle 1980 (Switzerland) and Matthiessen 1984 (Denmark).

Section 1.4: The EFP and Demographic Transition Theory

A central prediction of demographic transition theory is the decline of mortality before fertility. Were couples' responding rationally to a changing expectation of net family size? If this was the case, the data should show a clear and significant positive relationship between infant mortality and fertility. In other words, as the expected family size from a certain number of births increases, parents should adjust their fertility downwards in order to account for this new mortality environment. The results of the EFP's multiple studies detected no strong patterns in the relationship between these variables. For Belgium, Lesthaeghe found a negative effect for the language areas of Wallonia and Flanders (1977 p.200). For Great Britain and Ireland, Teitelbaum states "my analyses revealed essentially no statistical relationship between the level of infant mortality (and child mortality as well) and the decline of marital fertility"[14] (1984 p.215). For Germany, Knodel noted "it appears that the usual description of the demographic transition which postulates a prior decline in mortality…as an initiating cause of the fertility decline does not fit the facts in Germany" (1974 p.185)[15]. Demeny (1972) found that the extremely high infant mortality rates of Austria-Hungary did not hinder a full fertility transition[16] (1972 p.172).

As demonstrated in the previous section, there was no relationship between fertility and infant mortality at the national level in Europe during the demographic transition[17]. In the EFP's summary volume Francine van de Walle states "at the provincial level, correlations are sometimes stronger and sometimes weaker than at the national level, but they are not always in the expected direction" (van de Walle 1986 p.220). Table 1.3 summarises the provincial level associations and highlights the variety of patterns in the infant mortality-fertility relationship in Europe at this

[14] In fact, marital fertility declined *before* infant mortality declined in most English counties (Watkins 1986 p.436).
[15] Fertility declined *before* infant mortality declined in Germany. However, they did decline together with striking simultaneity in some areas, and in Germany as a whole (Knodel 1974 p.181).
[16] He did find an association *within* his subregions however (1972 p.172).
[17] A point also made by Francine van de Walle (1986 p.220).

time. Concluding, Watkins states that the "battery of tests" undertaken by the EFP showed "little association between fertility and infant mortality during the demographic transition[18] (Watkins 1986 p.436).

Table 1.3: The Provincial Level Correlation of Infant Mortality and the index of marital fertility in Europe

Country	1870	1900	1930
Belgium		0.575***	
Denmark	-0.134	-0.677**	-0.025
England and Wales	0.090	0.174	0.614**
France	0.007	0.281**	0.31**
Germany	0.545**	0.219*	0.473**
Netherlands	0.634*	0.798**	0.91**
Norway	0.327	-0.409*	0.166
Russia		0.399**	
Spain		0.110	
Sweden	0.126	-0.027	0.523**
Switzerland	-0.038	0.209	0.557**
Total	0.156**	0.383	0.078

*** Significant at the 0.001 level
** Significant at the 0.01 level
* Significant at the 0.05 level

Source: Van de Walle 1986 p.221

Demographic transition theory is built upon the stylized impression that modernisation (broadly defined) is a causal force of fertility decline. The EFP failed to uncover the mortality trigger for this switch in behaviour. Perhaps fertility acted in direct response to socioeconomic developments? The EFP was designed to detect this pattern in Europe's provinces. For Germany, Knodel failed to find any threshold level of economic development that was associated with fertility decline, although he did find a "moderately close" association between the level of socioeconomic development and the decline of fertility (1974 p.244). Demeny's study of Austria-Hungary found diverging associations between modernisation

[18] Van de Walle questions the very origin of the assumption that there ever was a relationship between the declines of infant mortality and fertility (1986 p.231). Some of the EFP author suggested that the appropriate variable should be child, and not infant, mortality. The decline in child mortality preceded the decline in infant mortality and thus would have acted to shift parents supply function upwards. Knodels data support this hypothesis (Knodel 1986 p.346). Unfortunately, this hypothesis was not systematically tested as part of the EFP (Watkins 1986 p.448).

and the fertility decline; "in the Austrian lands, fertility decline does seem to fit the conventional picture of demographic transition as a process associated with urbanization, industrialisation, and their various correlates" (1972 p.169). Remarkably, fertility decline in Hungary, an undeveloped and poor region of Europe, "originated and developed in and among the peasantry" (Demeny 1972 p.169). In addition to the lack of a socioeconomic trigger for the fertility decline in Austria- Hungary, cultural factors were not strong indicators of reduced decline either; "identical behaviour was generated in a variety of greatly differing cultural environments"[19] (Demeny 1972 p.171).

Elsewhere, the EFP's results were similarly confusing. In relation to Belgium, Lesthaeghe write; "the strong relationship between the rate of the marital fertility decline and the index of industrialization-urbanization indicates that modernisation of the occupational structure was indeed a forceful agent in the process of fertility reduction" (1977 p.224). However, Lesthaeghe concludes that because of the heterogeneous fertility-modernisation reactions across Europe, there was no economic threshold at which fertility decline would be initiated. Rather, it was the interaction of economic growth and cultural change, and in particular secularisation[20], which sparked the fertility transition in Belgium. Concluding, Lesthaeghe states in Belgium "fairly early economic and social transformations coincided with and were partly responsible for an early breach in ethical and religious barriers; a relatively low level of secularization was sufficient to release the mechanisms that would bring fertility down" (1977 p.231). However, for Spain, Livi-Bacci noted that fertility control and reduction took hold in a society which was "strongly Catholic both in affiliation and observance" (1968a p.101). Further, Livi-

[19] For instance, the leaders of fertility decline in the Transdanubian region were the Protestant Hungarians, in the Banat region it was the German Roman Catholics and in Krasso Szoreny it was the Romanian Greek Orthodox population (Demeny 1972 p.170).

[20] Through analysing the regional variation in the non-Catholic vote and computing the correlation coefficient between the level of secularisation and the index of marital fertility, 1880-1910 (resulting in values of 0.8-0.9) (1977 p.43). His multivariate analysis found a strong and significant association between secularization and fertility also (1977 p.213). However, secularization was only available for one year, 1910, so the explanatory power of secularisation as causal in the time trend of Belgian fertility decline is limited. This is also an example of how cross sectional variation may be confused for time series trends, see the discussion on Birch's Critique of the Innovation/Diffusion Hypothesis in section 2.4, chapter 2 of this thesis.

Bacci states "the usual demographic explanations of fertility decline do not fit the Spanish experience"[21] (1968c p.532). For Britain and Ireland, Teitelbaum argues "cultural variables…generally explain less of the variance in marital fertility than do socioeconomic measures taken on their own"[22] (1984 p.216). The most significant variables in his analysis were proportion urban, proportion voting conservative, proportion in manufacturing, female labour force participation and basic literacy. Place of birth had relatively small effects, as did an index of ethnic diversity and the proportion Catholic (1984 p.189).

The EFP could not detect the theorised strong modernisation-fertility decline patterns in the provincial level data. These associations were either weaker than expected or non-existent. This finding led many of the EFP authors to the belief that the fertility decline was not an adaptation, but a result of a process of 'innovative diffusion'. In other words, the fertility transition was cultural in origin, not economic. Many of the EFP authors pointed to their empirical findings that culture and linguistic heritage, and secularisation, was of greater importance than any socioeconomic variable, in understanding the timing of the decline of fertility in Europe. However, as this review illustrates, there were a variety of trends uncovered in each of the separate country monographs. For every case where culture mattered more than the economy (e.g. Belgium), we can point to a country where the reverse was true (e.g. Great Britain). As noted previously, radical changes in culture were not required to initiate the fertility decline in Hungary or Spain. As part of the summary volume, Lesthaeghe and Wilson analysed a pooled database of the provincial level estimates of fertility alongside proxies for the level of secularisation, represented by voting patterns, and the presence of a 'familial intensive' labour system, represented by the relative size of the agricultural labour force. They found strong correlations between the rate of change of marital fertility

[21] Here he means both cultural and economic explanations: education, secularisation, and industrialisation and urbanisation (1968c p.532).

[22] His cultural measures were primarily based upon the composition of the place of births of the counties of Britain and Ireland and the 1851 census of Great Britain and Ireland, which recorded religious affiliation (1984 p.159). He compared a 'transitional' model consisting of only socioeconomic measures against a purely cultural model and calculated an adjusted R^2 of .697 and .539 respectively (1984 p.165).

over the transition period and the percentage vote for secularised social-reformist political parties[23] (Lesthaeghe and Wilson 1986 p.281-3). However, the percentage of the variance explained by their secular variable was a small fraction of that explained by the proportion of the labour force in agriculture[24] (table 6.7 in Lesthaeghe and Wilson 1986 p.288).

A central proposition of demographic transition theory is the idea that rising education led to people demanding fewer children. However, the early fertility declines in France and Austria-Hungary, initiated by uneducated peasant populations, and the relatively late declines of highly literate societies such as Sweden indicates that there is no simple casual relationship. Remarkably, Livi-Bacci found for Portugal "the higher the illiteracy, the lower the fertility and the stronger its control" (Livi-Bacci 1971 p.122). Generally the EFP authors found positive but comparatively weak associations between basic literacy and the fertility transition[25], in Belgium (Lesthaeghe 1977 p.213), Great Britain and Ireland (Teitelbaum 1984 p.189), Germany (Knodel 1974 p.234), Austria-Hungary (Demeny 1972 p.172), Italy and Spain (van de Walle 1980 p.464)). The most complete investigation of the relationship between education and fertility in the EFP was undertaken by van de Walle for Switzerland (1980). She was able to go beyond the most basic indicators of literacy and use the results of written exams from military recruits for the period of the fertility transition (1980 p.464). He found a strong and persistent negative association between the level of education and the index of marital fertility in Swiss districts in 1888 (1980 p.470).

Another pillar of modernisation and therefore of demographic transition theory is the effect of the migration of the rural population to the towns and cities of industrialising Europe. The EFP found that fertility decline was earlier and faster in

[23] For Belgium, Italy, Germany, Denmark, Switzerland and the Netherlands. The correlation coefficient between the variables ranged from 0.706-0.890 (Lesthaeghe and Wilson 1986 p.284).
[24] This result was obtained by comparing the beta coefficients in a simple multiple regression framework. Secularisation appears to be more important in Italy and Catholic Germany in this analysis (Lesthaeghe and Wilson 1986 p.288).
[25] i.e where higher education was associated with lower fertility.

the urban areas of Europe for almost every country studied[26] (Sharlin 1986 p.249). However, the relationships varied between countries and the declines in both environments "overlapped". (Sharlin 1986 p.248). Further, Sharlin comments that "regional variations are always larger than urban-rural differentials" (1986 p. 251).

The EFP: Legacy and Judgement

The primary policy legacy of the EFP was to weaken the link between economic development and fertility decline, and strengthen the case for family planning as the most effective means to reduce fertility (Alter 1992 p.25). However, the EFP did not generate a theoretical breakthrough in our understanding of why fertility declined in the first place. The central finding was a negative result for the correlation of the central tenants of demographic transition theory. Empirically, cultural and linguistic variables were of greater significance than any socioeconomic measure. However, as Alter writes, "participants in the project have yet to explain what it is about linguistic regions that determines the timing of fertility decline" (1992 p.21). Demographic transition theory has been rejected but it has not been replaced by a similar over-arching theory of why fertility declined. As Sharlin, in the EFP summary volume states "the European Fertility Project has uncovered a series of detailed ad hoc arguments, rather than confirmed…general mechanisms" (1986 p.258). Further, Anderson (again from the summary volume) maintains; "no fully articulated, reformulated theory seems justified yet" (1986 p.312).

In the summary volume, Anderson states "the findings of the European Fertility Project do suggest that behaviour does not change directly and simply as the result of differences among individuals on the basis of socioeconomic variables" (1986 p.312). There are reasons to be hesitant about fully accepting the EFP's conclusions. Firstly, the EFP did not employ a consistent or standardised statistical methodology. Watkins points to the "simple" statistical methods employed in the country monographs and notes that "more sophisticated techniques may prove to be more fruitful" (1986 p.439). Secondly, the socioeconomic data collected by the

[26] The exceptions were France (because the data did not stretch back to cover the onset of the decline) and Norway (a result which may be an artefact of the data) (Sharlin 1986 pp.242-245).

project were not precise or consistently comparable over time or place. Knodel and van de Walle conceded that the socioeconomic measures used by the EFP were "crude and suffer from varying degrees of non-comparability between countries" (Knodel and van de Walle 1986 p.398). Finally, the aggregate detection of parity dependant fertility control is difficult: Knodel, following his micro analysis in the summary volume writes:

"The results also demonstrate that cross sectional or over-time differences in overall levels of marital fertility, the type of information typically available from conventional sources and relied upon heavily by the European Fertility Project – are not always sensitive to differences in the patterns of childbearing indicative of parity dependant control" (Knodel 1986 p.386)

The error of interpreting individual characteristics from aggregated data is known as the ecological fallacy, and the potential bias from this effect is the single greatest reason to question the EFP's conclusions. Many of the EFP authors were conscious of the ecological fallacy[27]. Teitelbaum admits that "the ecological nature of the data may have obscured some effects" (1984 p.212). Knodel statea; "The national average covers up the diversity found amongst the administrative areas" (Knodel 1974 p.182). Similarly Watkins writes "aggregate measures of infant or childhood mortality may be misleading" (1986 p.437). Lesthaeghe demonstrates how the pooling of the data from Wallonia and Flanders led to a significant positive relationship between infant mortality and the index of marital fertility at the national level (Belgium). The effect was illusory; when Lesthaeghe tested the two regions separately he found "no relation whatsoever" (1977 p.199). The question arises that if these mistaken relationships can be created by amalgamating smaller units into larger units, surely *any* aggregation is potentially erroneous. In other words, if the ecological fallacy operates in the aggregation of regions to nations, it certainly operates in the collection of individuals into regions.

[27] Some weren't. In the summary volume, Anderson states "The European Fertility Project showed that the relation of cultural and regional variables to marital fertility decline cannot be completely explained away by spurious association with socioeconomic characteristics at the individual level" (Anderson 1986 p.311).

Table 1.4 Year of Sustained decline in Marital Fertility

1800s		1880s	1890s	1900s	1910s	1920s
France (before 1800)		Belgium (1882)	Germany (1890)	Denmark (1900)	Finland (1910)	Ireland (1929)
		Switzerland (1885)	Hungary (1890)	Norway (1904)	Italy (1911)	
			England and Wales (1892)	Austria (1908)	Bulgaria (1912)	
			Sweden (1892)		Spain (1918)	
			Scotland (1894)			
			Netherlands (1897)			

Source: Knodel and van de Walle 1979 p.217

In summary, the conclusion of the project concerning the cause of Europe's fertility decline, modernisation, was a negative result. The central relationships of the key demographic transition theory variables were weak and statistically insignificant. The empirical correlations were inconsistent with the theory. Knodel and Van de Walle noted "Despite the great diversity of their socio economic characteristics, the striking factor that the countries of Europe had in common when fertility declined was time itself" (1979 p.235). The Princeton project defined the start of the decline as a 10% drop in marital fertility (I_g), and these dates are presented in a timeline format in table 1.4. The conclusions to the EFP seem to suggest the absence of Ansley Coale's first pre-condition for fertility decline. That is, fertility must be "within the calculus of conscious choice[28] (Alter 1992 p.22). Alter terms this the "unthinkability hypothesis" (1992 p.22). The empirical evidence seemed to support an 'innovation diffusion' process rather than a rationalsocioeconomic 'adaptation'.

[28] Along with desiring smaller family sizes and having access to the means of achieving this (Alter 1992 p.22).

Recently, however some scholars have questioned the validity of the EFP's findings. Brown and Guinnane for instance, have discussed in detail serious statistical problems in the Princeton project's methodology and called for researchers to "press on with new sources and new methods" in order to understand Europe's fertility decline (2003 p.26). They demonstrate how a ten percent decline in I_g may misdate the early stages of transition, and that it is "too blunt an instrument to be a reliable indicator of fertility decline". Further, they illustrate with specific examples how the units used (provinces) in the EFP's analyses were "too large and internally heterogeneous" (thus making them highly susceptible to the ecological fallacy) and the explanatory 'modernisation' variables used in most European Fertility Project studies were crudely defined, and do not support "meaningful tests of the role of social and economic change in the fertility transition" (Brown and Guinnane 2003 p.3-6). These criticisms echo many of the EFP authors stated concerns, discussed previously. Brown and Guinnane's own results, using individual level data[29], show that fertility declined at a more rapid rate for those in high income brackets. The structure of the EFP, through analysing aggregated data, was unable to detect these socioeconomic correlates of the fertility decline. The casebook is not yet closed on the causal process of Europe's fertility transition

Brown and Guinnane state that the EFP did not find any relationship between declining fertility and socioeconomic factors, because it couldn't - It did not have, or use data that was "sufficiently general enough to draw appropriate conclusions" (Brown and Guinnane 2003 p.26). Even some of the EFP's principal authors disagree with the sweeping dismissal of the economic causes of the fertility decline. Teitelbaum, for instance, who authored the monograph on the fertility decline in Britain, stated in his conclusion that "socioeconomic variables have high explanatory power" in explaining the British fertility decline (1984 p.184). The legacy of the EFP is therefore confusing. As commented by Wetherell, "economic

[29] Through examining the raw data from the Polizeimeldbogen (police records) for Munich, 1860 – 1914 and estimating a regression model.

demographers continue to question the EFP's major finding that economic factors were not central to the decline of fertility in Europe" (2001 p.591).

Other Literature on the fertility transition

The past half century has witnessed the blooming of the field of historical demography. In particular the analysis of micro data using the techniques of family reconstitution has allowed scholars in this discipline to assess the individual level characteristics of historical population processes. As Knodel noted however, "most of this work has been restricted to periods prior to the onset of the secular decline of fertility" (1986 p.338).

In the 1950s, Louis Henry pioneered the use of family reconstitution as a technique of population analysis. He demonstrated how parish records of births, deaths and marriages could yield demographic variables. At INED[30], he designed and led the family reconstitution study of 39 rural French villages from about 1600-1800. Unfortunately, the project was not designed with the availability of high quality economic information in mind (Weir 1995 p.2). As van de Walle has stated "unfortunately, the population of the parishes usually is not clearly stratified and most attempts in finding lags in the dates of fertility decline by socioeconomic groups have failed" (1978 p.264).

Wrigley and Schofield emulated Henry's methodology for 26 English parishes. They were able to calculate fine demographic measures such as the age structure of mortality and age specific marital fertility rates. In addition they were able to generate quinquinnial estimates of the English population and vital registration series (births, marriages and deaths), the gross and net reproduction rate of the population and the age structure from 1541-1871. Wrigley et al. write that fertility differentials by occupation were "trivial" (1997 p.427). They failed to pick up any significant differences between agricultural workers, manufacturing workers or those engaged in retail and handicraft (figure 1.4). For the analysis of the fertility

[30]Institut national d'études démographiques

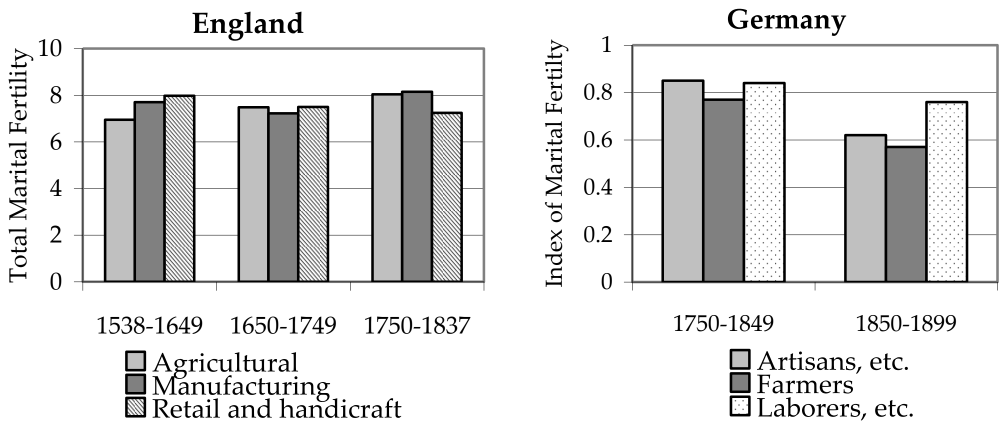
decline the Wrigley-Schofield database is limited by its termination in 1837, when the registrar general began to collect birth and death information. This is a full half century before the aggregate decline of marital fertility in England and Wales.

Knodel applied the tools of family reconstitution to Germany. His contribution to the EFP summary volume (1986) was an analysis of his dataset of 14 villages with respect to the fertility transition. He found “little consistency” in the relationship between occupational status and fertility amongst the villages (Knodel 1986 p.373). After 1850, just before the period of fertility decline, it was *farmers* who reduced their fertility the most (Knodel 1986 p.376). Further refuting demographic transition theory was Knodel’s analysis of child mortality and fertility decline where he found “no consistent association” at the village level (Knodel 1986 p.382). However, when he disaggregated to individuals and examined the relationship between child deaths and children ever born (for couples categorised as 0, 1 or 2 child deaths) he found a clear negative relationship (Knodel 1986 p.383).

Figure 1.4 illustrates fertility differentials by occupation for the 26 English villages in Wrigley et al.’s reconstitution and the village of Grafenhausen in Germany from Knodel’s reconstitution. Grafenhausen was the village which displayed the most significant fall in marital fertility over the sample period in Knodel’s study (1986). The evidence presented in figure 1.4 makes it difficult to pinpoint an occupational category as source for Germany’s fertility transition, or to detect a forerunner of England’s.

One study to evaluate the individual socioeconomic correlates of individual fertility during the period of fertility transition is that of Alter, Nevin and Oris (2005). Using population registers for three East Belgian areas, they find that the relationship between socioeconomic status (as indicated by occupation) and fertility changes direction over the course of the fertility transition (2005 p.32). Each “act” in the fertility transition “was characterized by important differences between the fertility of the poor and the wealthy” (Alter et al. 2005 p.2). Pre transition, the poor have lower fertility than the rich, yet during the transition, it is the rich who initiate fertility control first (also found in Alter 1988 p.194).

Figure 1.4: Fertility Differentials by Occupation, England and Germany



Source: England: Wrigley et al. 1997 p.428, Germany: Knodel 1986 p.374.

This pattern seems to be universal in historical fertility transitions[31] Schneider and Schneider state "it is often the least advantaged social groups which lag behind in the transition to a smaller family size" (1996 p.272). Yet many family reconstitution studies miss this effect (or its full strength) because they use occupational class as a proxy for socioeconomic status (e.g. the Henry and Wrigley et al. studies discussed previously). The results of the EFP suggest that economic variables are poor predictors of fertility control. At the same time, many micro level studies find socioeconomic lags in the adoption of fertility control. What the literature is missing is an individual level study which links demographic data to real economic variables, and analyses the socioeconomic status-fertility relationship over the period of fertility transition. This thesis will attempt to fill the gap.

Recent Fertility Declines

Figure 1.1 in section 1.2 charts the fertility transitions outside of the most developed countries which have occurred over the past half century. In general, recent fertility transitions have been far more rapid than they were in 19th century Europe. Fertility

[31] See chapter four of this thesis.

decline has taken hold in countries whose development is relatively low and the process has been accelerated by effective family planning programmes (see Tsui 2001 for an overview of the empirical evidence). The same simultaneity observed for the decline of fertility in Europe has been mirrored in Latin America's fertility transition (Cleland and Wilson 1987 p.20). At about the same time as the publication of the summary volume of the EFP (1986), the final results of the World Fertility Survey[32] (WFS) were also being disseminated (see Cleland and Wilson 1985). The key finding for our understanding of fertility transitions from the WFS is the "failure to identify any divergence in fertility between familial and non-familial economic sectors" (Cleland and Wilson 1987 p.20). Further, there was no clear cut association between female labour force participation and fertility reduction. However, there was a significant association between parent's education and fertility control (Cleland and Wilson 1987 p.22).

Section 1.5: This Thesis: A Summary of the Chapters

The legacy of the EFP may justifiably be summarised as one of intellectual confusion. However, scholars are increasingly aware that the way forward is to examine fertility at the individual level. To 'detect' the socioeconomic correlates of the fertility decline data must be collected which contains useful individual level economic variables. The primary contribution of this thesis is the construction and analysis of two unique individual level databases for transition era England and France. Using the value of a person's estate at death as an indicator of wealth and relative social status, fertility life histories are developed and analysed in detail. There are no previous studies of the wealth-fertility relationship for either England or France during the period of fertility decline.

In chapter 2, I summarise and discuss some of the most influential theoretical models of fertility decline. The microeconomic theory of fertility, and in

[32] The WFS produced comparable data on fertility and family planning for 66 developing countries between 1973 and 1984. For more details and a list of the countries studied see http://opr.princeton.edu/archive/wfs/.

particular the quantity-quality trade off, is focused upon and compared with the non-economic 'innovation diffusion' hypothesis. Both approaches are found to be missing an important element. In order to explain why fertility decline could be initiated for rational reasons, yet display 'contagion' like patterns, I introduce some insights from the evolutionary biology literature on human fertility. Human's strong inclinations to compete socially for relative position are forwarded as a potential explanation for the fertility decline and its empirical characteristics.

To detect these patterns, I argue that we must collect and analyse individual level data. Chapter 3 serves as the macro backdrop to the individual level analyses in the rest of the thesis. Using newly constructed annual estimates of the index of marital fertility, the microeconomic theory of fertility is tested for its implied macro level effects. The theory is found wanting and cannot explain why countries at very different levels of income per capita experienced close to simultaneous fertility transitions. The chapter serves to emphasise the argument that our understanding of the fertility decline can only be advanced with the analysis of individual level data with real economic variables.

The fertility life history and wealth at death for 3,000 English testators from 1800-1920 forms the empirical base for chapter 4. Two large and opposing patterns are discovered – a positive association of wealth and net fertility and a negative association of occupational status and net fertility. My analysis demonstrates that it was the poorest members of the top occupational status classes who restricted fertility first in England. This suggests that the decline in fertility may have been related to a desire to avoid downward social mobility. Through analysing the changing relationship between occupational status and wealth, this hypothesis is supported. Chapter 4A extends the testator database back to 1500 and finds an earlier demographic transition to the one traditionally associated with the 1890s. Around 1800, the 'super-fertility' of the rich, which was evident from 1500, declines to the level of the poor. This suggests that the origins of the fertility transition are earlier than we first thought.

The population of four rural villages in France from 1750-1850 is the foundation for the analysis in chapter 5. The analysis of French fertility is central to understanding Europe's fertility decline. Through linking the demographic data from the *enquete Henry* to wealth at death data from the *tables des successions et absences,* two distinct patterns are discovered. The wealth-fertility relationship was strongly positive in the villages were fertility was high and non declining and sharply negative in the villages where fertility was declining. Between the two demographic regimes, the wealth-fertility relationship had switched. The analysis demonstrates that it was the rich, of the decline villages, who restricted their fertility first. To explain this pattern, various hypotheses are tested. The hypothesis that a change in the environment for social mobility was behind the fertility decline has the greatest explanatory power. Through the analysis of inequality and the perseverance of wealth within families in the sample, a strong association is found between fertility decline and the environment for social mobility.

The final analytical chapter brings together the conclusions of the earlier chapters to propose a simple-status fertility model of fertility decline. Using a numerical example, it is demonstrated how changes in key variables can initiate a fertility transition. At each stage, the empirical evidence from the thesis is used to justify the hypothesis. Following this, the new micro data was analysed together to test for the implied patterns of the simple status fertility model. The results show that declining inequality, as indicated by the model, is strongly related to the presence of fertility decline. Chapter 7 is a conclusion to the thesis.

Section 1.6: Conclusion

It is the early 21st century and global fertility is sharply differentiated by the level of socioeconomic development. Everyone agrees that this is due to the variation in the onset of the demographic transition in the countries of the world. The developed World experienced sustained fertility decline over a century ago, roughly coinciding with the onset of the Industrial Revolution. However, scholars have failed to empirically isolate the socioeconomic triggers for this revolutionary adaptation. Demographic transition theory has been demolished and has left a huge gap to be filled. In his summary of the fertility decline literature, Kirk concedes “this review may leave an impression of chaos” (1996 p.379).

The central research question of this thesis is to ask why fertility declined. To do this I have constructed two unique datasets that link individual level demographic behaviour to estimates of wealth. Previous research, such as that of the EFP (discussed earlier in this chapter), has been heavily criticised for pursuing aggregate level analyses with poor quality socioeconomic data. Further, individual level studies have used occupational class as a proxy for socioeconomic status. I argue that using the value of deceased’s estates is a far better measure of economic status. I intend to contribute to the literature on Europe’s fertility transition by presenting and analysing individual level data which covers the span of the transition and is linked to real economic variables. In addition to this, I will present and test my own hypothesis of the likely reasons why fertility declined. I construct a simple status-fertility model, inspired by previous theoretical work in economics and evolutionary biology, and test it with the new micro data.

Chapter 2 - Theoretical framework for the Analysis

Abstract

This chapter provides the theoretical background for the thesis[33]. The Easterlin-Crimmins organisational schema is introduced and each component of our theoretical understanding of the determination of individual fertility is discussed in turn. Namely they are the demand for children, the supply of children and the costs of fertility regulation. These elements are discussed with reference to chapter 1's 'adaptation' and 'innovation diffusion' categorisation. Finally, selected insights from evolutionary biology are included. This literature forms the basis for a simple status-fertility model introduced in chapter six.

Section 2.1 Introduction

A useful unifying structure to categorise theoretical models of fertility is that of Easterlin and Crimmins (1985). They have developed the traditional method of analysing individual fertility behaviour by inserting a "proximate determinants" analysis, through which basic determinants (such as changes in the economic structure) affects fertility not directly, but indirectly through these determinants (Easterlin and Crimmins 1985 p.13). For example, modernisation does not in itself cause fertility to decline, but rather stimulates the use of deliberate fertility control which directly causes a reduction in fertility.

Easterlin and Crimmins further develop this analysis by inserting another set of variables between basic and proximate determinants, namely the demand and supply for children, and the costs of fertility regulation (1985 p.13). Demand is defined as "the number of surviving children parents would want if fertility

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[33] Issues relating to gender and family systems are relatively underplayed in this thesis, see Mason (2001) and McDonald (2000) for an over view of these issues and how they relate to the fertility transition. An interesting paper on the changing relationship between female labour force participation and fertility in recent years is that of Rindfuss et al. (2003).

regulation were costless", supply as "the number of surviving children a couple would have if they made no deliberate attempt to limit family size" and costs of fertility regulation is seen as the cumulative effect of couples attitudes, the disadvantages of many techniques (e.g. abortion) and the economic cost[34] (Easterlin and Crimmins 1985 p.14).

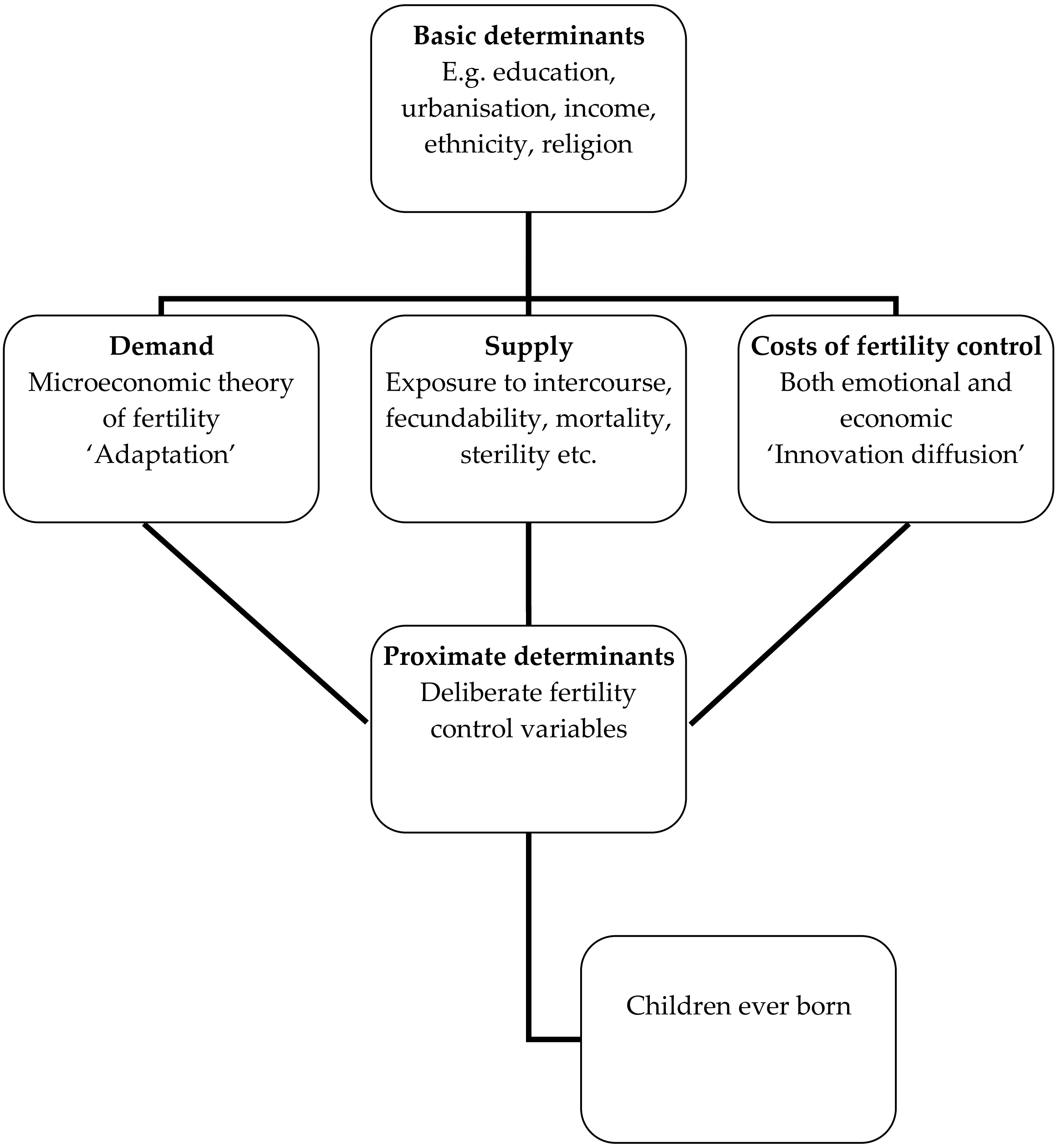
There are limitations to Easterlin's approach. Kirk states "He, like early writers on transition, fails to specify the socio-economic factors that explain demand" (1996 p.371), a limitation also noted by Hirschman (1994 p.215). Into the 'demand' slot of the Easterlin-Crimmins framework, we can simply insert the microeconomic theory of fertility. Into supply we can group together the basic biological influences (which may depend partly on culture, for example a taboo on intercourse while a mother is nursing). Together, demand and supply determine the motivation for fertility regulation. For instance, if demand is less than supply, couples will seek to limit their fertility. However, the constraint, the costs of fertility regulation (both psychic and economic) is influenced by culture and access to the knowledge and means of control may be limited (Easterlin and Crimmins 1985 p.16-18). Here, we may slot in the 'innovation diffusion' arguments for fertility decline. Figure 2.1 illustrates the intellectual organisation schema of Easterlin and Crimmins.

In this model, we can see how both an 'adaptation' and 'innovation diffusion' process for fertility decline would occur. A sizeable reduction in demand holding supply and costs constant, will lead to a reduction in fertility. If you assume that a pre-transitional society in this model has an excess of supply, that is demand < supply, and holding these constant, a reduction in the costs of fertility regulation would directly cause a reduction in fertility. However, the most appealing aspect of this model is that the two possible explanations are integrated into a complimentary

[34] Age at marriage is treated as exogenous in Easterlin and Crimmin's model. They cite evidence from Thailand which suggests that couples do not consider their age at marriage as being linked to their ultimate family size (1985 p.19).

approach. The relative importance of these variables is a matter for "empirical determination" (Easterlin and Crimmins 1985 p.30)[35].

Figure 2.1: The Easterlin-Crimmins Organisational Schema



Source: Easterlin and Crimmins 1985 p.13.

The rest of this chapter is comprised of five sections. Section 2.2 describes in detail the microeconomic theory of fertility, and Section 2.3 discusses the supply

[35] Easterlin and Crimmins find strong support for their model in the empirical data, a micro level analysis of Sri Lanka and Colombia (using WFS data) and a macro level analysis of Karnataka and Taiwan.

side of human fertility. Section 2.4 analyses the costs of fertility regulation and the 'innovation diffusion' hypothesis, while section 2.5 introduces some insights from the evolutionary biology literature. Section 2.6 Concludes.

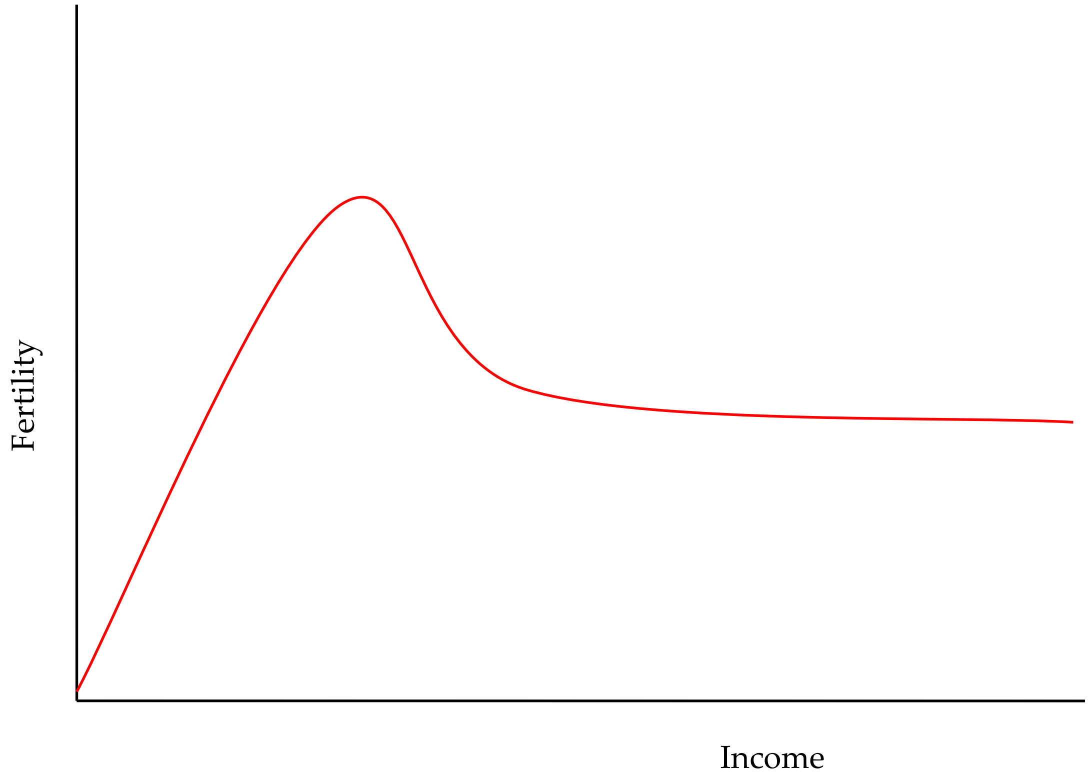
Section 2.2: Demand Theories of Fertility

Gary Becker first formulated the microeconomic theory of fertility in 1960, and he along with other scholars, such as Schultz (1981, 1985) have applied the economic theory of consumer behaviour to fertility decisions. The individual is viewed as a utility maximising agent subject to a budget constraint, and children are viewed as a special kind of 'good', just like cars, TVs and other consumer goods. Individual fertility is as a response to the consumer's demand for children, relative to other goods, and therefore responds to income and the relative price of these goods (Easterlin 1975 p.54).

According to Easterlin, this approach has resulted in some valuable contributions to our understanding of fertility. Firstly, it is "full" or "potential" income, which includes both money and time, as opposed to money income alone, that has the most relevance in fertility decisions. The implication is that desired fertility is not only affected by the income constraint and the cost of children, but also by the opportunity cost of parents time (particularly the mother). Further, this model has been developed to include formal modelling of the relationship between family size and the level of child investment in the form of a 'trade-off' between the quantity of children demanded and their 'quality' (Becker 1960, Mincer 1963, Schultz 1981). It is this trade off, the substitution of quality for quantity, which is central to the microeconomic explanation for Europe's fertility decline.

Historically, the evidence overwhelmingly suggests a positive income-fertility relationship before the 20th century, and Becker cites such examples as Italy 15th – 16th centuries, and Canada, the United States and Germany in the 18th century (1991 p.144). For the town of Nuits in France, Hadeishi not only found a positive correlation between fertility and income (18th century), but also between changes in income and changes in fertility (2003 p.489). Examining wills, Clark finds a positive relationship between income and net fertility for 17th century England (2005 p.9). Sometime about 1900 the income-fertility relationship appears to have become wholly negative, and in modern times the relationship is difficult to clarify. The microeconomic theory of fertility suggests that the relative price of children is the key to parent's decisions on family size. Economic growth will exert non-monotonic effects on the birth rate, as the relative prices of children and other goods changes over time. Figure 2.2 sketches the theorised income fertility relationship over time. Early on, we see a strong positive association due to a positive income effect[36] on the number of children demanded, which turns negative beyond a certain income level before flattening out.

Figure 2.2: The Income-Fertility Relationship



Source: Clark 2005a p.9

[36] Clark gives three reasons for a positive association between fertility and income in the pre-industrial world, 1. a minimum consumption level had to be reached before having children, 2. Children needed a minimum consumption transfer, 3. Human capital was not productive. (p.7 2005a).

At the turning point, income growth starts to have a negative impact on fertility. It is theorised that at this point the Substitution effect (Parents substituting child quality for quantity) is greater than the income effect. Mechanisms through which this happens include increased costs of children, increased returns to human capital, and changes in the structure of the economy from agricultural to industrial.

Another important idea in the economic study of fertility is the Easterlin' hypothesis, which assumes that an individual's taste for goods, services and children is formed at an early age, during socialisation in the parental home. (Van de Kaa 1996 p.413). If they find it difficult to achieve this standard of living as adults, marriage may be delayed and family size reduced [37](Van de Kaa 1996 p.413). His empirical analysis found a rise in US relative incomes between 1930 and 1950, associated with rising fertility. In this analysis, the relevant variable for fertility is relative economic status, not necessarily income (Freedman 1976 p.412).

The Microeconomic Theory of Fertility in Detail

I will now examine the microeconomic theory of fertility in detail. To reconcile the apparent contradiction of human behaviour since the fertility transition with respect to Darwinian theory, Becker distinguishes between the number of children demanded and the expenditure per child. The logic is "a reduction in the number of children born to a couple can *increase* the representation of their children in the next generation if this enables the couple to invest sufficiently more in the education, training and "attractiveness" of each child to increase markedly their probability of survival to reproductive ages and the reproduction of each survivor (Becker 1991 p.137)[38]. Increased expenditure per child or increased investment in child 'quality' can also improve the child's competitive position in the marriage market. The interaction between the quantity of children demanded and their quality (the

[37] Similarly, if conditions were better than what they expected, they may marry earlier and increase family size.

[38] Becker's italics.

amount of expenditure per child) is "probably the major contribution of the economic analysis of fertility" (Becker 1991 p.135).

This section fully describes Becker's model as I believe that it captures some fundamental principles of people's fertility decision making processes. Further, it is important to lay down a firm theoretical foundation for the project. As well as directly testing for Beckerian patterns in chapter 3, chapter 6 will develop and adjust some of the variables in Becker's model. The approach is to model human fertility behaviour just as you would model a firm. Instead of profit maximising, the individual agent is utility maximising subject to constraints[39]. Becker assumes that parents will maximise a utility function consisting of the number of children, *n*, their quality, *q* and a basket of other goods, $Z_1,...,Z_n$.

$$U = U(n, q, Z_1,..., Z_n)$$

Combining all other goods into one (because there are no good substitutes for children), and ignoring quality (for the time being), the utility function becomes

$$U = U(n, Z)$$ [40]

The budget constraint of each family is

$$p_n n + \pi_z Z = I$$

Where *I* is full income (monetary income and opportunity cost of parent's time), p_n and π_z are the costs of production of children and purchasing goods respectively. Given *I*, p_n and π_z the optimal quantities of n and Z, are where

$$\frac{\partial U}{\partial n} \Big/ \frac{\partial U}{\partial Z} = \frac{MU_n}{MU_z} = \frac{p_n}{\pi_z}$$

Therefore, the demand for children is conditional upon full income and the relative price of children.

(All of the above derived from Becker 1991 p.137-138).

[39] What follows is entirely derived from Becker 1991 p.137-138.

[40] These utility functions assume no changes in the ages of children and the spacing of births (Becker 1991 p.138).

Factors exogenous to the model drive the decline in fertility at this point. Becker argues that rural communities will have higher fertility than urban areas because there is a greater potential for children to contribute productively to the household, than there is in cities, thereby reducing their net cost and stimulating demand. Endogenously, factors that affect the relative cost of children will affect fertility levels. For instance, the growth in female earnings potential has been accompanied by a large increase in female labour force participation and the decline of fertility in the western world over the past 2 centuries. The value of women's time and market place potential has risen thus increasing the opportunity cost of having children[41] (Becker 1991 p.140).

The principal insight from the economic analysis of fertility however is the interaction of child quantity and quality. From the same utility function described previously:

$$U = U(n, q, Z_1, ..., Z_n)$$

Assuming that all children in a family have the same quality and this quality is fully produced within the family from its own time and market goods. The budget constraint is

$$p_c nq + \pi_z Z = I$$

Where p_c = the constant cost of a unit of quality. This is not a linear budget constraint, but depends multiplicatively on *n* and *q*. Maximising utility subject to this constraint gives three equilibrium conditions

$$\frac{\partial U}{\partial n} = MU_n = \lambda p_c q = \lambda \pi_n$$

$$\frac{\partial U}{\partial q} = MUq = \lambda p_c n = \lambda \pi q$$

$$\frac{\partial U}{\partial Z} = MUz = \lambda \pi_z$$

[41] At the time of Europe's fertility transition (late 19th century), female labour force participation was in general relatively constant and in some countries was actually decreasing (see Bairoch and Goertz 1986).

π_n and π_q are the shadow prices of quantity and quality. From the above conditions, we can see that both shadow prices depend on the cost of a unit of quality, p_c and also that the shadow price for quality (π_q) depends on the quantity of children (*n*), as conversely does the shadow price for quantity (π_n) depend on the quality of children (*q*). Maximising utility subject to the budget constraint for the equilibrium values, results in the following relationships:

$$n = d_n(\pi_n, \pi_q, \pi_z, R)$$

$$q = d_q(\pi_n, \pi_q, \pi_z, R)$$

$$Z = d_z(\pi_n, \pi_q, \pi_z, R)$$

Where *R* is full shadow income. Quantity, quality and demand for other goods are functions of the shadow prices and income. For example, an increase in the shadow price for child quality, would lead to a reduction in the quantity of children demanded

$$n \downarrow = d_n(\overline{\pi_n}, \pi_q \uparrow, \overline{\pi_z}, \overline{R})$$

Now suppose an exogenous increase in *n*.

$$n \uparrow$$

$$\pi_q \uparrow \quad (p_c n = \pi q)$$

$$q \downarrow \therefore \pi n \downarrow \therefore n \uparrow \therefore \pi_q \uparrow \therefore q \downarrow \ldots$$

This interaction continues until a new equilibrium is found, and is dependant upon the elasticity of substitution of *n* for *q* in the utility function. If they are close substitutes, the interaction outlined above will continue until either *n* or *q* were negligible. The relationship described by this interaction means that it cannot be presumed that quantity and quality are close substitutes (internal equilibrium would be impossible otherwise).

Adding a fixed cost per child for all expenditure independent of quality (for example time, family planning, risk and discomfort in pregnancy), called P_n and P_q to symbolise expenditures on quality that are independent of quantity (learning from parents for example) to the budget constraint:

$$p_n n + p_q q + p_c nq + \pi_z Z = I$$

Maximising utility subject to the constraint:

$$MU_n = \lambda(p_n + p_c q) = \lambda p_c q(1 + r_n) = \lambda \pi_n$$

$$MU_q = \lambda(p_q + p_c n + \frac{\partial P_c}{\partial q} nq) = \lambda p_c n(1 + r_q + \varepsilon_{pq}) = \lambda \pi_q$$

Where $r_n = p_n / p_c q$ (the ratio of fixed to variable costs for quantity), $r_q = p_q / p_c n$ (the ratio of fixed to variable costs for quality) and $1 + \varepsilon_{pq}$ is the ratio of marginal variable costs to average variable costs. Therefore

$$\frac{MU_n}{MU_q} = \frac{\pi_n}{\pi_q} = \frac{q}{n} \frac{(1 + r_n)}{(1 + r_q + \varepsilon_{pq})}$$

The ratio of the shadow prices of *q* and *n* is related to the ratio of *q* and *n* themselves, the ratio of the fixed to variable costs, and the ratio of marginal to average variable costs of quantity and quality. Now, let us illustrate what would happen following a rise in the fixed cost of children, P_n.

$$P_n \uparrow$$

$$\therefore \pi_n \uparrow \therefore \frac{\pi_n}{\pi_q} \uparrow \therefore n \downarrow \therefore q \uparrow \therefore \pi_n \uparrow \;\ldots\ldots\ldots$$

The interaction between quantity and quality established in the model indicates that even a small rise in the fixed cost of children can induce a strong substitution effect from quantity to quality, even if the elasticity of substitution between *n* and *q* is not large. In Becker's model, an exogenous decline in infant mortality will raise the fixed cost of quantity, lowering the demand for surviving children, and so the expected relationship of fertility and infant mortality should be positive. (All of the above summarised from Becker 1991 p.135-154).

What are the practical implications of Becker's theory? At low levels of income, income growth will increase both quantity demanded and the quality of children. At a certain income threshold, the quality-quantity trade-off effect will kick in, and the increased investment in child quality will serve to depress the number of children demanded (Winegarden and Wheeler 1992 p.423). This generates an 'inverted U' shaped relationship between income growth and fertility, consistent (at least in a general way) with the pre-modern positive relationship, and today's negative relationship. A simple econometric model reflecting this structure is tested for transition era Europe in chapter 3.

Further tests of Becker's theory can be pursued by adding other socioeconomic variables. Table 2.1 summarises the expected correlations already mentioned in this section. All of these implied relationships are driven by the changing costs of children.

Table 2.1: Expected Relationships from the Economic Theory of Fertility

Variable	Expected relationship	Cost of Children
Urbanisation	-	↑
Population in agriculture	+	↓
Female labour force participation	-	↑
Education[42]	-	↑
Infant mortality	+	↓

(Becker 1991 p.139-144).

The microeconomic theory is perhaps a better specified version of classical demographic transition theory. The model is simple and eloquent and has rightfully been placed at the centre of fertility analyses by economists. However, as with demographic transition theory, there are problems reconciling the theoretical expected relationships with the empirical record. As Becker's theory relies upon modernisation to initiate the quality-quantity trade off, how does this model explain the earlier decline of fertility in France compared to her more industrialised neighbour, England? How does it explain the wild fluctuations in the levels of marital fertility and infant mortality reported in figure 1.2? How does it explain the close timing of the decline in all the provinces of Europe, which differed dramatically in their respective labour forces, income and education? Further, fertility decline in many countries in 19th century Europe was accompanied by

[42] Increases in 'education' reflect increases in the costs of children.

stagnant and in some cases, declining not rising, female labour force participation[43]. The microeconomic model of fertility cannot answer these questions. The most complete empirical test of the quality-quantity trade-off in humans is that of Kaplan et al. (1995). Using a sample of over 7,000 men from New Mexico, they find that smaller family sizes are indeed correlated with higher offspring education and income (1995 p.325). However, this quality-quantity trade-off does not result in a higher number of grandchildren for those who have smaller families (1995 p.325).

In the 1970s, Caldwell offered an alternative hypothesis concerning the economic causes of the fertility decline. He theorised a reversal in the intergenerational flow of wealth. In traditional societies, children can work and contribute to family income (for instance by helping out from an early age on the family farm). As societies modernise, this net wealth flow reverses and children are now a net cost rather than a net benefit (Caldwell 1976 p.344). Large families make sense in the traditional era, small families in the modern era. In reality however, Caldwell's model is "fundamentally a cultural model, not an economic one" (Alter 1992 p.24). His definition of wealth includes the satisfaction men receive from the deference of their children and his empirical work stresses the importance of changing attitudes to education (Alter 1992 p.25). As pointed out by Kirk, the most economically rational behaviour in the modern era in Caldwell's model is to be childless (1996 p.372). The model itself remains empirically unproven (Kirk 1996 p.372, Hirschman 1994 p.214). Kaplan, following his empirical test of Caldwell's theory stated "under most conditions, humans, like all other known organisms, invest in, rather than exploit, their offspring" (1994 p.785)

In chapter 6, I use the foundation of the microeconomic theory of fertility to model a neglected aspect of our theorising of Europe's fertility transition, that of relative status, social mobility and economic inequality. I will describe my motivation for these ideas after first describing the supply of fertility.

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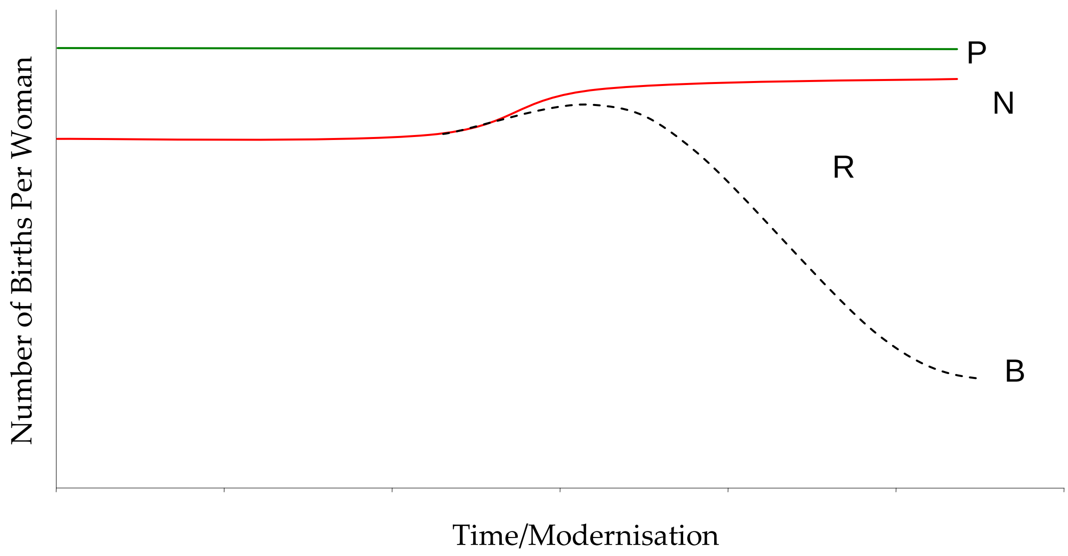
[43] For instance France, Belgium, Sweden and Denmark (Bairoch and Goertz 1986). Further, Alter argues that it is not the cost of children which is rising but parents' "definition of appropriate childrearing", in other words a change in their subjective preferences and not the economic environment (1992 p.16).

Section 2.3: Supply Theories of Fertility

The supply of fertility can be thought of as all the biological and institutional constraints on the number of potential children. To illustrate why this is important in understanding why fertility declined, let us discuss 'natural fertility'. The number of live births in a population which practices no form of birth limitation is known as "natural fertility"[44]. However, its variation is not purely biological as many cultures differ in their customs of intercourse, abstinence and breastfeeding. The birth interval and the length of the reproductive span are the main determinants of natural fertility, which can be broken down to underlying factors such as postpartum infecundability, the waiting time to conception, intrauterine mortality, permanent sterility and age of entry into the reproductive span[45] (Bulato and Lee 1983 p.4). Figure 2.3 shows how modernisation can increase the supply of children.

Figure 2.3: Modernisation, Potential Fertility and Actual Fertility[46]



Where: P = biological reproductive potential, N = 'natural fertility', B = actual fertility and R = N-B (averted/unwanted births).
Source: Easterlin and Crimmins 1985 p.7.

[44] Henry defined natural fertility (1953) as "the fertility of a human population that makes no deliberate effort to limit births" (Bulato and Lee 1983 P.3)
[45] The first three relate to the birth interval, the last two refer to the length of the reproductive span
[46] Source: "Schematic representation of the Fertility Revolution" (Easterlin and Crimmins 1985 p.7)

As time or modernisation increases, the supply of fertility increases as see by the jump in 'N' in figure 2.3. Better nutrition and medical knowledge are examples of how modernisation can increase natural fertility. Figure 2.3 illustrates how actual fertility can initially rise in direct response to modernisation's positive influence on natural fertility. Dyson and Murphy find strong evidence for this pattern in almost all fertility transitions, a significant rise before a sustained fertility decline. Examining I_f, the Princeton projects measure of overall fertility, Dyson and Murphy state "I_f was generally rising before about 1880 or 1890; the years around which declines set in" (Dyson and Murphy 1985 p.401). Examining a wide global database, they observe that "virtually all series indicate that fertility rises, frequently to unprecedented levels, before it begins its long term decline". Further, "available series strongly suggest that the origins of fertility transition are located prior to the pronounced peak that typically precedes a sustained period of fertility decline" (Dyson and Murphy 1985 p.420). Such analysis provides justification for modelling fertility over a long period, both pre and post decline, as opposed to only identifying the onset of decline.

Section 2.4: Diffusion Effects

The costs of fertility regulation

The apparent dismissal of an association between fertility decline and socioeconomic measures by the EFP, discussed in chapter one, has led many researchers to argue that fertility decline is the result of the diffusion of new birth control techniques and/or ideational change. Cleland and Wilson, for instance, argue against the assumption that reduced parental demand for children is the main cause of fertility decline. They attribute fertility transition to ideational forces, and argue strongly against an economic interpretation. They argue that the absence of birth control in pre decline populations does not necessarily mean that children generated a high economic value for their parents. Many of these children were unwanted[47] . Further, they point out that fertility decline had a higher correlation with social variables such as literacy and culture, than with any economic variable, and the speed of transition from high to low fertility reflects the diffusion of new ideas. In their view, Pre-transitional European populations did not exercise conscious control over their fertility. They see the demographic transition as occurring in 2 phases, the first induced by the introduction and diffusion of birth control which enables the elimination of excess fertility, and following this "a second phase in which a complex and poorly understood set of factors determine the level of controlled fertility" (Cleland and Wilson 1987 p. 21-30). Potts argues that unconstrained access to fertility-regulation technologies is the primary factor responsible for fertility decline (1997 p.10). He states:

"For as long as people did not have access to the means to control their fertility, they behaved as other animals, with the biologically most successful leaving most descendants" (Potts 1997 p.6).

The argument is that people have always wanted to control their family size but have not always been aware of how to achieve this goal. The fertility transition begins when some population sub-groups 'discover' an effective method of fertility regulation. Potts proposes: "because the wealthy are more likely to be successful than the poor in obtaining contraception, there is a negative relationship between income and fertility" (Potts 1997 p.18). The relationship of aggregate and individual level fertility to economic change is therefore ambiguous. Potts paper argues strongly that unrestricted access to fertility regulation technologies is the key factor in fertility decline. Subsidising contraception for the poor is his primary policy recommendation (1997).

The EFP placed much of its focus in explaining the *onset* of fertility decline, as signified by a sustained reduction of 10% in marital fertility. Knodel and van de Walle (1979) and Cleland and Wilson (1987) argue that the association of this timing

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[47] However, parents in Africa frequently desire large number of *surviving* children, a difficulty for a pure birth control diffusion argument (and recognised as such by Cleland and Wilson) (Mason 1997 p.445, Bledsoe 1994 p.107). Bledsoe argues that women in the Gambia are eagerly adopting Western contraceptives, not to reduce fertility, but to control the timing and circumstances of births (Bledsoe 1994 p.129).

and socioeconomic changes is less than its association with cultural and geographical variables. However, this does not mean that economic and structural changes played no part as the underlying cause of the fertility decline in the first place, only that some results indicate that the *timing* of the decline is more correlated with cultural measures. Burch states "modernisation, industrialisation, urbanisation—the central variables of classic transition theory—eventually and unfailingly have been followed by low fertility (1995 p.15). If we take a 1000 year perspective, relatively minor deviations in the onset of the transition would not alter the justifiable argument that the fertility transition must have some relation to the economic upheaval in our world over the past two centuries.

Becker argues strongly against the 'innovation diffusion' argument for fertility decline, pointing out that small changes in marriage patterns, reducing the frequency of sex, extending breastfeeding and implementing simple birth control techniques[48] can result in significant decreases in fertility[49] (1991 p.142). In other words, he is suggesting that the technology to limit births has always been there. Notestein would agree; "It does not follow that contraception can be viewed as the cause of the declining birth rate in any profound sense. Relatively effective methods of contraception were widely known for centuries before they were generally used" (1945 p.40). The fertility decline is a function of demand, not technology. The development of contraceptive technology such as the diaphragm and the pill are an "induced response to other decreases in the demand for children rather than an important cause of the decreased demand" (Becker 1991 p.143).

Proponents of the 'innovation diffusion' argument often seek to downplay the role of economic variables in the determination of fertility decline. On the other side, many economist do the opposite, insisting that the demand for children is primary. Some argue that the 'innovation diffusion' hypothesis and the adaptation

[48] Such as Coitius interruptis.
[49] Becker estimates that delaying marriage by three years, reducing the frequency of coition by 10%, extending breast feeding by three months would reduce fertility by nearly 25% (1991 p.142).

hypothesis are two elements of a complimentary explanation of the demographic transition, as opposed to being competing theories (Guinnane et al. 1994 p.1).

The third component of Eastern and Crimmins framework is the 'costs of fertility regulation'. Fertility regulation includes contraception, induced abortion and infanticide. Its costs include not only monetary cost but also costs relating to time, information, 'psychic costs' such as embarrassment and guilt and also the fear of breaking social norms and morals (Bulato and Lee 1983 p.7). Here, there is a perfect space to include the 'innovation diffusion' hypothesis via the spread of knowledge concerning birth control technology. If we assume that parents in pre-Transitional societies are unaware of any technology to limit births, the discovery of this technology will bring fertility decisions within "the calculus of conscious choice", as Ansley Coale would put it (Alter 1992 p.19).

However, in order for fertility to decline there must be a motivation for doing so. Birth control technology is a method, not a reason. Further, the technology employed in Europe's fertility revolution was not new. Coitus interuptus, or 'withdrawal' was the principal way that European's controlled their family size (Lee 2003 p.174). This technology has always been available to parents[50]. So how much of an 'innovation' was this? What exactly was diffusing?

A central empirical pillar of the 'innovation diffusion' hypothesis is the close association of fertility decline along linguistic and cultural lines, one of the results of the EFP (discussed in chapter one). As Alter summarises:

"Fertility patterns in nineteenth century Europe followed the language and dialect boundaries established centuries earlier" (1992 p.21).

Thus it is fair to say that fertility decline seems to have a higher association with these cultural delineations than it those with any socioeconomic variable. The speed of the fertility decline within these linguistic or cultural groups suggest that

[50] It is mentioned in the old testament as the "sin of Onan", Genesis 38:9.

individual fertility decisions are interdependent. It appears that individuals choose their fertility not in isolation but relative to their reference group. Once a certain number of this group adopt a smaller family size 'norm', all other members are bound to imitate.

Figure 2.4: Individual and Group Fertility

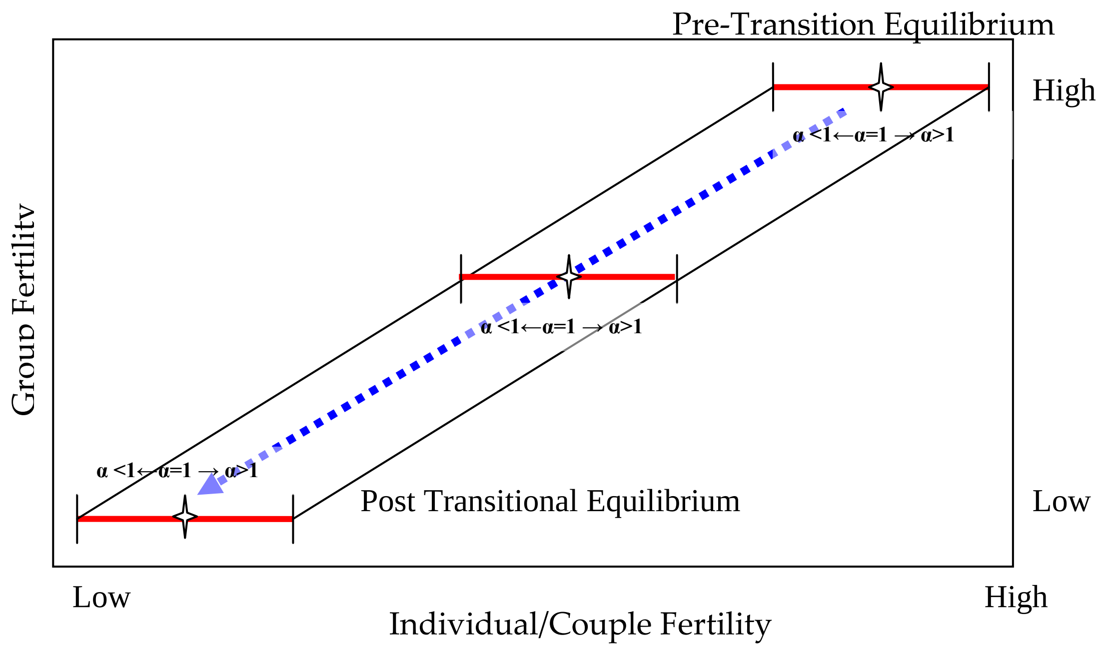

Figure 2.4 is a simple visual representation of the fertility choices of individuals as a function of 'group' fertility[51]. Allowing for individual preferences (represented by α), members will choose a level of fertility such that

$$\text{Individual/couple fertility} = \alpha \text{ (Group fertility)}$$

This simple and reasonable hypothesis can explain why fertility decline is more associated with cultural and linguistic delineations than socioeconomic variables. However, it does not explain why fertility declined in the first place.

Richards has raised the question of whether we can assume "structural stability" in statistical models of fertility, that is if we can assume that the same process which accounts for cross sectional variation can account for changes over

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[51] Kohler (2001) models individual fertility choice as a function of aggregate fertility. Bongaarts and Watkins (1996) and Newsom et al. (2005) also analyse the role of social interactions in fertility transitions.

time as well (1983 p. 696). If the view is taken that the fertility levels for individual countries are the result of a long historical process, resulting from levels of natural fertility and supply of children amongst other factors, the path of variation of fertility and socioeconomic measures *within* a country over time should not be expected to be the same *between* countries. Unfortunately, Richards claims "there is no theory for aggregate fertility time series that is distinguishable from propositions concerning cross-sectional differentials" (1983 p.720).

The idea that cross sectional variation in the onset of fertility decline can lead to confusion over the time trend causal forces is explained concisely by Burch:

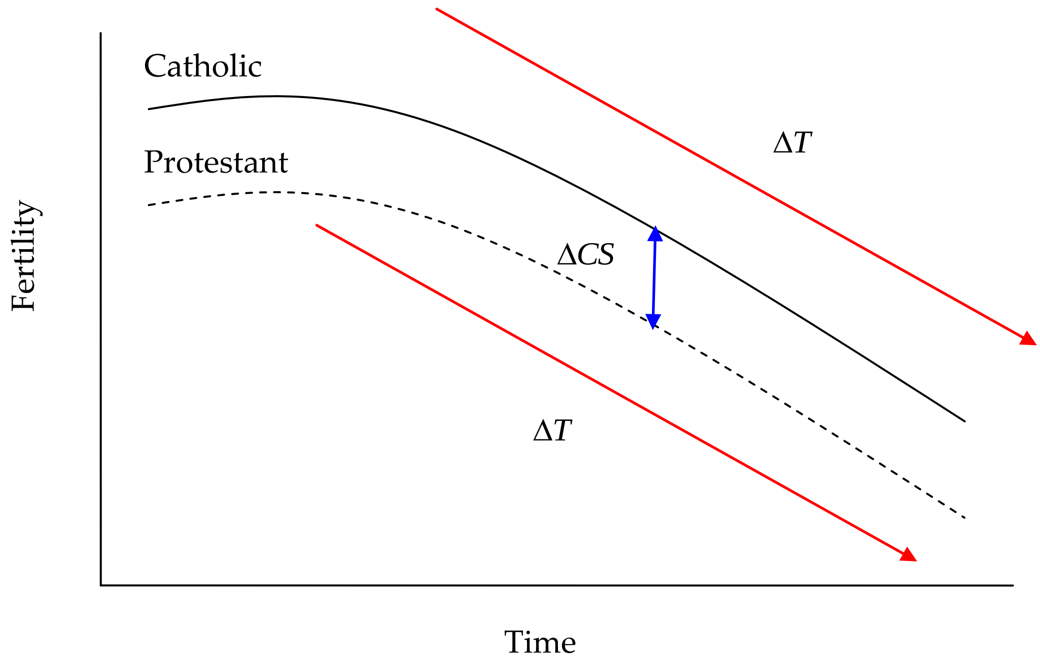
"For example, in early post-war U.S fertility surveys, it was discovered that one of the largest individual fertility differentials was by religion. In terms of averages and net of multiple controls, Catholics tended to have roughly four children, Non-Catholics roughly three. In regression analyses, religious denomination explained the most variance in completed or predicted fertility. Can we say therefore that religion was the most important determinant of fertility or of catholic fertility? Certainly not. The most important determinants of fertility were those factors that caused *both* Catholics and Non-Catholics to have only moderate fertility—three or four children versus eight or nine or even more of which they were capable. These common causal factors, shared by Catholics and non-Catholics alike, included such facts as common residence in a modern, urban, industrial, democratic, open society, with a somewhat secularized culture and with ready access to information and means of birth control. These factors explain why Catholics had *only* four children; Catholicism presumably explained why they had slightly more than other Americans. Factors that account for a difference of five or more children on average surely can be said to be more important than those which explain a difference of one child on average"[52] (Birch 1995 p.16).

Figure 2.5 illustrates the argument behind Burch's example. At every point in time, Catholics have higher fertility than Protestants. Yet over time, fertility is declining for both. Cross sectional regressions will always find a highly significant religious differential, represented by ΔCS, but the source of the decline may not be religion but a joint environmental factor for both groups, which causes the common

[52] The same is true for Germany, Knodel writes:
"Essentially at any time between unification and the 1930s differences in the level of fertility of the three major religious groups were evident wherever data were available. Jews had the lowest fertility, Catholics the highest, and the Protestants occupied an intermediate position…Eventually, however, the fertility of all three religious groups declined substantially" (1974 p.253).

time trend, ΔT .In Europe's provinces, fertility decline was clearly stratified by linguistic groups (as discussed in chapter 1). The EFP emphasised these cultural correlations in with fertility. Yet, as Alter notes, "all of Europe's linguistic regions ultimately underwent a demographic transition," (1992 p.21). In Europe, linguistic heritage was a source of differences in the *timing* of the decline; it does not tell us *why* fertility declined for every linguistic group eventually.

Figure 2.5: Burch's Critique of the Innovation/Diffusion Hypothesis



The micro economic model of fertility assumes that preferences are completely independent. However, the empirical character of Europe's fertility decline seems to indicate non-economic forces at work. The next section introduces some insights from evolutionary biology, in order to make sense of this apparent paradox.

Section 2.5: Evolutionary insights

Within the field of Evolutionary Biology, there is also active debate on the European fertility transition (see for instance Mace 2000, Kaplan et al. 1995, Kaplan and

Lancaster 2003, Newsom et al. 2005). Economic interpretations are taken into account, but there is more emphasis on the supply side of fertility decisions. The puzzle here is, given that "humans…have been designed by natural selection to strive to maximise their genetic representation in future generations", why have the richest and most advanced populations of the World reduced their fertility? (Turke 1989 p.62) Evolutionary explanations of human fertility have generally faced a similar lack of success in explaining the empirical record as economic explanations (Kaplan et al. 1995 p.326).

Evolutionary explanations for Europe's fertility decline have traditionally focused on the quantity-quality trade-off (first proposed for clutch size by Lack), and this has "structured most subsequent thinking in life history analysis, including work on humans"[53] (Borgerhoff Mulder 1998 p.266). Turke's theory of fertility decline is remarkably similar to the traditional economic explanation, focusing on the changing costs of children. However, Turke includes the idea of *relative* fertility as being a causal factor for fertility decline and his ideas will be discussed later in this section (1989 p.64). The fertility transition and "the fact that people in an increasing number of societies worldwide voluntarily reproduce at lower levels than would apparently maximise their lifetime reproduction poses a major challenge to evolutionary anthropologists" (Borgerhoff Mulder 1998 p.266).

Other scholars in this field take a different view (just as in economics and sociology), that the decline of fertility had more to do with culture and the availability of effective contraception than socioeconomic factors. Potts (1997) questions the assumption that people make rational choice in relation to family size, citing three biological assumptions; (1) humans are genetically predisposed to seek sexual relations, (2) to cherish and support their children when they arrive and (3) to be socially and sexually competitive. Therefore, "For as long as people did not have access to the means to control their fertility[54], they behaved as other animals, with

[53] There is also the argument that low fertility is a "maladaptive" outcome (Mace 200 p.386).

[54] This analysis ignores the presence of birth control techniques in pre-modern populations, such as abstinence and even more importantly the European Marriage Pattern.

the biologically most successful leaving most descendants". Potts argues that unconstrained access to fertility-regulation technologies is the primary factor responsible for fertility decline (1997 p.5-10).

Kaplan and Lancaster state that there are two tradeoffs affecting natural selection on fertility. Firstly, there is a trade off between present and future reproduction. Most organisms have a juvenile stage in which fertility is zero, and energy is focused towards growth. The second trade-off is between quantity and quality of offspring. These trade-offs are expected to result in the maximisation of fitness and of long term descendants[55] (Kaplan and Lancaster 2003 p.172). In this analysis, there are four factors which affect fertility, the timing of reproduction and parental investment: (1) The resources used in the reproduction process (and their production processes), (2) Mortality (risks and technology of reduction), (3) The complimentarily between the sexes in reproduction and (4) Variation in resource production (among and within individuals). Because of ecological variability throughout history, humans have evolved to deal systematically with variations in these four factors, resulting in "radical shifts in parenting and mating practices" (Kaplan and Lancaster 2003 p.175-9).

Kaplan and Lancaster discuss the variation and development of these four factors through the long run of human history. For hunter gatherers, monogamy was optimal because the sexes could specialise in either hunting or gathering. In horticultural societies, there is a high frequency of polygynous marriages, due to high male mortality[56] and made possible by the ability of women to support themselves and their children through their own labour. Fertility is higher here, mainly due to the reduction in infant mortality. The domestication of animals had a "profound" effect upon human social relations, nuptiality and child investment. Kaplan and Lancaster state, "For the first time in history, men could control a form of extra-somatic wealth that could be held by individuals, thus increasing the

[55] Becker uses the same reasoning to reconcile low fertility with Darwinian selection (1991 p.137).

[56] Through "chronic intergroup warfare and raiding increases" as society develops from hunter gatherer to horticultural (Kaplan and Lancaster 2003 p.188).

variance in male quality based on the resources each could control" (Kaplan and Lancaster 2003 p.190). With herds forming the basis of the new economy, economic conflict increases, and this places "a high premium on males as defenders and raiders" (Kaplan and Lancaster 2003 p.190). Polygamy is dominant, with wars, feuds, social stratification, male alliances, and "a geographic flow of women from the subordinate to the dominant groups via bride capture" (Kaplan and Lancaster 2003 p.190). A male's ability to attract wives and his reproductive success depend now upon his extra-somatic wealth, his ability (and that of his family) to make "bride wealth" payment. Families will both make and receive these payments on behalf of their daughters. It is at this point in human history, where a crucial key to understanding fertility behaviour, first becomes apparent. Kaplan and Lancaster write:

"Most significantly, there is suggestive evidence that for the first time humans began to reproduce at levels that may not maximise the number of descendents with the appearance of extra-somatic wealth and its inheritance. Men appear to marry fewer wives than they could afford in the interests of providing each child with a greater endowment. In other words, male pastoralists may pit quality against quantity of children to preserve a lineage status and resource base rather than simply maximising the number of descendents"[57]
(Kaplan and Lancaster 2003 p.192).

The onset of civilisation enabled fertility to increase through the increased reliability of food resources, where mortality continued to decreases the stock of young males. Kaplan and Lancaster point to historical evidence for the size of despotic male's harems, which varied with socioeconomic status in the Indian, Chinese, Inca and Aztec civilisations (2003 p.194). As well as near universal marriage for women, the wide variance in resource endowment meant that a significant number of men had no access to the marriage market. This leads to competition between females for the limited number of quality husbands, and the development of customs such as the payment of dowries and assurances of virginity and chastity (Kaplan and Lancaster 2003 p.195). Parents will adjust their investment in children in order to maximise their access to the marriage market, but also, in

[57] Kaplan and Lancaster cite Borgerhoff Mulder (2000) and Mace (2000) for this view.

some circumstance, balance this with the possible child labour contributions to the household (particularly in rural areas).

Population growth and the increases saturation of productive lands lead parents to adopt reproductive strategies which help to sustain the concentration of wealth. Potential heirs are reduced through monogamy, abandonment, preference for boys over girls and preference based on birth order[58] (Kaplan and Lancaster 2003 p.197). With these provisions, the wealthy raise as much children as they can, but only a predetermined few inherit the majority of the wealth. Kaplan and Lancaster state "during this period, there is a strong correlation between wealth, probability of marriage… and completed fertility"[59] (2003 p.197). The transition to low fertility begins when the income-fertility relationship goes from positive to negative, and finally to no relationship at all. According to Kaplan and Lancaster (2003 p.202) the reason for lower fertility amongst the wealthy first, is due to infant mortality being lower and returns to investment in education larger, earlier than they are for the poor. Eventually, all of society experiences significant decline in infant mortality and there is an increased demand for skilled workers, thereby resulting in equal fertility between economic strata. The gradual decrease in fertility as evident from national aggregates of fertility rates may then represent an increasing proportion of the population who have low fertility preferences. To sum up their argument, it is the presence of extra-somatic wealth which causes the deviation in human fertility behaviour away from the 2 influences of natural selection stated at the outset. Modern fertility rates, some below replacement (many parts of Western and Eastern Europe) may be a reflection of "the extreme importance of extra-somatic wealth" (Kaplan and Lancaster 2003 p.207).

Turke also contributes the angle of evolution to our understanding of the changing demand for children, and argues that "humans, like other organisms, have been designed by natural selection to strive to maximize their genetic representation

[58] Marriage and childbirth are no longer near universal for women also (Kaplan and Lancaster 2003 p.197).

[59] Kaplan and Lancaster cite Voland (2000) for this.

in future generations" (1989 p.62). Humans "rely extensively on learning" and it has been social competition which has driven its development, with human behaviour continuing "to centre around social competition" (Turke 1989 p.63).

Turke builds an evolutionary theory of fertility from the staring point that the human mind has evolved to "facilitate individual reproduction", which leads to hypotheses concerning resource flows, kinship and individual goals (1989 p.64). Assuming demand for children is mainly determined by the extent of kin support[60], Turke's model can be summarised as follows:

1.*Humans have evolved to strive for economic and social success.*

Simple maximisation does not occur in the human species because of the problem of providing for children and the impact on parents social and economic potential. Turke argues that the desire for children is "weak" in humans, and conception is primarily the result of strong desires for copulation. Humans have adapted to use planning and foresight in the pursuit of economic and social success, and will "nearly always take steps that increase their and their children's" relative position (1989 p.66).

2. *In traditional societies, the costs of children are spread amongst an extended kin.*

Kinship networks are important for fertility analysis in traditional societies because the burden and cost of child rearing can be spread out amongst the extended family. It is optimal for many members, from an evolutionary angle, to be involved in the upbringing of children, even if they are not their own. For instance, a parent who successfully rears a child perpetuates ½ of his/her genes while an aunt who raises a niece perpetuates ¼. For post menopausal women, the successful rearing of grand children is the genetic survival of 1/8 of her genes. This reasoning leads to the hypothesis that "the net flow of resources and services should be from individuals of low direct reproductive value to close relative of high direct reproductive value" (Turke 1989 p.67).

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[60] A direct contradiction of Caldwell's intergenerational wealth flow theory (1976), which states that the flow is from children to parents in traditional systems.

3. Modernisation results in more opportunity for economic and social success, breaking down the traditional kinship networks

Modernisation via economic growth alters the traditional system and kinship networks breakdown, due to factors such as increased economic opportunities and growth of the state amongst others (Turke 1989 p.67). Modern couples not only lack the support of an extended kin, they also lack kin *encouragement* for higher fertility – the high levels of exposure to non-relatives in modern societies is a very recent environmental change (on an evolutionary timescale)[61] (Mace 2000 p.386).

4. This breakdown means that the cost of a child is concentrated on the parents[62]

The opportunity cost in raising children is now greater that it was under the traditional system. Shortages of babysitters and teachers are likely to arise, but parents are also freed from kinship obligations (Turke 1989 p.71).

5. Once some parents concentrate resources on small numbers of children, other parents must do the same if there offspring are to be socially competitive

Individuals who have fewer children are able to concentrate more resources on each child (and themselves). This extra investment increases both the parent's and the child's social and economic success. Other parents are compelled to restrain their fertility in order so they and their children can be socially and economically competitive (Turke p.71).

Turke finds support for parts of his theory from his research on the Ifaluk people of Micronesia (1989 p.73). Element 1 to 4 of Turke's theory is almost identical

[61] Newsom et al. discuss this change in the frequency of communication with kin and its relationship with fertility decline explicitly (2005).

[62] Turke's theory puts a different interpretation on 'wealth'. Pointing to the observed negative income-fertility relationship evident from cross national analysis today, he states that a contradiction with evolutionary theory is only correct if you assume "that women in modern societies have more resources for reproduction" (1989 p.83). They do not, according to Turke, because of the absence of the extended kin system, educational demands and the desire to consume many luxury goods, the latter two essential to their children's and their own economic and social success. (Turke 1989 p.83).

to the microeconomic theory of fertility. The development comes with element 5, the relative fertility status of a couple[63].

The term 'diffusion' as used in the fertility transition literature, generally refers to the diffusion of birth control technology, and can affect overall fertility by reducing the costs of fertility regulation, by increasing information and social acceptance of new or little known techniques. However, a process of diffusion can act in another way, in the form of a 'trend'. This distinction is not made explicit in the literature, but I believe it adds another dimension to our understanding of the determinants of aggregate fertility. Traditional economic theory on fertility, as outlined previously, assumes socially isolated couples. Insight and theory from evolutionary biology and anthropology can provide structure to the view that a couple's fertility is not only determined by supply and demand, but also by the fertility behaviour of the community, social group and 'trendsetters' (i.e. the wealthy). Where the wealthy class reduce their fertility (for their own socioeconomic reasons[64]), a 'low fertility wave' can be generated, spreading down the social strata, inducing parents to reduce their fertility so that they can increase child quality, and thereby ensuring that their children will be socially and economically competitive[65]. The wave can be self contained if the size of the wealthy class is very small (such as in ancient Rome, where Caldwell documented a fertility decline amongst the elites (2004)), and there exists a large degree of economic inequality between the various subsections of the society. Similarly, such a theory would propose that fertility decline would be more rapid where income inequality is more even, and aspirations are growing. Crucially, such a viewpoint can explain how aggregate fertility can decline, for socioeconomic reasons (via a child quantity-quantity trade-off) in the *absence* of any significant changes in the level of real wages or modernisation, but perhaps alongside a changing environment for social mobility between subsections of the population.

[63] The traditional economic model for the demand for children assumes isolated couples.
[64] By substituting quality for quantity, to "sustain the concentration of wealth" (Kaplan and Lancaster 2003 p.147).
[65] As set out in element 5 of Turke's theory.

To illustrate this idea lets take a hypothetical three couple 'community':

Couple 1: wealthy, with income Y^*, and fertility F_1

Couple 2: poor, with income Y, and fertility F_2

Couple 3: poor, with income Y, and fertility F_3

Where $Y^* > Y$

As their income rises and reaches a certain threshold point, couple 1 substitute child quality for quantity, consistent with economic and evolutionary theory.

$$Y^* \uparrow \therefore F_1 \downarrow$$

Supposing Y is held constant, what happens to the fertility rates of couples 2 and 3?

Economic theory: The level of fertility depends on full income and the relative costs of children. With no change in either of these, there is no change in fertility.

Evolutionary theory: Parents will adjust their fertility to enhance their children's social and economic competitiveness:

$$F_1 \downarrow \therefore F_2 \downarrow \therefore F_3 \downarrow$$

The process by which this happens will resemble 'innovation diffusion', and would happen rapidly in this small setting. For larger communities, the speed of diffusion would depend on informational constraints, where increasing urbanisation, for example, would serve to depress fertility. We would expect this diffusion trend to operate along social strata, as parents will focus on ensuring their children are socially competitive within their immediate social group, and also, perhaps, the social group which they aspire to join (or have their children join). Further, this effect would be expected to operate along linguistic and cultural lines, as the historical experience of Europe suggests[66]. The environment for social mobility will affect the fertility rate through this social competition dynamic. As the possibilities for upward (an of course downward) social mobility are a function of the underlying level of economic inequality in a society, changes in inequality themselves can influence the birth rate.

[66] Leasure (1963) discovered a remarkable similarity between the linguistic and fertility map of Spain, as did Knodel with Germany (1978).

Section 2.6: Conclusion

This chapter has used the Easterlin-Crimmins framework to organise the many different and competing theories of Europe's fertility decline into appropriate intellectual categories. Following this, brief but detailed analyses of the theoretical foundations behind the demand and supply of children, and the costs of fertility regulation were conducted. Throughout, the underlying theory was cross referenced with the empirical findings so that the reader could be aware of each theories weak spots. The principal weak point of the microeconomic theory of fertility, as with demographic transition theory, is the unfortunate fact that the historical record does not support it. The historical record points to a non-economic, or 'innovation diffusion' hypothesis for Europe's fertility decline. However, these ideas do not offer us a reasonable reason for why fertility declined in the first place.

However, linking the microeconomic model of fertility to evolutionary arguments concerning human's preoccupation with social competition provides hope for understanding. Following a brief discussion and example, I argued that fertility could decline in the absence of great change in the level of 'modernisation', with 'innovation diffusion' like characteristics. The reason for this is human's preoccupation with *relative* socioeconomic position. The simple hypothetical example served to illustrate the intuition behind the idea, but in the real world, society is stratified along linguistic, cultural and economic strata. A change in the environment for social mobility, as indicated by measures of the level of economic inequality may induce fertility responses in population subgroups. I pursue these theoretical ideas further in chapter 6.

Chapter 3 – Is Economic Growth Correlated with the Onset of the Fertility Transition in Europe?

Abstract

This chapter uses newly constructed estimates of the index of marital fertility to re-date the year fertility declined in ten European countries. Econometric structural break tests are applied to time series data, providing a novel and endogenous method to detect the onset of a new demographic regime. The new estimates are in every case earlier than the original European Fertility Project estimates. However, these results do not point to any socioeconomic threshold for fertility transition. The levels of socioeconomic development, along with levels of infant mortality vary widely at the onset of the fertility transition in Europe. Following this, the data is tested for the presence of an 'inverted U' income fertility pattern, as predicted by the microeconomic theory of fertility. The 'turning-point' level of income per capita was rarely statistically significant. Where it was, the negative effect of income on fertility kicks in *after* the onset of fertility decline.

Section 3.1: Introduction

The decline in European fertility rates during the last half of the 19th century was an unprecedented and revolutionary break from the past. This new pattern of behaviour allowed economic growth to be transformed into sustainable growth in income per person and allowed European populations to escape the 'Malthusian Trap', where income growth was always brought back to subsistence levels via the expansion of population. This monumental transition followed the Industrialisation Revolution in most countries and preceded it in others. Our current knowledge on the exact processes involved in the initiation of fertility decline allows us to make the following generalisations: Fertility was driven downwards via control of fertility within marriage, and once this process began, it was irreversible (Watkins 1986 p.431). As chapter one described, the decline was concentrated in time but not in space – 59% of Europe's provinces experienced the beginnings of their fertility transition almost simultaneously (Knodel and van de Walle 1979 p.394).

As a precursor to the disaggregated individual level analyses in later chapters, this chapter will provide a thorough description of the demographic, economic and structural characteristics of Europe's fertility decline at the macro level. The analysis will proceed in two major analytical sections. Section 3.3 will examine the onset of decline via new annual estimates of marital fertility. Econometric Structural break tests will be employed to date the decline and the socioeconomic characteristics at this year will be summarised. This information will form the basis for an empirical critique of demographic transition theory. Section 3.5 will test the marital fertility, infant mortality and income series for the presence of a Beckerian 'inverted U' relationship between Income growth and fertility change.

The trend in historical demography over the past 50 years has been one of disaggregation, with researchers testing economic and demographic relations via individual level data. However, the conclusions to the European Fertility Project (EFP) emphasised the simultaneity of the decline, which prompts research to begin at the macro level. Further, a researcher who began at the micro level could conclude that fertility declined in his painfully reconstituted village sample because of specific factors such as, say, the local factory closing. Another researcher could find that in his village fertility declined because the local market for female labour increased its demand, while another could find that the most important factor was the changing influence of religious adherence. The point is that multiple researchers examining multiple localities might find multiple location specific explanations for fertility decline. What we already know is however, at the aggregate level, these declines took place at pretty much the same point in time[67]. This suggests that we must first examine the macro level climate before disaggregating to the individual level. The policy implications of historical demographic studies are mainly discussed at the macro level. This fact is increasingly being recognised by

[67] This is a summary of an observation conveyed by George Alter at a seminar at the University of Michigan, August 2006.

researchers, and recently there have been a number of aggregate level investigations into the determinants of the fertility rate. McNown and Ridao-Cano state: "Since this debate [economic v. attitudinal explanations for fertility decline] concerns trends and patterns in fertility behaviour at the societal level, aggregate time series analysis is appropriate" (2005 p.521).

The EFP has been heavily criticized by many authors (in particular Brown and Guinnane (2003). Chapter one summarised the EFP studies and detailed the EFP authors' stated concerns. Galloway et al. provide a neat summary of the reasons why the conclusions of the EFP are questioned;

The EFP's "inability to test existing theory adequately for a variety of reasons, including excessively large units of analyses, lack of useful socio-economic measures (for example, direct measures of income have rarely been used), coarsely defined independent variables, insufficient sample size, inadequate method and improperly specified models. Indeed, because of these problems important elements of fertility transition theory have not yet been adequately tested for Europe."
(1994 p.135).

The European Fertility Project (EFP), discussed in detail in chapter one, was the largest empirical project on Europe's demographic transition. The results of the EFP led to the abandonment of demographic transition theory as the consensus explanatory hypothesis of Europe's fertility decline. Simultaneous with this rejection by demographers, economists have modelled the micro level determinants of family size. Gary Becker's work in this regard (1960, 1991) has been hugely influential (and is detailed in chapter two). Despite the wholesale acceptance of Becker's model within mainstream economics, the central empirical predictions of his model have rarely been tested. In a paper reporting the early stages of the fertility transition in Kenya, Robinson firmly queries Becker's model. He states "this proposition has not been proven, only asserted often enough to gain a certain credibility and force through repetition" (Robinson 1992 p.453). As chapter one discussed, explanations for Europe's fertility decline can be categorised as either innovation-diffusion or adaptation. The simultaneity of Europe's transition has led many researchers to the conclusion that economic growth could not be a causal force in the fertility transition (the innovation-diffusion hypothesis). However, as mentioned previously, other researcher question the EFP's conclusions and reason for an adaptation explanation for the fertility decline. With regard to the simultaneity of the decline, Guinnane et al. make the following observation;

"Cleland and Wilson observe that fertility fell in 71% of Europe's provinces between 1880 and 1930, and refer to this period as a "short time". Is 50 years really so brief a period? Europe's declines in fertility…were no more closely timed than its industrialisation. If economic forces could not be an important factor in the decline of fertility, as Cleland and Wilson argue, are we to think that economic forces did not bring about industrialisation of England or Germany" (1994 p.17).

This thesis is a re-examination of the economic correlates of the fertility transition. This chapter[68] will provide the macro level backdrop to the individual level analyses in the rest of the thesis by testing newly constructed estimates of fertility for patterns predicted by the economic theory of fertility.

The rest of this chapter is comprised of five sections. Section 3.2 details the data and its summary characteristics. Section 3.3 details the methodology and results of a new test for estimating the onset of fertility decline. Section 3.4discusses the implications of the results of section 3.3 for demographic transition theory, while section 3.5 tests for a Beckerian 'inverted U' income-fertility pattern. Section 3.6 Concludes.

Section 3.2: The Data

This chapter re-dates the aggregate decline in fertility for ten European countries using a new time series and methodology. This section details the methodology employed to generate annual estimates of marital fertility. The EFP analysed Europe's fertility decline through a set of standardised fertility and nuptulaity indices which were developed by Ansley Coale. These indices, I_f (the index of

[68] Methodologically, much of the inspiration for this chapter comes from the work of Winegarden and Wheeler (1992[68]), particularly in examining the income-fertility relationship for evidence of an 'inverted-U' income-fertility pattern.

overall fertility), I_g (the index of marital fertility), I_h (the index of illegitimate fertility) and I_m (the index of nuptiality) were presented as a fraction of a 'maximum' level of fertility – (that of the Hutterites[69]). The standardisations control for varying age structures and proportions married amongst the female populations. For this analysis, annual estimates of Coale's measures were constructed by linearly interpolating the age structure of the female population between censuses, and doing the same for the proportion of females married at different ages. Then by factoring in the available annual series of births in each country, and also the total number of legitimate births, annual estimates of I_f, I_g, I_h and I_m were calculated. In other words, the fertility potential of a country was estimated annually by applying the Hutterite schedule to the specific female age structure, which was then used as the denominator. The numerator is the actual level of births/legitimate births. The results of this exercise were perfectly consistent with the Princeton data (at the census dates), and revealed a lot of inter censual variation (See the appendix for a comparison between these annual estimates and the Princeton estimates).

Annual estimates for I_g[70], the index of marital fertility and the 'key variable' in this analysis, were constructed for all European countries where the data was available. The formula used was:

$$I_g = \frac{LB_t}{\sum_{a=15-19}^{15-49} N_{a,t} h_a m_{a,t}}$$

Where LB_t = Legitimate births in year t, $m_{a,t}$ = the marriage rate of female age group a, at year t, $N_{a,t}$ = Number of women in age group a, at year t and h_a = marital fertility rate of Hutterites in age group a. Annual estimates of Coale's indices were estimated for 22 European countries. The index of marital fertility (I_g) for

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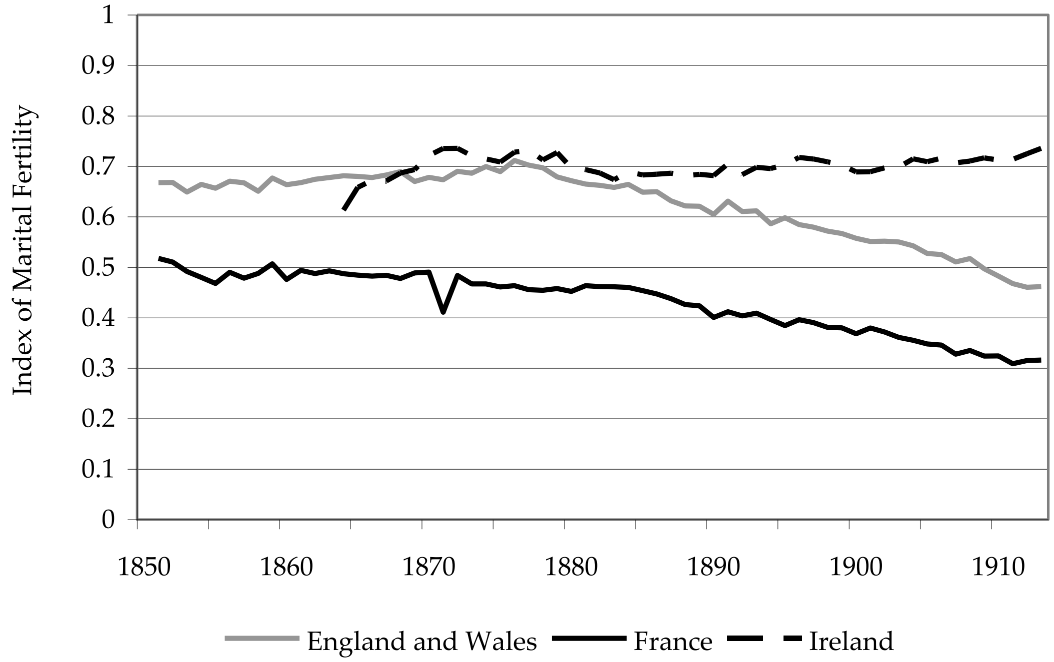
[69] An Anabaptist religious group who make no attempts to control their fertility and marry at young ages.

[70] Annual Estimates for Coale's Indices Sources:
Hutterite Schedule: Sardon 1996 p.253.
Age Structure, female population, married female population and births (legitimate and illegitimate): Rothenbacher 2002 CD:Rom.

three representative cases are illustrated below in figure 3.1.

Figure 3.1: The Index of Marital Fertility, 1850-1913



Source: Own calculations based on Rothenbacher 2002.

The index of marital fertility for England and Wales, France and Ireland roughly represent the variety of fertility decline patterns in Europe during the late 19th century. The early decliner (and alone in this group) is France, where fertility decline began before the start of the sample period. More representative of the general European experience is England and Wales, where decline appears to set in about the 1870s and is certainly experiencing irreversible decline by the mid 1880s. Ireland represents the late decliner group, with marital fertility high (and even rising) during the period 1850-1913. Sustained fertility decline is not established until after World War I. In general most European countries fall within the range established by England and Wales and the late decliner Ireland. So as to pinpoint the decline of fertility in Europe, these annual estimates for the overall fertility and marital fertility indices were analysed for the presence of a structural break. This exercise is reported in the next section.

Section 3.3: The year of Fertility Decline

The EFP collected and analysed fertility data for over 600 provinces of Europe. The project conclusions (summarised in Watkins (1986) stressed the simultaneity of the fertility decline across varying environments of socioeconomic development as a key reason to believe that the two were unrelated. The EFP defined the onset of fertility transition as a 10% drop in the value of I_g, where I_g never again reaches its pre-transition level. However, the EFP was restricted to using census year data and the estimated years were based on interpolations between these dates[71] (Watkins 1986 p.395). The availability of annual estimates permits a more specific pinpointing of the year of decline.

Identifying structural change in a time series has received some attention in the Econometric literature over the past decade. The attraction of using these techniques on the historical trend of fertility in Europe is the fact that it does away with the clumsy 10% definition of fertility decline, and offers an endogenous and objective new dating procedure. A popular methodology used to detect structural breaks in a time series is that of Zivot and Andrews. The Zivot-Andrews procedure tests the null that the variable in question contains a unit root with drift (no structural break) versus the alternative that the data is a trend stationary process (TSP) with one structural break

Formally the Zivot Andrews test is as follows

H_0: $$y_t = \mu + y_{t-1} + e_t$$

H_1: $$y_t = \hat{\mu} + \hat{\theta} DU_t(\hat{T}_b) + \hat{\beta} t + \hat{\gamma} DT_t(\hat{T}_b) + \hat{\alpha} y_{t-1} + \sum_{j=1}^{k} \hat{c} \Delta y_{t-j} + \hat{e}_t$$

Where DT_t - Dummy representing a break in the trend term at time T_b and DU_t - Dummy representing a change in the constant term. $DU_t = 1$ if $t > T_b$, 0 otherwise.

[71] See also Casterline (2001 p.46) for criticism of the EFP's timing of the fertility transitions.

Nelson and Plosser (1982) famously demonstrated that the majority of US macroeconomic time series could be classified as 'random walks' – that is the trend was not fixed, but could be shifted by random shocks which would persist until moved again by another random shock (Hansen 2001 p.124). This prompted a backlash, one of which was Perron (1989) who argued that the movement of the trend in macroeconomic time series could be explained by "a parsimonious single structural break" (argument as summarised by Hansen 2001 p.124). Perron's original test involved an exogenous knowledge of the trend break, which was disputed by Zivot and Andrews (1992), who developed a test which could endogenously determine the date of the structural change. The structural change is accounted for by a change in either the constant or the trend term, or both. Repeated regressions are run for different values of the break term (a dummy variable as employed in the test structure above). The breakpoint is chosen where the (one sided) t-stat for the coefficient on the autoregressive term ($\hat{\alpha}$) is minimised – therefore the break is chosen where the support for the null hypothesis (of a unit root) is the weakest (Hansen 2001 p.124).

The Zivot-Andrews test[72] for structural change was applied to 10 European countries for which the historical fertility data was of sufficient length (in order to identify a genuine structural shift and avoid identifying a short-run fluctuation). The sample period for all countries apart from France and Switzerland is 1850-1913 (1852-1913 for Switzerland, 1740-1911 for France[73]), and the test is constructed to allow for a structural break in the trend, the intercept or both. The results are listed in table 3.1.

Allowing for one structural break produced the latest (and therefore most conservative) estimates for the year of structural change in the time series of marital fertility[74]. The exercise has resulted in some important clarifications on the macro

[72] I used Christopher Baum's ZANDREWS module for Stata.
[73] The data from France is taken from Weir (1994) Table B3. p.330-1.
[74] In 10/12 countries tested.

Table 3.1: Structural Breaks in European Marital Fertility

Country	Year of Break	Break Type	Country	Year of Break	Break Type
Austria	1901**	T+I	**England and Wales**	1862	I
	1901	I		1872	T+I
	1908	T		1877*	T
Belgium	1863	I	**France**	1772	I
	1872	T+I		1776*	T
	1874	T		1789**	T+I
Switzerland	1870	I	**Hungary**	1865	I
	1865	T+I		1881	T
	1884	T		1881	T+I
Germany	1872**	T+I	**Norway**	1874**	I
	1872	I		1874	T+I
	1877**	T		1899	T
Denmark	1874	I	**Sweden**	1871	I
	1875	T+I		1873	T+I
	1887	T		1887	T
Spain	1893***	T+I	**Finland**	1870***	I
	1893**	I		1870***	T+I
	1897**	T		1887***	T

Where T=Trend and I=Intercept.

Table 3.2: Structural Break in Marital Fertility Trend

Zivot-Andrews Test Unit Root Test allowing for 1 structural break in the **TREND**

Country	Break Year	talpha[75]	Princeton Date	Difference to Princeton dating
France	1776	-4.33*	1800	-14
Belgium	1874	-3.90	1882	-8
England and Wales	1877	-4.22*	1892	-15
Germany	1877	-4.53**	1890	-13
Switzerland	1884	-3.55	1885	-1
Denmark	1887	-2.39	1900	-13
Sweden	1887	-3.60	1892	-5
Finland	1887	-5.20***	1910	-23
Norway	1899	-2.49	1904	-5
Austria	1903	-4.87**	1908	-5

* $P<0.05$, ** $P<0.01$, *** $P<0.001$

[75] The asymptotic critical values for this test "should only be used as a crude guide" – they make it hard to reject the null hypothesis of a unit root (Hansen 2001 p.124). Therefore the 10% level is used as a cut-off.

level picture. Firstly, we now have an exact year for the start of the macro level fertility transition in France. Previously estimated as ca.1800 (Watkins 1986 p.394), the Zivot-Andrews test indicates 1776 as the "year of decline". This is important as it places the origin of the French fertility decline over a decade *before* the Revolution of 1789-1799, and casts fresh doubt on the causal link of events surrounding the Revolution and the onset of the fertility transition. Strikingly, France experiences fertility decline 98 years before anywhere else in Europe. The next country to start a transition is Belgium, in 1874. The structural change in Belgium's fertility series is dated eight years before its date of 10% decline. For England and Wales and Germany, both of whom experience structural change in 1877, the EFP underestimation is 15 and 13 years respectively. The details of the structural break in trend are listed in table 3.2, along with the EFP dates (calculated as the year fertility declined by 10%).

The results of this exercise follow recent criticisms of the EFP's methodology and conclusions. Brown and Guinnane (2003 p.26) have taken issue with the definition of fertility decline and argued that it fails to capture the origins of the transition in a meaningful way. While this exercise can say nothing on the problem of identifying fertility decline with aggregate level data (as opposed to individual level datasets), a new method for dating fertility decline is forwarded and the results indicate significant underestimation of the fertility transition in Europe by the EFP. The differences are not large but are calculated based on the most conservative estimates of the Zivot-Andrews tests. Further work, particularly with tests which can locate more than one structural break is desirable. These dates are now taken to summarise the relative socioeconomic status of Europe at the time of fertility decline in each of the countries tested.

Section 3.4: Demographic Transition Theory Debunked

The results of the re-dating exercise, where the most conservative (latest)

Table 3.3: Summary Table of Socioeconomic Characteristics at Year of Decline

							Labour Force: Sectoral shares (%)				
Country	**Year of Decline**	**Index of Marital Fertility**	**GDPpc**	**Primary Schooling (per 1000)**	**Crude Death Rate (Per 100)**	**Infant Mortality Rate (per 1000)**	**Agriculture**	**Industry**	**Services**	**Female Labour Force Participation (%)**	**Urbanisation (%)**
France	1776	0.811	<$1,135	<388[76]	-	185.0	*70+*	-	-	-	<12.2
Belgium	1874	0.813	$2,890	604.1	20.7	136.9	41.6	36.9	20.7	34.3	41.2
England[77]	1877	0.703	$3,425	423.1	20.3	136.0	14.1	47.9	28.9	-	54.5
Germany	1877	0.800	$2,033	711*	26.4	218.0	46.7	35.4	16.6	18.1	30.4
Switzerland	1884	0.651	$2,657	765.7	20.2	160.8	40.8	42.8	16.3	-	22.4
Denmark	1887	0.680	$2,395	670*	18.2	131.2	46.5	25.5	17.6	Apx. 30.	26.7
Sweden	1887	0.707	$1,926	666.8	16.1	103.1	59.0	12.7	11.8	25.7	15.1
Finland	1887	0.730	$1,276	94.7	19.0	131.8	64.3	11.7	12.8	14.8	7.6
Norway	1899	0.717	$1,927	628.7	16.8	106.7	41.8	26.9	29.0	12.4	23.9
Austria	1903	0.643	$2,941	671.2	21.6	210.9	58.9	23.2	15.0	45.2	26.5

Source: See appendix.

[76] Lindert Source used (nearest available year, 1830 for France, 1890 for Denmark and 1880 for Germany)

[77] And Wales.

break year I selected, is listed in ascending order of break point year in table 3.3[78]. For each country, table 3.3 lists GDP per capita, primary schooling enrolment rates, crude death rates, infant mortality rates, sectoral composition of the labour force, female labour force participation and urbanisation rates. The reported values refer to the 'year of decline'.

Again, the striking peculiarity of the French experience is highlighted by this table. With a proportion of over 70% of the working population in agriculture, urbanisation rates of less than 12.2% and a GDPpc of less than $1,135 (1990 Gary-Kheamis dollars) irreversible fertility decline took hold. The variety of the European experience can be illustrated by looking at the variation in these socioeconomic measures at the time of decline. Excluding France, GDPpc ranged from $1,276 to $3,425 – an almost 300% differential. Combining this with the proportion in agriculture (varying from 14.1% to 64.3% - a 450% differential!), the observations of classic demographic transition theory fail to apply to the European case. There is no relationship in the National data which demographic transition theory can predict or explain. If one takes a thousand year perspective, the general idea holds: 'modernisation equals fertility decline' with varying regions experiencing varying leads and lags in the transition date. However, the processes involved behind the impulse for fertility decline to take hold are not adequately explained by this vague concept of modernisation. Urbanisation rates vary from 7.6% to 54.5% and crude death rates vary from 16.1 per thousand to 26.4 per thousand. The variation in level of child mortality at the time of the decline (for the selected countries tested for structural change in marital fertility) is from 103.1 per thousand (Sweden) to 218 per thousand (Germany). In short, I (and many researchers before me) can find no 'silver bullet' with the standard socioeconomic variables available for explaining Europe's fertility decline in the aggregate data.

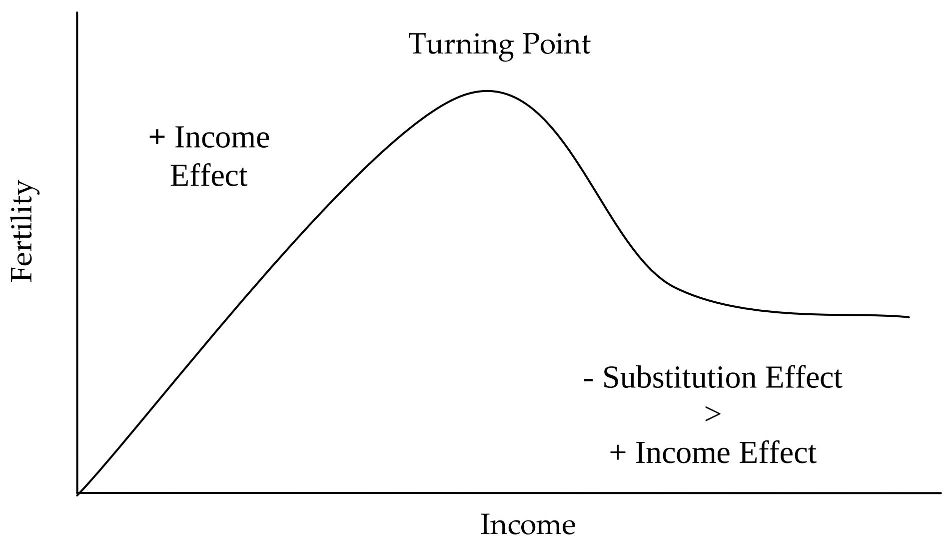
[78] The table is inspired by table 1 in Knodel and van de Walle, 1979 (p.221-2).

Section 3.5: Empirical Evidence for a Beckerian Inverted U Income –Fertility Relationship?

The results of re-dating Europe's fertility decline indicated that there was no simple socioeconomic threshold that would initiate a fertility transition. However, there is reason to expect a non-linear modernisation-fertility relationship. The economic model of fertility demonstrates how parents will substitute child quantity for child quality, once the returns to child investment reach a certain point. Initial sustained increases in income will prompt parents to increase the number of children demanded. Once child quality is demanded however, parents will sacrifice family size for a higher level of quality per child. 'Quality' may be understood as expenditure on children above a fixed cost of subsistence. Becker's theory is discussed in some detail in Chapter 2. The point at which parents substitute quality for quantity is related to the aggregate economy. The more developed an economy, the greater the need for educated workers, and the greater the incentive for parents to invest in child quality. The best proxy for the level of economic development in a country is it's GDP per capita. The theoretical framework established by Becker produces a testable hypothesis for the aggregate level. If the decline in fertility is wholly due to parental substitution of child quantity for quality, then we should expect to find an inverted U relationship between a country's fertility rate and its level of economic development. Due to econometric problems in estimating these type of relationships, the testable hypothesis can be re-expressed in terms of *changes*: changes in the fertility rate should respond positively to income changes *before the decline of fertility*, and negatively thereafter.

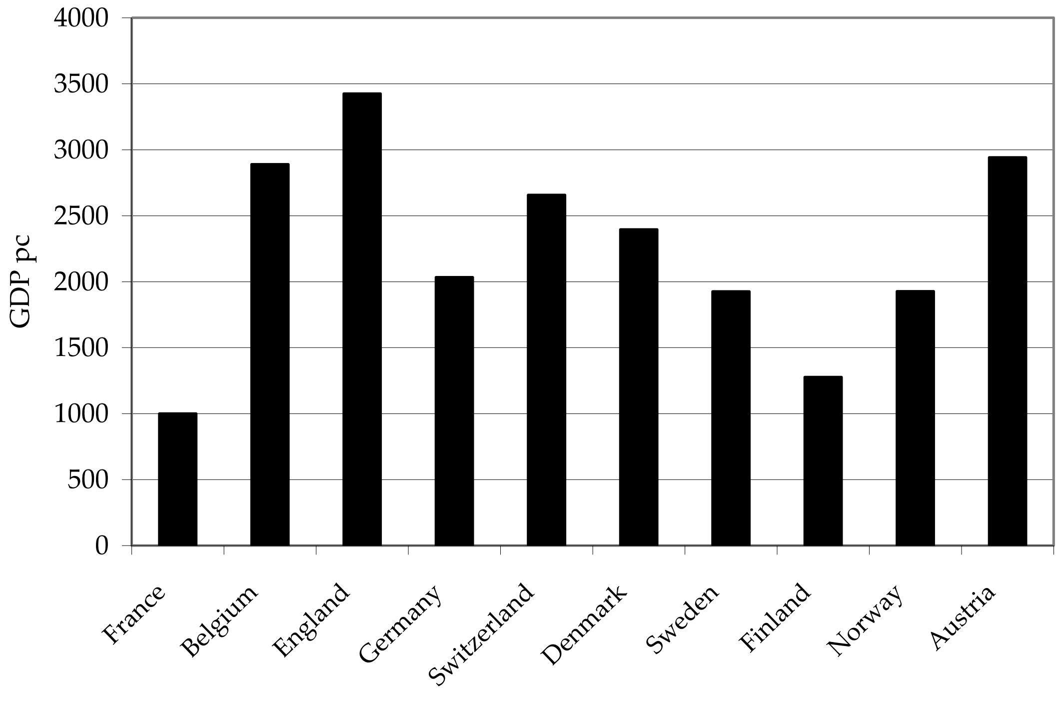
Figure 3.2 illustrates the income-fertility relationship. At low levels of income, increases to income have a positive effect on fertility. Populations where a significant proportion of the population are living near subsistence will experience increased fertility levels due to the greater nutrition of mothers. Further, more and better nutrition will allow for a decrease in child mortality. This effect is expected to dominate in a pre-industrial society. As incomes grow, however, the microeconomic theory of fertility predicts a threshold where parent's switch from choosing quantity to quality of children. After this threshold level, all increments to income are expected to reduce fertility, as a greater proportion of the population switch to demanding high quality children. This chapter will conduct two tests for this pattern. The first is a 'strong' test of the microeconomic theory of fertility. The calculation of the year fertility decline begins via the econometric structural break tests will allow the comparison of GDP per capita across the countries of Europe at this date. The second, 'weak' test is to allow the thresholds to vary across the countries in the sample, and econometrically test for the significance of the relationship between GDP per capita and the index of marital fertility. Following this, the 'turning point' year is calculated from the regression coefficients and compared with the year of structural change in the index of marital fertility. If this 'turning point' year occurs before the year of structural change in the fertility series, this is strong evidence for the validity of the economic model of fertility as a powerful explanation for the decline of fertility in Europe. If it occurs after, this will represent a refutation of the economic model of fertility, as applied to Europe's 19th century decline.

Figure 3.2: The Income-Fertility Relationship



The idea that the empirical pattern of the aggregate level income-fertility relationship takes the form of an inverted U was first raised by Nancy Birdsall (1980). Theoretical justifications come not only from Becker (1991), but Ehrlich and Liu (1991), Tamura (1996) and Galor and Weil (2000), in the form of a trade off between child quantity and quality. Becker, states "I am convinced that the most promising explanation is found in the interaction between the quantity and quality of children, for it implies that the demand for children is highly responsive to price and perhaps to income, even when children have no close substitutes" (Becker 1991 p.149).

Figure 3.3: Levels of GDPpc at the Year of Fertility Decline



Source: Structural change dates from test, Maddison 2003

Figure 3.3 reports the GDPpc levels at the year fertility declined in the ten countries tested for a structural break in the index of marital fertility. As reported in the last section, the levels of GDP varied immensely. For instance, England's GDP at the time of fertility decline (1877) was over 3.5 times that of France (1776) and over three times that of Finland (1887). Across countries, there is no evidence for a threshold level of economic development which initiates fertility decline. Thus we can conclude that the 'strong' test of the microeconomic theory of fertility is a negative result.

The 'weak' test of the economic theory of fertility is to allow the income thresholds to vary within the countries of Europe. Through testing each data series individually, separate estimates of the income threshold can be calculated. The idea is to impose a quadratic functional form on the relationship between the index of marital fertility and income. The following equation represents the econometric model applied to the data series;

$$I_g = C + Y_{t-1} + Y_{t-1}^{\ 2} + IM_{t-1}$$

Where *Ig* = Index of marital fertility, *C* = constant term, *Y* = per capita GDP, Y^2 = per capita GDP squared and IM_{t-1} = Infant mortality.

The model is intentionally parsimonious to reflect the unambiguity of the underlying theory. The lag format assumes that fertility decisions are made (on average) in the 12 months before the year of birth. The model assumes that changes in economic growth will exert non-monotonic effects on the birth rate, with the quadratic formation intended to capture the theorised parental substitution of child quantity for quality. Low levels of income should see a positive correlation between economic growth and the birth rate. At a certain level, the income effect (which increases parents demand for children), will be offset by the price effect of another child. This relationship is based upon the economic model of fertility developed by Becker (1960, 1991), as Docquier argues that the macroeconomic characteristics of the income fertility relationship "are linked to the theoretical micro foundations of fertility decisions" (2004 p.263).

Very few empirical attempts have been made to detect the presence of this inverted U relationship, or the implied income threshold, where the effect of growing income on fertility changes from positive to negative. However, Nagarajan (1980) tested a similar model of fertility using a quadratic income formation, for 20th century American data. His model was of the form: B = aY +bYSquared +cT. He tested this against other linear models (and also models excluding the time trend, T), and found that this was by far the most statistically accurate model, producing a non-linear income-fertility relationship, with a turning point around $1479 (Nagarajan 1980 p.167). Winegarden and Wheeler applied a similar model to Norway, Sweden, the UK and Germany, finding that economic growth played a role in fertility decline but could not be linked to the initiation of the decline (1992 p.432). In a comparative study, Barro and Sala-I-Martin show that for countries with income per capita below $767, fertility and income have a positive correlation, those above tend to have a negative relationship (Docquier 2004 p.261). As well as finding some support for the inverted U relationship, Strulik and Sikander's results show "that in every year under investigation, there exists a certain income threshold above which the correlation between income and fertility is significantly negative" (2002 p.4). Also, they find that while the fertility coordinate of the threshold does not change much (apx. 6.5 from 1960 to 1985), the income coordinate changes considerably over the period. "The more recent the observed period the lower the level of income from which an income improvement goes hand in hand with a marked and persistent reduction in fertility" (Strulik and Sikander 2002 p.4).

To begin with, separate time series regressions were run for each European country. Once the results are obtained a simple formula is applied to the coefficients of the two income terms to obtain the formula for the slope of the regression line. Solving where this equals zero results in a 'turning point' level of per capita income, which also gives a turning point year (cross referenced from the original data series). This year is then compared to the year of structural change in the marital fertility series (obtained via the Zivot-Andrews technique). A value of 0 or a negative value in the net difference of these years would suggest that income growth may have acted to initiate fertility decline, consistent with microeconomic theory.

The fertility series is the annual estimates of marital fertility used in the structural break tests, and infant mortality is taken from Rothenbacher (2002). The variable used to represent income is GDP per capita expressed in constant prices, and these values are taken from Maddison, A *The World Economy: Historical Statistics* (2003)[79]. There are well known problems associated with the development of internationally comparable real income estimates, as exchange rates do not reflect relative purchasing power. Maddison uses the long span projection procedure to correct for this problem, projecting a 1990 GDP per capita benchmark (in purchasing power parity adjusted international dollars) to all other years, using domestic growth rates (Pamuk 2005 p.5). Maddison's data are the "best estimates" of this kind available (Prados de la Escosura 2000 p.2).

Non-Stationarity represents the principal econometric issue to be overcome in this analysis, as its presence can lead to incorrect inferences about the estimated parameters of the model (McNown and Ridao-Cano 2005 p.521). The purpose of this test is to generate country specific 'turning point years' via individual time series regressions, and also to pool the data to test for a European wide pattern. Visual inspection revealed a strong tendency for these variables to trend over the sample period. Classical regression analysis assumes that the underlying process generating the data is stationary – that is it has a constant mean and variance. In other words, the mean, variance (and also auto-covariance) must be the same no matter what time they are tested. Intuitively, the assumption of stationarity seems implausible for GDP pc and fertility during this period. Formally, a popular method to test for stationarity is to test for a unit root. A unit root exists if the coefficient ρ is equal to 1 in the following regression of a variable, Y

$$Y_t = \rho Y_{t-1} + u_t$$

Such a series is known as a *random walk*. Augmented Dickey Fuller tests (ADF)[80] test for this pattern and were applied to all the variables in the data series. For marital

[79] See pp.25-31, and 91-94 for the sources Maddison uses to derive his estimates.

[80] The ADF tests the following regression: $\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \alpha_i \sum_{i=1}^{m} \Delta Y_{t-i} + \varepsilon_t$

Where $\delta = \rho - 1$, t =the trend. The null, hypothesis is that $\delta = 0$, i.e. there is a unit root. The lagged difference term on the RHS is included to account for autocorrelation, and the lag length is chosen so that the error term, ε is independent (Gujarati p.721 1995). For robustness, the tests were conducted with and without the trend term, and also for 1, 2 and 3 lags of the test variable.

Table 3.4: Summary Statistics for Regression[81]

	I_g	GDP pc	IM	I_g	GDP pc	IM
	Austria (1870)			**Netherlands** (1850)[82]		
Mean	.69	2537	153	.77	3055	171
Max	.85	3505	189	.87	4048	252
Min	.53	1650	107	.6	2363	87
Standard Dev.	.06	516	16	.07	483	35
	Belgium (1850)			**Norway** (1850)		
Mean	.69	3052	130	.72	15632	96
Max	.84	4219	167	.8	2447	126
Min	.42	1847	92	.6	955	64
Standard Dev.	.12	666	15	.05	360	14
	Denmark (1850)			**Sweden** (1850)		
Mean	.64	2424	158	.67	1989	116
Max	.71	3912	392	.74	3096	170
Min	.49	1662	108	.52	1216	70
Standard Dev.	.05	660	41	.51	537	26
	Finland (1860)			**Switzerland** (1852)		
Mean	.68	1359	162	.65	2766	165
Max	.76	2111	238	.75	4377	221
Min	.47	885	104	.51	1365	94
Standard Dev.	.04	327	23	.06	907	30
	France (1850)			**England** (1850)		
Mean	.43	2301	215	.62	3613	145
Max	.52	3514	262	.71	4920	163
Min	.3	1568	147	.46	2330	95
Standard Dev.	.06	500	23	.07	717	15
	Germany (1852)					
Mean	.69	2270	215			
Max	.8	3648	262			
Min	.52	1407	147			
Standard Dev.	.06	625	23			

Total	I_g	**GDP pc**	**IM**
Mean	.66	2335	164
Max	.87	4920	396
Min	.31	885	64
Standard Deviation	.1	865	47

Where I_g is the index of marital fertility, GDP pc is gross domestic product per capita and IM is infant mortality (rate per 1000).

[81] Start year of sample in parenthesis, end date is 1913 for all countries.
[82] Gaps in sample (1864-69).

fertility and income, the null hypothesis of a unit root failed to be rejected in all cases. The same was true for infant mortality, with one exception, Belgium[83].

Therefore, there is a high risk of spurious regression (i.e. establishing astatistically significant relationship even when none exists in reality) when analysis is performed on levels. Traditionally, one solution has been to include a linear or polynomial time trend on the explanatory side, thereby 'detrending' the data. This approach does not help to solve the problem of a non-constant variance however. A better solution is to first difference the data, and use these in place of the original levels (providing they themselves are stationary). This approach has the penalty of washing out any level effects – any inference must therefore concern the effects of changes. This changes the nature of the underlying test, as mentioned before. The testable hypothesis must re-expressed in terms of *changes*: changes in the fertility rate should respond positively to income changes *before the decline of fertility*, and negatively thereafter.

Serial correlation was present in almost all series, as indicated by the Durban Watson statistic from exploratory OLS regressions. This may represent a certain inertia/trend in fertility rates, where on a year to year basis they may be quite 'sticky'. This means that while the estimated coefficient estimates are consistent, their standard errors are biased downwards and the R^2 is overestimated. Various techniques have been developed to deal with the problem of autocorrelated residuals, one of which is Cochrane-Orcutt regression. This method assumes that the errors are correlated with a one year lag, and includes rho (ρ) times the lag of the dependent variable on the right hand side of the model. The idea is to dynamically model the error component, as illustrated in the following:

Take the model

$$Y_t = \beta_0 + \beta_1 X_t + u_t$$

Where the error term is autocorrelated:

[83] However, the null of unit root was only rejected at the 10% level when 3 lags of infant mortality were included.

$$u_t = \rho u_{t-1} + e_t$$

Where: Y_t = the dependant variable at time t, X_t = the independent variable at time t, u_t = the serially correlated residual, β_n = the parameters of the model, ρ= The coefficient of autocorrelation, e_t = 'white noise'

Using the previous year's model:

$$Y_{t-1} = \beta_0 + \beta_1 X_{t-1} + u_{t-1}$$

And multiplying by ρ gives

$$\rho Y_{t-1} = \rho\beta_0 + \rho\beta_1 X_{t-1} + \rho u_{t-1}$$

Subtracting this from the first equation:

$$Y_t - \rho Y_{t-1} = (1-\rho)\beta_0 + (\rho\beta_1 X_t - \rho\beta 1 X_{t-1}) + u_t - \rho u_{t-1}$$

$$= (1-\rho)\beta_0 + \beta_1(X_t - \rho X_{t-1}) + e_t$$

A Prais-Winsten transformation is used to keep the first observation (as the Cochrane Orcutt method uses first differences in the explanatory variables to calculate ρ, the coefficient of autocorrelation).

The model, being integrated of I-1, will explain the variation in the difference of the dependent variable, $F_t - F_{t-1}$. The specification is now:

$$(F_t - F_{t-1}) = C + (Y_t - Y_{t-1}) + (Y_t^2 - Y_{t-1}^2) + (IM_t - IM_{t-1}) + u_t$$

$$u_t = \rho u_{t-1} + \varepsilon_t$$

This does not change the underlying theoretical pattern: Growth in income will positively affect fertility changes, up to a turning point; thereafter the relationship will be negative.

The results of the Prais-Winsten regressions are reported in table 3.5 and indicate the presence of and inverted U income-fertility relationship for 6 out of 11 countries tested. These countries are Austria, Belgium, Finland, France, Germany and Switzerland. For Denmark, the Netherlands, Norway, Sweden and England and Wales there is no evidence for the inverted U hypothesis in the aggregate level data. For those countries where a significant income fertility relationship was detected, turning point income values and corresponding years were calculated. For all of these countries the turning point in the income-fertility relationship occurs after the onset of fertility decline (as indicated by the Zivot Andrews tests). Therefore the macro level evidence for a causal relationship between income growth and fertility decline, acting via a threshold effect, is non existent. The microeconomic theory fails this 'weak' test. These results are roughly consistent with Winegarden and Wheelers previous analysis (1992).

Table 3.5: Prais Winsten Regression Results

Country	GDPpc	GDPpc Squared	Infant Mortality	Constant	Rho	Adj. R2
Austria	3.66E-04**	-5.69E-08*	6.50E-04**	-3.82E-03	-0.46	0.01
Belgium	4.64E-04**	-5.38E-08*	4.96E-05	-1.11E-02***	-0.30	0.02
Denmark	2.68E-05	-1.63E-08	3.94E-04***	-2.38E-04	-0.50	0.14
Finland	2.00E-03***	-5.51E-07***	2.73E-04***	-9.26E-03**	-0.20	0.53
France	1.72E-04**	-2.49E-08*	-1.72E-05	-4.66E-03***	-0.60	0.12
Germany	6.30E-04***	-1.18E-07***	2.11E-04	-3.96E-03	-0.48	0.21
Netherlands	3.68E-04	-5.51E-08	-1.13E-04	-4.74E-03**	-0.77	0.02
Norway	-6.61E-05	2.24E-09	1.19E-04	-7.73E-04	0.04	-0.04
Sweden	1.91E-04	-3.96E-08	5.92E-04***	-2.52E-03	0.02	0.08
Switzerland	2.16E-04***	-2.92E-08***	-3.67E-06	-4.29E-03**	0.03	0.43
England	1.39E-04	-1.61E-08	-1.56E-04	-4.42E-03***	-0.42	0.01

Significance: * $P<0.10$, ** $P<0.05$, *** $P<0.01$

.

Table 3.6: Turning Point Years

Country	Tuning point GDPpc	Turning Point Year	Year of Structural Break in Fertility
Austria	3220	1907	1903
Belgium	4315	Post 1913	1874
Finland	1815	1907	1887
France	3446	1912	1776
Germany	2671	1895	1877
Switzerland	3705	1899	1884

To summarise, income growth cannot be directly related to fertility decline at the macro level, even when allowance is made for a non-linear income-fertility relationship with varying country specific income thresholds. This analysis fails to find the macro level evidence for the Economic theory of fertility. In common with the Princeton project, the level of analysis is highly aggregated and fails to account for within country variation.

Section 3.6: Conclusion

This chapter has re-examined the macro level economic correlates of the fertility transition in Europe. Relative to the EFP's results, the re-dating of the onset of fertility decline for ten European countries resulted in earlier estimates of the fertility transition for every country tested. However, the level of economic development still varied widely at the year of fertility decline. Testing the microeconomic theory of fertility for its implied macro level patterns resulted in its failure via both a 'strong' and 'weak' test.

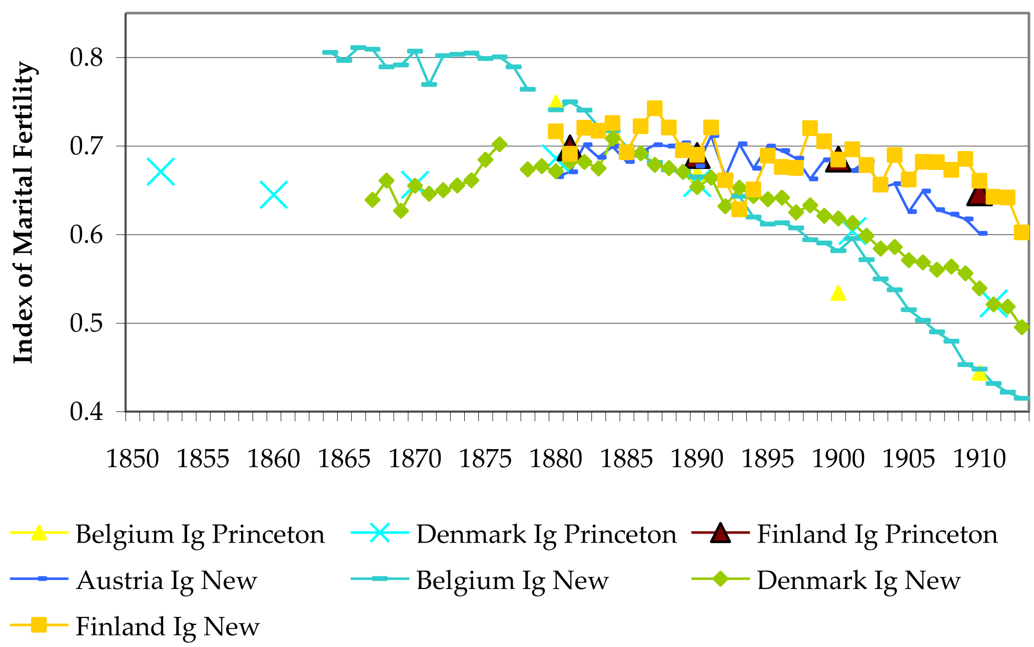
This analysis suggests a number of ways forward. Firstly, dis-aggregation is essential as the national level data hides a great deal of within country variation. However, the economic theory needs to provide some explanation of why fertility declined at different points in time for many countries in Europe. The theory does not fit the empirical record at the national level, and this needs to be explained. Further, the economic theory should explicitly incorporate important elements evident from other disciplines, as discussed in chapter two. Most importantly, I believe, is the incorporation of evolutionary reasoning with respect to fertility decisions. Couples do not decide on a family size in isolation (as they do in the microeconomic theory of fertility) but are influenced by their reference groups. Movements in variables such as the degree of economic inequality can shift the 'rules' on social mobility and introduce new climates of social competitiveness. Here is where we may find the most important economic variable related to couples family size – not absolute income or wealth but relative socio-economic status.

In conclusion, this chapter underlines the point that we cannot link the conventionally used measures of socioeconomic development to the onset of fertility decline in 19th century Europe. However, I believe that we have not specified correctly the relevant socioeconomic measures that determine aggregate and individual fertility. In particular, I would like to propose the level of economic inequality and the environment for social mobility as being highly relevant variables for the understanding of fertility decisions. These ideas are discussed, developed and tested in chapter six of this thesis.

Appendix to Chapter 3

Below I have charted my estimates of annual marital fertility (I_g). Inspection of these charts reveals the reliability of the technique employed, and also the considerable inter-censal variation.

Figure 3.4: Comparison of Annual Fertility Estimates with Census Year Estimates



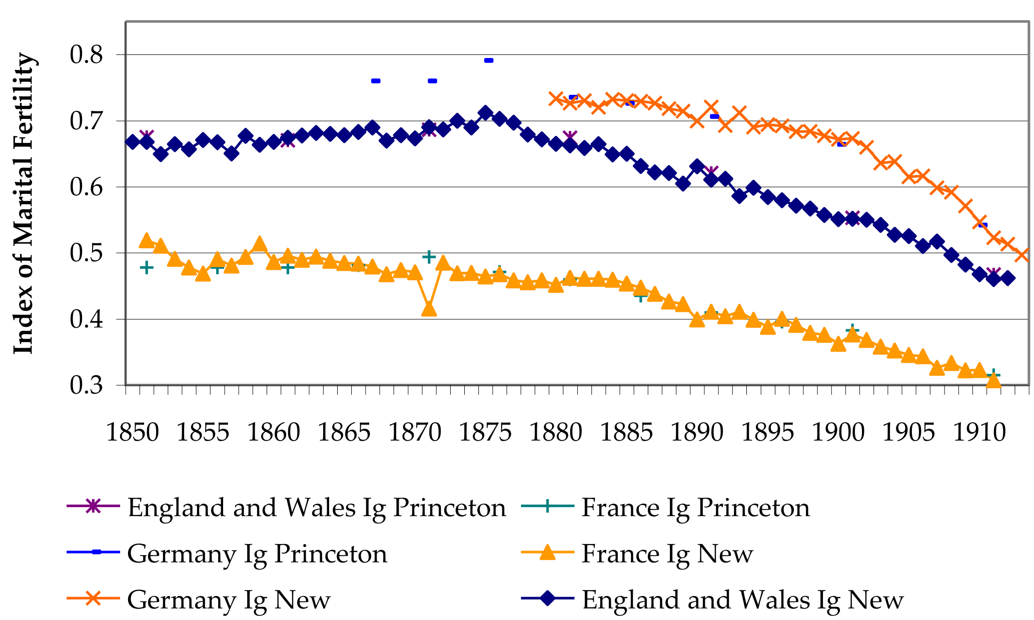
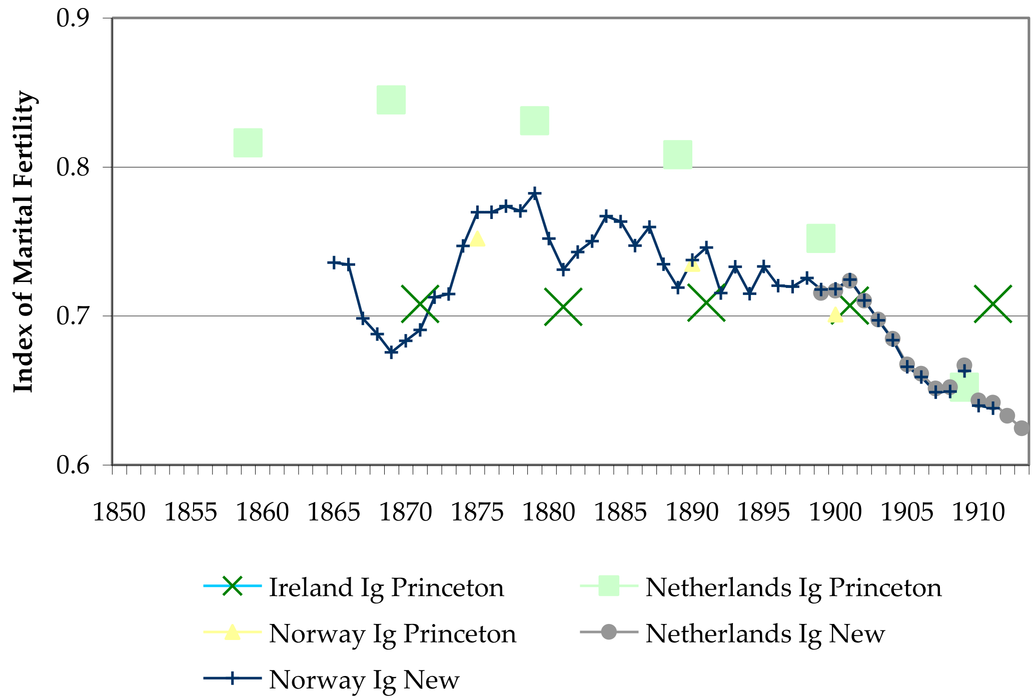


Figure 3.4 ctd.



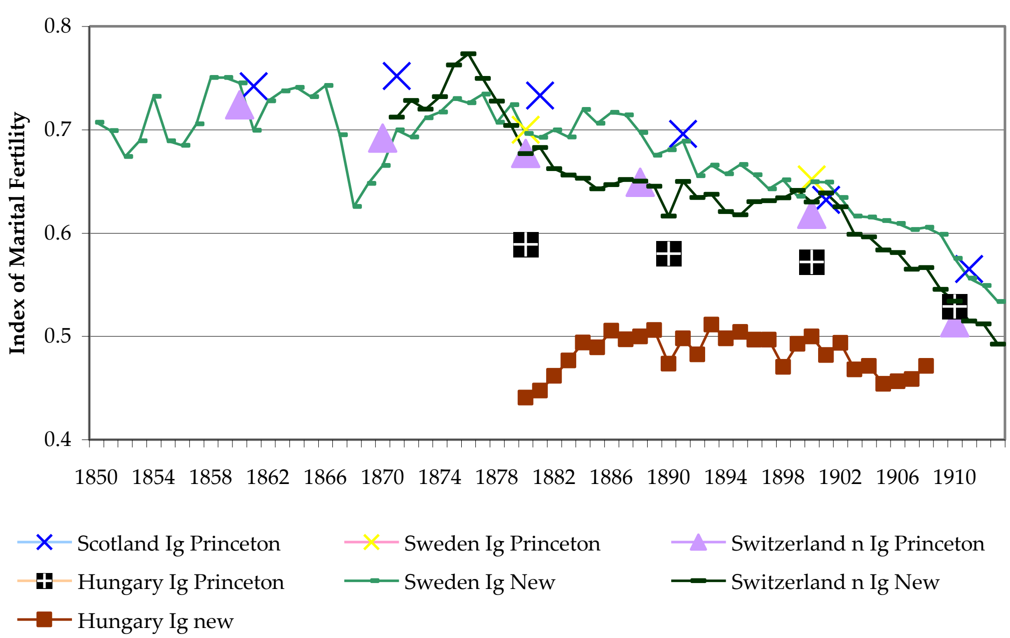
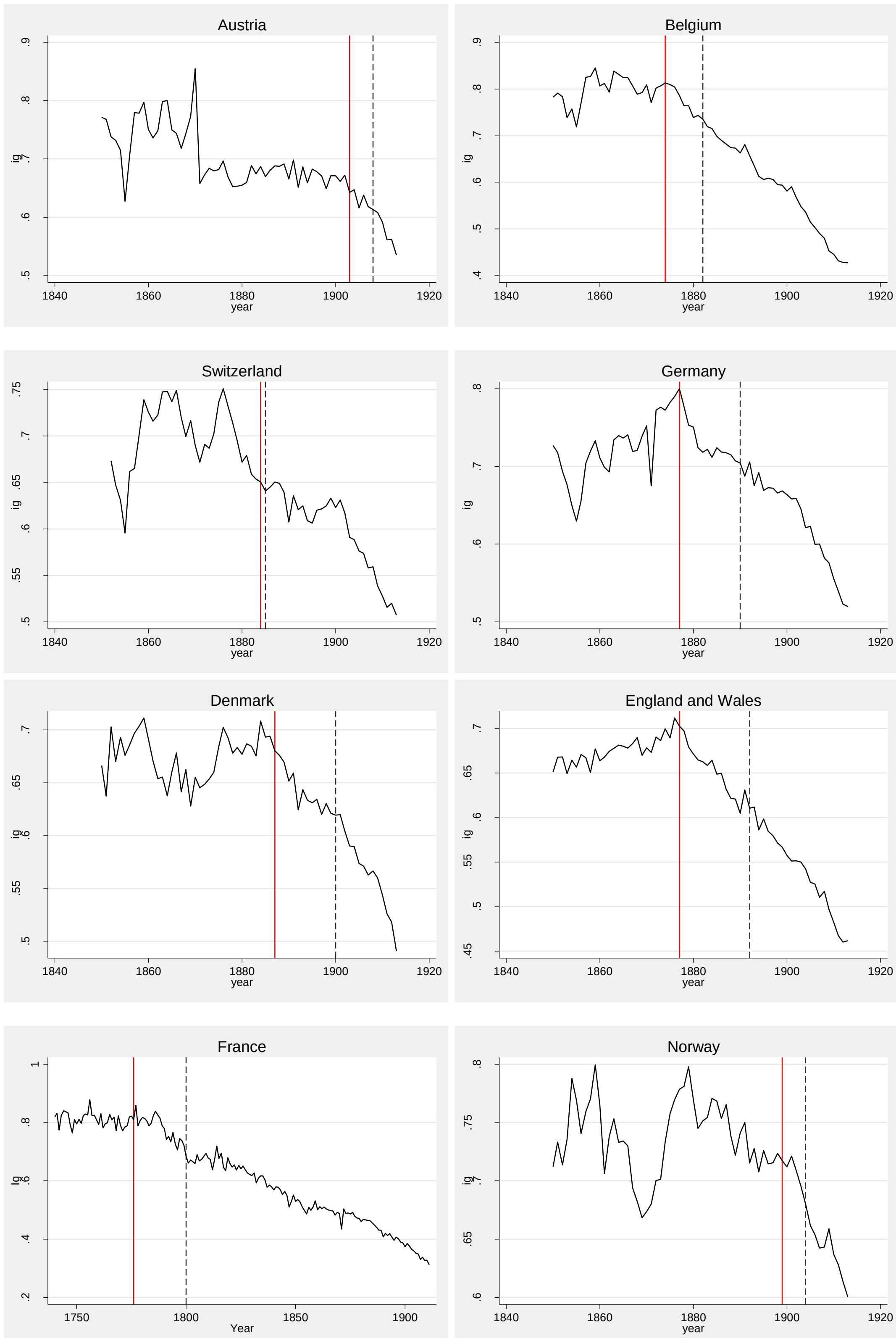
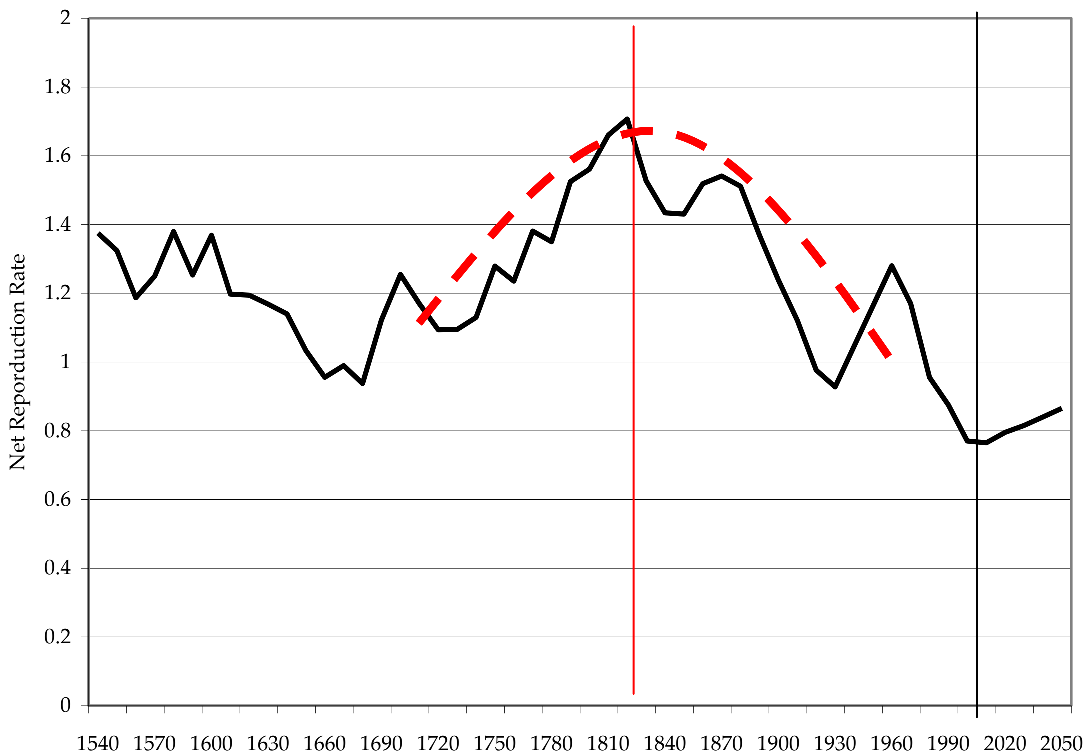


Figure 3.5: Graphs of Structural Breaks in the Time Series of Marital Fertility (Ig)



Are we measuring the right thing? From the economic model of fertility, surely the NRR is the best measure of fertility

Figure 3.6: The Net Reproduction Rate in the 'Developed World' 1540-2050

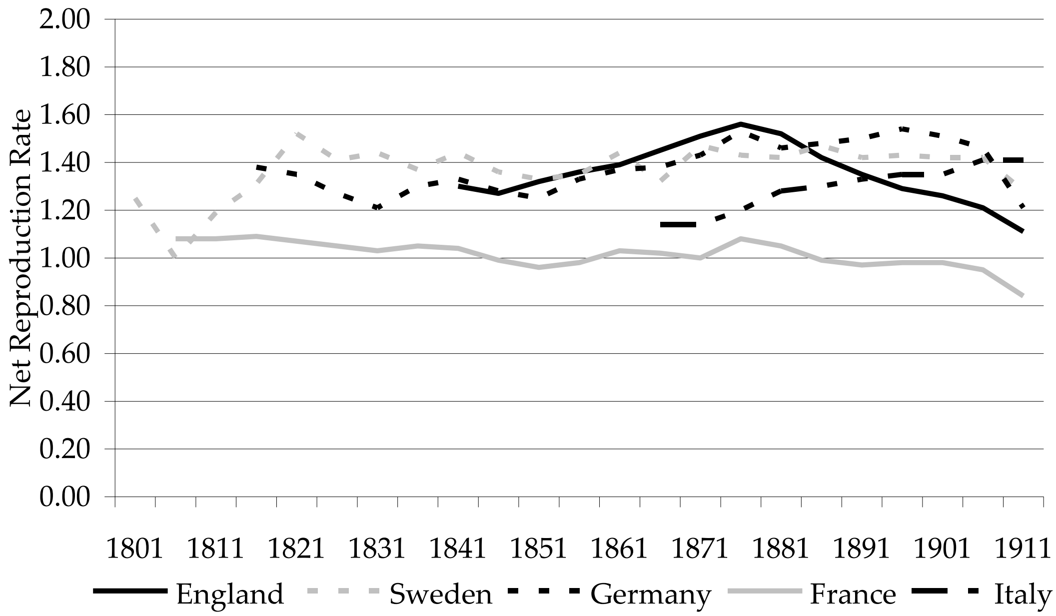


Source: 1540-1910 (England): Source: Wrigley et al. 1981 p.528-9, 1910-1930 (England): Depoid 1941 p.39, 1950-2050 (Most Developed Countries): UN 2009.

Figure 3.4 plots the net reproduction rate for the 'developed' world of the 21st century from 1540 to 2050 (post 2000 rates are of course projections). Examining the very long run raises issues that are hidden by analysing the 19th century alone. Visually, a sustained decline is evidenced from the 1820s. The data used here was from England (1540-1910), and this date is far earlier than the any previous dating (including that undertaken in this chapter) of the fertility transition in England. Further, the most striking pattern in the graph is the presence of an inverted 'U' fertility pattern from 1750-2000. Just as the industrial revolution is beginning in England, we have a coincident rise in the level of net fertility, related to both underlying increases in births per women and improvements in mortality conditions. This suggests that fertility must be analysed over the very long run. Constricting analysis to the period of decline may not be the ideal empirical strategy. In chapter 4A, Greg Clark and I analyse the wealth-fertility relationship at the individual level over the very long run in England, 1500-1914.

The net reproduction rate, a measure of fertility adjusted for mortality, shows very different patterns than the index of marital fertility (as illustrated in figure 3.7). For instance, no decline in the NRR is visible for Germany before World War I, even though the index of marital fertility enters a sustained decline in 1877. The NRR must be considered the best estimates of *realized* fertility. In this sense it is the closest demographic measure for the number of surviving children demanded in the theoretical economic models. The disaggregated analyses in the rest of this thesis concentrate on measure of fertility such as the NRR.

Figure 3.7: Net Reproduction Rate in Europe, 1801-1911



Source: Depoid 1941 p.39

Sources for Table 3.3:

For France, 1800 value used for Urbanisation,		
For Germany, 1882 values used		
Sources:		
	Maddison, A., *The world economy: historical statistics* (2004)	
GDP	.	
Population		Rothenbacher, F., *The European population, 1850-1950* (2002)
Labour force	Sectoral shares	Bairoch *The working population and its structure* (1968),
	Female labour force participation	Bairoch, P. and Goertz, G. *Factors of Urbanisation in the Nineteenth Century Developed Countries:*
	Urbanisation	A Descriptive and Econometric Analysis Urban Studies (1986)
Education	Enrolment	Mitchell, B.R., *International historical statistics: Europe, 1750-2000* (2003)
	Schooling'	Lindert, P *Growing Public: Social Spending and Economic Growth since the Eighteenth Century* (2004)
	Literacy	Flora, P, Kraus and Pfenning, W., State, economy and society in Western Europe 1815-1975 (1987)

France, Agriculture proportion and 1800 Infant Mortality rate (Watkins 1986 p.394).

Chapter 4: Marital Fertility and Wealth in England, 1800-1914

Abstract

This chapter uses the wills of 3,000 English testators, from 1800-1920, for the analysis of the relationship between wealth and fertility during the demographic transition. The methodology employed to extract relevant data from the source material is described in detail. Following this, robustness checks are employed, and the testator dataset is checked for representativeness with respect to the general population. The analysis discovers two large and opposing patterns – a positive association of wealth and net fertility and a negative association of occupational status and net fertility. I demonstrate that it was the poorest members of the top occupational status classes who restricted fertility first in England. This suggests that the decline in fertility may have been related to a desire to avoid downward social mobility. Through analysing the changing relationship between occupational status and wealth, this hypothesis is supported.

Section 4.1: Introduction

England and Wales experienced sustained aggregate fertility decline in 1877. Chapter 3's national Analysis failed to find any economic correlates with this transition. In fact, fertility decline *followed* the Industrial Revolution in England and Wales by over a century. Further, tests for a Beckerian inverted U income –fertility relationship failed to find any support for this mechanism as a causal force in the fertility transition. However, the study of fertility at such a high level of aggregation must be accompanied by a micro level analysis for a complete picture. This chapter analyses the link between wealth and fertility at the individual level for the period of fertility decline in England.

The fundamental research question of this chapter is to ask: Was there a relationship between wealth and fertility during the demographic transition in

England? There is no previous work on this question, although this relationship is a central theme in explanatory models of the fertility transition, for example the microeconomic theory of fertility and demographic transition theory. It is theorized that as the absolute level of real wealth increases, people will switch from demanding child quantity to child quantity. Is this what happened in England during the 19th century? For these models to be valid we must observe a strong and significant association between wealth and fertility pre-transition, which then switches to a negative association. With individual level data collected here, we can analyse smaller and smaller sub-groups. Following the thorough account of the data collection and generation processes, I test the data for these patterns.

The primary source for both the wealth and fertility information is the wills of male testators who died during the 19th century in England. These types of records have limitations and this chapter outlines them fully in a comprehensive data and data generation section (section 4.3). This section details the methodology employed to extract wealth and fertility information along with robustness checks on the final data. Regarding fertility, it must be noted at the outset that wills can only record *net* fertility. This is because wills were a legal device to determine the destination of an individual's cash and property wealth. These bequests, of course, would only be designated to surviving children at the time of the writing of the will. Wills represent a much underutilized resource in the analysis of net fertility and wealth and status.

Table 4.1: Children Born Per Married Man, 1891-1911, England

Occupation	**1891**	**1901**	**1911**
Professional	4.9	4.7	3.8
Miner	6.7	6.5	5.9
Construction labourer	6.4	5.6	5.4
General labourer	6.4	6.4	5.2
Agricultural labourer	6.6	5.9	4.9

Source: Garret et al 2001.

Any trace of this pattern seems to have disappeared by the 19th century, as the table 4.1 illustrates. The professional classes have significantly smaller family sizes than those of the rest of the population. A pattern is implied by these observations: Somewhere between the 17th and 19th century, the relationship between net fertility and wealth, or occupational status, reverses. The purpose of this chapter will be to describe, account and explain the changing nature of the wealth-fertility relationship in England during the 19th century.

Higher occupational status implies higher wealth. However, occupational status certainly does not equal wealth. The consensus in the literature points to a *negative* net fertility-occupational status relationship during the 19th century in England (discussed in the next section). However this does not necessarily mean that the relationship with wealth is negative too. Further, a possible source for the decline in fertility may be the changing relationship between status and wealth itself. A pre-modern static society typically exhibits a high degree of association between status and wealth. As economies modernize, the old rules break down. Industrialists and others rise to challenge the aristocracy for the level of wealth held. These dynamics may spur elements of the population to employ family limitation as a strategy to either achieve upward status, or wealth, mobility. Others may be induced to practice family limitation in order to preserve status, or the concentration of wealth. Examining the link between status, wealth and fertility can enlighten these propositions about the demographic transition in England.

The rest of this chapter is comprised of five sections. Section 4.2 provides some background on previous research into the wealth-fertility relationship in England. Section 4.3 details the methodology employed to generate the data from the primary sources and also its summary characteristics. Section 4.4 analyses the mechanics behind the fertility patterns, while section 4.5 evaluates explanations for the English fertility transition. Section 5.6 Concludes.

Section 4.2: Background

As mentioned previously, high socio-economic status is strongly associated with increased reproductive success before the demographic transition. During the transition the relationship appears to turns negative. Skirbekk (2008) has recently collected multiple studies on this relationship, and his findings, in terms of the reproductive advantage of the high status groups relative to the low, for England, are listed in table 4.2. Each study reported here used a different definitional schema, and Skirbekk transformed the underlying data to be comparable with other studies. Quite simply he divided the mean number of children for the top status group by that of the bottom. The reported numbers can be interpreted as the percentage difference between the top and bottom status groups. These collated estimates display a high degree of variance but the overall pattern is strikingly clear. Before the 19th century, membership of the top status group was associated a substantially bigger family than that of the bottom status group. Some time during the mid 19th century this relationship flips, and status is negatively associated with family size. Nowadays, this relationship appears to be non-existent.

What were the characteristics of the studies behind these numbers? Here I briefly summarise a selection of the research behind table 4.2. Hollingsworth analysed 1908 individuals who were the direct descendants of "British kings, queens, dukes or duchesses" born between 1330 and 1954 (1957 p.4). The calculated family sizes were incorporated by Skirbekk into his analysis (2008) and he compared these numbers with those of the general population. These values showed that this elite group held a massive reproductive advantage over the general population. Hughes (1986) compared fertility of farmers and skilled craftsmen for eight Lancashire parishes between 1753 and 1812. He found a small advantage for farmers in terms of children ever born, but a more significant advantage in terms of net fertility, children successfully raised to maturity[84]. Scott and Duncan (2000) studied the parish of Penrith in Cumbria (Northern England) from 1600-1800, distinguishing between elites (landowners, merchants, etc.), tradesmen (Blacksmiths, Butchers, etc.) and subsistence (subsistence farmers) categories[85]. Elites had significantly higher marital fertility than subsistence farmers (a total marital fertility rate of 7.6 and 6.0 respectively) and marginally higher marital fertility than tradesmen (6.9). Given that infant mortality was considerably lower for the elites (especially amongst girls); this would have resulted in net family sizes significantly larger for the elite groups relative to both the tradesmen and subsistence farmers (Scott and Duncan 2000 p.75).

Table 4.2: The Reproductive Advantage of Status in England, 1270-1970

Period	Fertility of high relative to low status group	Author
1270	114.29%	Razi (1980)
1350	3.70 to 60.00%	Hollingsworth (1957)
1600	26.67%	Scott and Duncan (2000)
1700	24.15 to 96.30%	Hollingsworth (1957), Hughes (1986)
1850/51	-19.03 to + 65.00%	Hollingsworth (1957), Innes (1938)
1861	-15.53%	Thompson and Lewis (1965)
1871	-15.31%	Innes (1938)
1881	-57.14%	Newsholme and Stevenson (1906)
1891	-25.04%	Innes (1938)
1911	-37.61% to -35.67%	Vining (1986), Haines (1989)
1951	-44.82%	Haines (1989)
1955	-33.71% to 9.66%	Scott (1958)
1970	0.00%	Pérusse (1993)

Source: Skirbekk 2008

[84] Surviving to age 21 (Hughes 1986 p.111).
[85] The mean values for the value of inventories at death were £293 for elites and £44 for tradesmen (Scott and Duncan 2000 p.73).

The appearance of a sudden reversal in the status-fertility relationship can be focused upon by reference to the 1911 'fertility' census of England and Wales. The 1911 census of England and Wales was the first British census to include questions on duration of marriage and on numbers of ever born and surviving children. This allowed the breakdown of fertility trends not only by locality but by occupation, and also by 'occupational class'. Stevenson's analysis (1920) of the 1911 census data clearly demonstrated the lower fertility rates of the top 'social class'. His designation scheme is used, and detailed in full later, in this analysis. The occupational scale ran from those at the top class I (the professional and upper classes), class II (an intermediate class, farmers and shop keepers), class III (skilled workmen) and classes IV and V (the working classes). For marriages dating from the 1850s, class I register by far the lowest rates relative to the other classes (1920 p.416). In general, Stevenson described the fertility decline as spreading "from above downwards", with the lower infant mortality rates of the higher social orders failing "to compensate for their low fertility" (1920 p.431). Since Stevenson, many other scholars have used the 1911 census data to detect class-fertility trends (Innes 1938,, Haines 1989, Woods 2000). The following chart, figure 4.1, plots surviving children against occupational class for different marriage periods. This chart follows very closely the style and content of a similar chart in Woods (1984 Figure 3, p. 185), which neatly summaries the class-fertility story[86].

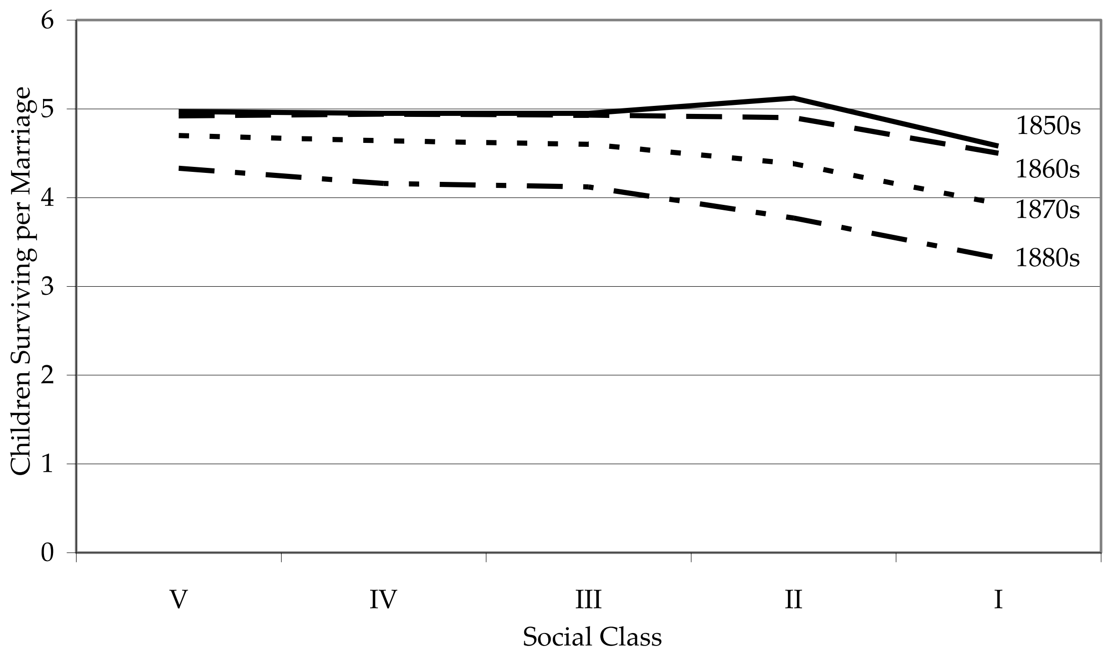
As already noted – class I always have the lowest fertility rates. The general decline in overall fertility rates (net rates graphed above) can be seen by the falling level of the line joining the social classes in each marriage cohort between 1851 and 1886. Secondly, the slope of the relationship, which starts out relatively flat, becomes sharply

[86] In using the 1911 census data in any analysis, two potential biases must be taken into account. Firstly, the sample consists only of women (and also their husbands) who survived to census night. This has the effect of selecting for couples with lower mortality. As Haines points out, this has the effect of biasing fertility (and class fertility differential) estimates downwards as those women who have high mortality because of frequent life course pregnancies will be excluded from the sample (1989 p.311). Secondly, differential age at marriage patterns between classes could result in the fertility divergence. Stevenson standardised all fertility measures for this and his results stood firm.

negative for the later marriage cohorts[87]. This pattern indicates a widening of class-fertility differentials during the period of fertility decline, and this pattern is supported by Haines later work with the same data (1989 p. 321).

In summary, previous work on class fertility differentials in England and Wales indicate the presence of a strong negative class-fertility relationship during the period of fertility decline. This pattern has been noted for other fertility transitions. As Haines states "It appears, for England and Wales, the United States, France, and Norway, at least that fertility decline was 'led' by the middle and upper classes. Social and economic elites apparently did act as leader in modifying this most basic of activities-human reproduction" (as quoted by Woods (2000 p. 119)).

Figure 4. 1: Class-Fertility Differentials, 1860-80, England



Source: GRO 1923: Census of England and Wales, 1911, Volume XIII: Fertility of Marriage, Part II, p. xcvii.

[87] The class-fertility relationship would be even greater if gross fertility were used here (children ever born). The use of surviving children serves to flatten the relationship between social class and fertility (Woods 2000 p.119).

The purpose of this analysis is to add to the existing literature by including an important and under researched economic variable into our empirical knowledge of the demographic transition in England. This variable is the level of real wealth held at the time of death. To generate this data, I had to construct a sample and, of course, a sampling strategy. The next section fully details this process.

Section 4.3.1: The Data and Data Generation Methodology

The wills used in this study come from a range of sources and the strategy was to collect at least 400 wills for each decade of the second half of the 19th century, and 200 per decade for the first half. The major distinction in the sources is due to the administrative changes in 1858. Before 1858, probate of a will could be granted at a number of different ecclesiastical courts. For wealthier individuals, whose property lay in multiple parishes, a higher court such as the prerogative court of Canterbury or York was required for the administration of the will. After 1858, the granting of probate for all wills in England and Wales was the responsibility of the principal probate registry in London. Thus, all post 1858 wills were collected from the principle probate registry in London. Pre 1858 wills were collected from the National Archives at Kew and the local history archives at Essex. Additional wills were added to the database from amateur genealogists who had posted transcripts on the internet. Please see the reference section for a complete listing of all the sources used.

Wills were sampled for testators dying in Essex, Ipswich and Surrey. Figure 4.2 reports the number of observations by county of origin for the death cohorts of 1820 to 1910. In contrast to other European countries, English regional fertility patterns varied little during this period. As Wilson and Woods state "In Victorian England and Wales demographic variations were local rather than regional (1991 p.414). Further, Wrigley and Schofield stress the “remarkable homogeneity of the patterns” observed in the data for individual English parishes (1991 p.510) For this reason, it makes sense to focus in on representative English counties, with the appropriate level of heterogeneity with respect to the urban and rural population.

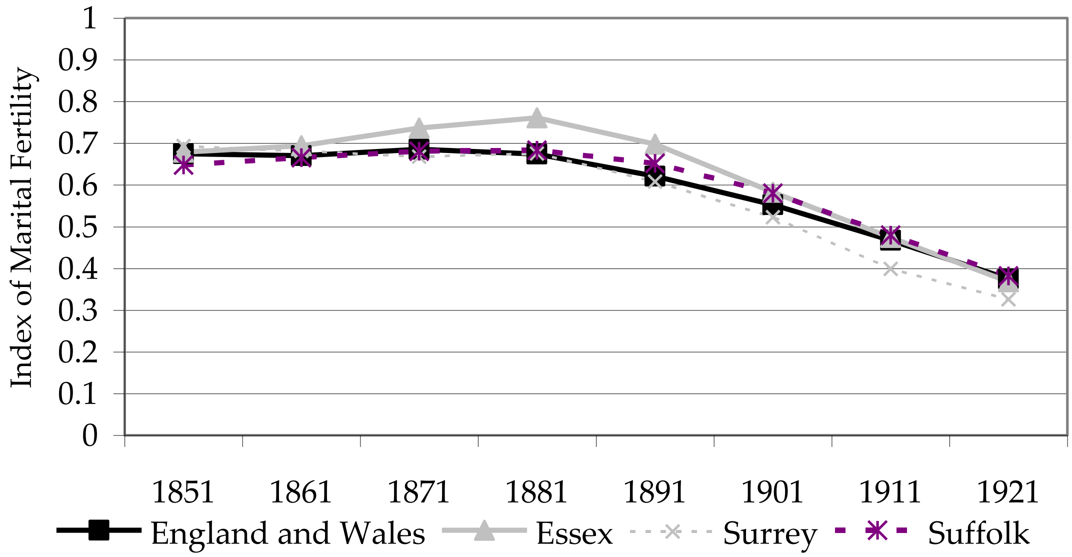
Figure 4.2: Geographical Composition of the Sample

Source: Wills Database

Figure 4.3 plots the level of marital fertility in the sample counties alongside that of England and Wales as a whole. Essex has high marital fertility relative to the national level, but the time trend is identical. Surry and Suffolk have marital fertility levels which almost exactly match the national trend, but with a steeper decline for surrey towards the end of the 19th century. These observations are consistent with analysis of the coefficient of variation in marital fertility in England. This variation is exceptionally low relative to other European countries.

The location of these counties is plotted in figure 4.4 alongside a closer map displaying the urban/rural composition at the 1910 census (urban areas are displayed in black, rural in white). The thick black area in between Surrey and Essex is London.

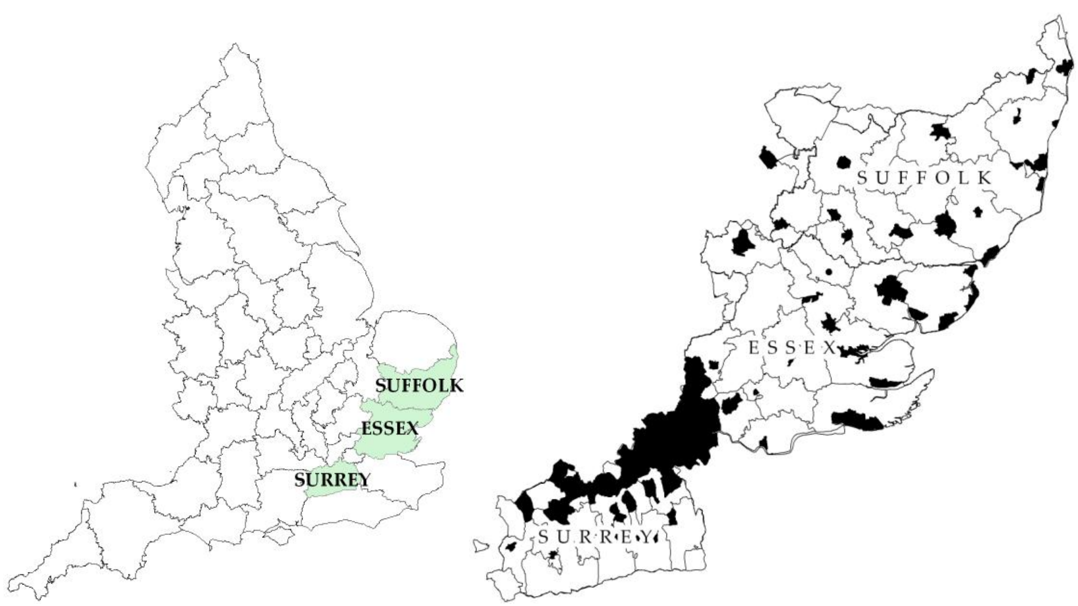
Figure 4.3: The Index of Marital Fertility, 1851-1921



Source: Coale and Treadway 1986 pp.88-93, raw data available at

http://opr.princeton.edu/archive/pefp/demog.asp

Figure 4.4: Map of the Sample Counties and Urban/Rural Parishes



Source: GBHGIS 2009.

Table 4.3 reports the urbanization rates for the sample counties, and England and Wales as a whole. For most of the sample period (deaths 1800-1920), the sample counties are relatively more rural than the national average. However, each of the counties is rapidly converging to the national trend. By 1901, Essex is more urbanized than the national average and Surrey is not far behind – the urbanization rates for these three units differ by less than 10%. Suffolk is consistently more rural than the other sample counties and the national trend. It must be noted that the entire Suffolk sample is from Ipswich, and is therefore urban. Research in historical demography has consistently found significant urban-rural demographic differentials. In the substantive analysis section of this chapter, a testator's origin is controlled for (section 4.4), and urban-rural differences are explored fully.

Table 4.3: Urbanisation in England, 1871-1901

Year	England and Wales	Essex	Surrey	Suffolk
1871	0.62	0.35	-	0.34
1881	0.68	0.52	0.54	0.35
1891	0.72	0.67	0.60	0.38
1901	0.77	0.78	0.71	0.47

Source: Coale and Treadway 1986 pp.88-93, raw data available at http://opr.princeton.edu/archive/pefp/demog.asp

A consistent strategy was employed when coding the wills and the methodology employed is illustrated by reference to a specific example in the following.

Will Coding Example: A typical will

The Pre 1858 wills used in this study contained only copies of the will itself. Each post 1858 will would contain a front-sheet and transcript of the individual's will. The front-sheet was the source for the following information

1. Date of probate

Figure 4.5: Example of the Front Sheet of a Post 1858 Will

1 ON the 23rd day of March 18 72

the Will ~~with Codicil thereto~~ of

2 John Birdseye late of

~~formerly of~~

3 Kelvedon in the County of Essex Gentleman

~~but late of~~

4 deceased, who died on the 24th day of February 18 72

at Kelvedon aforesaid.

was proved in the Principal Registry of Her Majesty's Court of Probate, by the Oath

of

5 John Birdseye of Clapham Common in the County of Surrey Draper the Son of the said Deceased

~~the sole~~ one of the Executors named in the said Will he having been first sworn duly to administer, power being reserved of granting Probate of the said Will ~~and~~

6 to Sarah Birdseye Spinster the Daughter of the said Deceased the other Executor named in the said Will.

~~the other Executor having renounced the Probate and Execution of the said Will~~

7

Effects under £ 600.

R. 8 No Leaseholds]

G [47] 8000 2/72

Source: Will of John Birdseye, Gentleman. Date of Grant Entry: 23/03/1872 at the Principal Probate Registry London, Folio 149. Available at First Avenue House, High Holborn, London.

2. Name of deceased
3. Address and occupation of deceased
4. Date of death
5. Executor of will (recorded if family member)
6. Person granted probate (recorded if family member)

Gross value of the effects (Post 1880 wills also record a 'net' value). Pre 1880 wills record the estimated value of the deceased's estate in value bands – see the discussion later in this section.

7. Duty band valuation
8. Indicator of the possession of leasehold property

Information points 1-8 are illustrated in the following example of the front sheet of the will of John Birdseye, gentleman of Kelvedon who died in 1872. This front-sheet information corresponded to the information recorded from the Probate indices at the Principal Registry of the Family Division, First Avenue House, High Holborn, WC1 6NP, London. This information was used to locate individuals in the relevant last census before death. Only those who could be found in the census made the sample and the census coding will be discussed later in this section.

Once the front sheet and census information were recorded, the will was read carefully and a systematic technique was employed to extract the relevant information for the study. From the will, the following information was recorded (Note: not every will provided complete information for each variable).

1. Name
2. Wife's name
3. Marital Status

Either "M" – married, "W" – widowed, or "S"- single. Where no wife or children are mentioned, individuals are recorded as single

4. Father, mother, brother or sister

Used to identify father-son relationships in the data

5. Named Sons
6. Named daughters
7. Number of married daughters
8. Number of children under 21
9. Number of grandchildren

As the estimated value of the estate reported on the front-sheet omitted property, it was crucially important to record all mentions of property in the will. The following indicators were measured for all wills:

10. Mention of Real property?
11. Number of houses
12. Number of town houses
13. Number of London houses
14. Number of 'Mansions'
15. Number of business premises, mills. Etc.

Further, it was important to include all mentions of land.

16. Mention of land?
17. Number of parishes that land is held in.
18. Number of land holdings
19. Minimum total land area

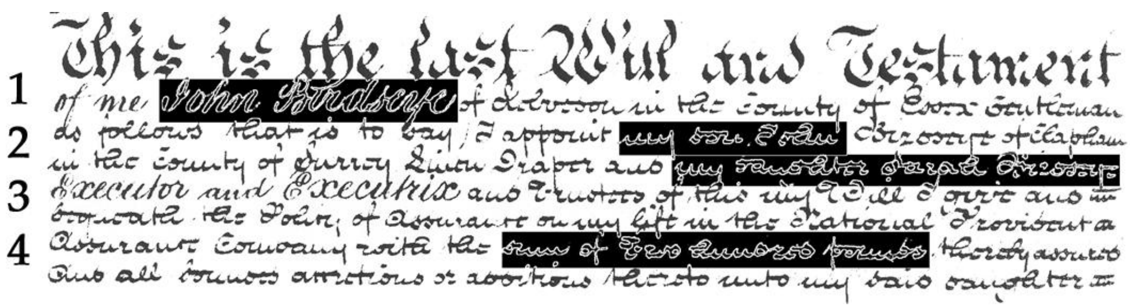
For a small number of the Pre 1840 wills in the database, no estimate of the gross value of the estate was available. In this case, I employed an alternative strategy. I coded the wills for all information that could indicate the level of wealth held. The variables searched for were:

20. All bequests to the poor
21. All bequests to related individuals
22. All bequests to others
23. Annuities to wife
24. Annuities to others

Finally, I added indicator variables for the quality of the family and wealth information. For example, a complete will with detailed and full family information and specific mentions of property could be used for the analysis of wealth and fertility. If the mentioned property was non-specific, but family information was complete – the recorded data could be included for calculating an overall fertility rate but not for the analysis of wealth and fertility together. Similarly those with accurate wealth information but incomplete family information could contribute to the wealth description but not the wealth-fertility analysis.

Figures 4.6-.8 illustrate examples of wills coded, with the indicated numbers corresponding to the fields listed previous. The first example is (as before) the will of John Birdseye, gentleman of Kelvedon.

Figure 4.6: Example will – Segment 1



Source: Will of John Birdseye, testator database.

The opening lines of this will, as with 99% of all other wills in the sample provide information on abode, occupation and close family. John Birdseye (1) names his son John (2) and daughter Sarah (3) as executors of his will. Further, a life assurance policy of £200 is mentioned and given to his daughter. The sum total of bequest information such as this was used for the earlier wills because no estimate of the estate valuation was provided (pre 1840s).

In segment 2, John Birdseye mentions his wife Mary (2), indicating his marital

Figure 4.7: Example will – Segment 2

2,3 Sarah Birdseye for her own absolute use and benefit And I give to my
[redacted] Birdseye All my household furniture plate linen china
and other household effects for her own use And I devise to my said wife
10,11 Mary Birdseye All those my freehold messuages or tenements with the
yards gardens and appurtenances thereto belonging at [redacted]
[redacted] in the said County of Essex and at [redacted] aforesaid
16,17,18 And also all that [redacted] in the same
County And all other if any my freehold and copyhold Estates whatsoever
and wheresoever To hold the same to my said wife for and during her

Source: Will of John Birdseye, testator database.

Figure 4.8: Example will – Segment 3

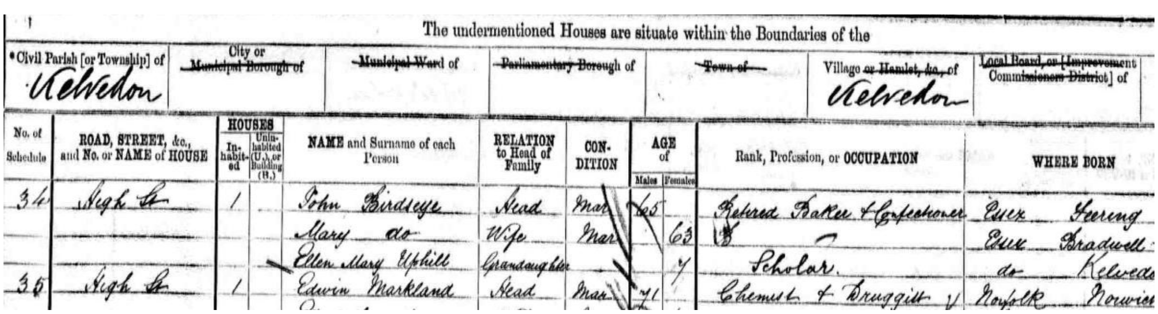
therefrom from time to time as the same shall arise to my said wife
for her life for her own use And upon the decease of my said wife I di-
rect that my said trustees for the time being shall stand possessed
of the whole of my said pecuniary trust estate (including the monies
to arise from the sale of my said freehold and Copyhold Estates and the
rents and profits thereof from the decease of my said wife until sale
thereof) Upon trust to pay and divide the same unto and equally between
5,6 [redacted] (namely [redacted] Birdseye [redacted] Birdseye the
7 said [redacted] Birdseye [redacted] of James Alpeill and [redacted]
Birdseye share and share alike except as to the share of my said da-
daughter Sarah Birdseye whose I declare shall be less by one half than
the shares of my other children on account of the bequest in her favour
hereinbefore contained And I declare it to be my intention that each
and every of my children shall take a vested interest in my trust property
immediately on my decease Provided nevertheless that if my said daughter
Elizabeth Alpeill shall depart this life in the lifetime of my said wife leaving
a child or children who shall survive my said wife then my Will is
that the share of and in my said trust estate intended for her the said
Elizabeth Alpeill as aforesaid shall go and be paid to her child or children
so surviving my said wife share and share alike if more than one
and if but one then the whole share to that one And if my said
daughter Elizabeth Alpeill shall depart this life in the lifetime of my
said wife without leaving a child who shall survive my said wife
then my Will is that the said share intended for the said Elizabeth
Alpeill shall go and be paid to her brothers and sister who shall be
living at the decease of my said wife share and share alike And lastly
Date I revoke all former Wills In witness whereof I have hereunto set my hand
of Will this [redacted]
John Birdseye — Signed by the said John Birdseye the testator in the
joint presence of us who in his presence at his request and in the presence
of each other have hereunto set our names as witnesses — Henry Siggers
Builder Kelvedon — Jno Church Clerk to Messrs Blood & Son Sols Witham
Proved at London 23rd March 1872 by the Oath of John Birdseye
the son one of the Executors to whom Admon was granted Power reserved of
making the like grant to Sarah Birdseye Spinster the daughter the other
Executor —

Source: Will of John Birdseye, testator database.

status – married (3). Property is also described in this section. John holds 2 houses – one at Broad Street Green (a village in Essex) and one at Kelvedon (10, 11), as well as one piece of freehold land at Inworth, Essex (16, 17, 18). Towards the end of the will (segment 3), John Birdseye states he has "five children" and lists each of them (5, 6). In most cases, testators indicated whether their daughters were married or single, as John does here (7). In some cases, testators indicated if their children were under 21, and also mentioned grandchildren. All of this information was recorded in the database. Finally, the date of the will was recorded. The will of John Birdseye contains accurate wealth information and also complete family information. This will can be used to understand the wealth fertility relationship. It is of approximately average length.

Once the index data had been collected, testators were searched for in the respective last census before death. The UK censuses from 1841-1901 were used. Online resources such as www.ancestry.co.uk and also the National Archives at Kew were relied upon to link the testators in the sample to their last census before death. As I have already mentioned, I first collected the Probate index data for Ipswich and Essex testators from First Avenue House. Then I searched for these individuals in the relevant census. This strategy ensured that all my observations are linked to the census returns. However, For the 1840s it was not possible to link a satisfactory number to the census. Therefore many 1840s testators were included in the analysis without census information. Dates of births were inferred for these individuals. 2135 out of 2319 post 1840 wills were linked to the census (92%).

Figure 4.9: 1871 Census Entry for John Birdseye



The undermentioned Houses are situate within the Boundaries of the

Civil Parish [or Township] of Kelvedon | City or ~~Municipal Borough~~ of | ~~Municipal Ward~~ of | ~~Parliamentary Borough~~ of | ~~Town of~~ | Village ~~or Hamlet, &c.,~~ of Kelvedon | ~~Local Board, or [Improvement Commissioners District]~~ of

No. of Schedule	ROAD, STREET, &c., and No. or NAME of HOUSE	HOUSES In-habited	HOUSES Uninhabited (U.), or Building (B.)	NAME and Surname of each Person	RELATION to Head of Family	CONDITION	AGE of Males	AGE of Females	Rank, Profession, or OCCUPATION	WHERE BORN
34	High St	1		John Birdseye	Head	Mar	65		Retired Baker & Confectioner	Essex Feering
				Mary do	Wife	Mar		63		Essex Bradwell
				Ellen Mary Uphill	Grandaughter			7	Scholar	do Kelvedon
35	High St	1		Edwin Markland	Head	Mar	71		Chemist & Druggist	Norfolk Norwich

Source: UK Census of 1871, at www.ancestry.co.uk accessed 26/02/2009

Figure 4.9 illustrates a typical census entry. Again, the testator used is John Birdseye, gentleman from Kelvedon (died 1872). Testators would be linked to the census using Name, Address, spouse and occupation. Where there was ambiguity, the testator was dropped from the sample. This meant that common names such as "John Smith" were rarely selected[88]. Once a testator was identified in the relevant census, the following information was recorded:

1. Census year
2. Surname, Name
3. Residence
4. Age at census
5. Occupation
6. Place of birth
7. Spouse name
8. Spouse's age

Once age at census had been recorded, the probate and census sources could be cross referenced to give each testator a year of birth. For John Birdseye, table 4.4 reports all the information derived from the primary sources:

The Reported Cash Value of Testator's Estates

After an individual's death, those seeking to act on authority of their will needed to be granted an act of probate. For tax reasons, the testator's estate was valued. The executors or administrators of the wills submitted estimates, and because of a fine for undervaluation "the gross valuation was always likely to be an upper estimate of an individuals worth" (Owens et al. 2006 p.386). What was included in this valuation? The probate duty was exclusively payable on *personalty* and not *realty*. Thompson

[88] There are two John Smiths in the database. One could not be linked to a census entry but his family and wealth information are included in the sample with an inferred year of birth. The other "John Smith" was linked to a census entry via a very specific address – "Skinners Farm, Theydon Mount" and a spouse called "Susannah".

Table 4.4: Example Data from John Birdseye

Variable	Value
Name	John Birdseye
Date of Death	24/02/1872
Will 'Gross Val £	600
# of Houses	2
# of Land Holdings	1
# of Children	5
# of Sons	3
# of Daughters	2
Son 1	John
Son 2	Jonathon (checked)[89]
Son 3	Thomas
Daughter 1	Sarah
Daughter 2	Elizabeth
Number of Daughters Married	1
Probate Occupation	Gentleman
Census Age	65
Year of Birth	1806
Age at Death	66
Spouse	Mary
Spouse's age	63
Spouse's year of birth	1808
Census Occupation	Retired baker and confectioner
Place of birth	Feering, Essex,
Census Residence	High st., kelvedon
Census Year	1871
ASSETS	Complete
CHILDREN	Complete
County	Essex

Source: See figures 4.5-9

summarises the issue succinctly:

"The law was that only personalty was liable to probate duty, and hence probate valuations were confined to the personalty assets left at death. All cash and near cash, and all moveable property, had the character of personalty, which thus included the moveable machinery, stock-in-trade and goodwill of a business, as well as the stocks

[89] Verified, not double entry.

and shares, furniture, pictures, plate, and other chattels that an individual possessed. Real property, which was excluded from probate evaluations, comprised land, and everything permanently attached to land, such as buildings and fixtures inside buildings like fixed plant and machinery that was deemed to be immovable"
(Thompson 1992 p.363)

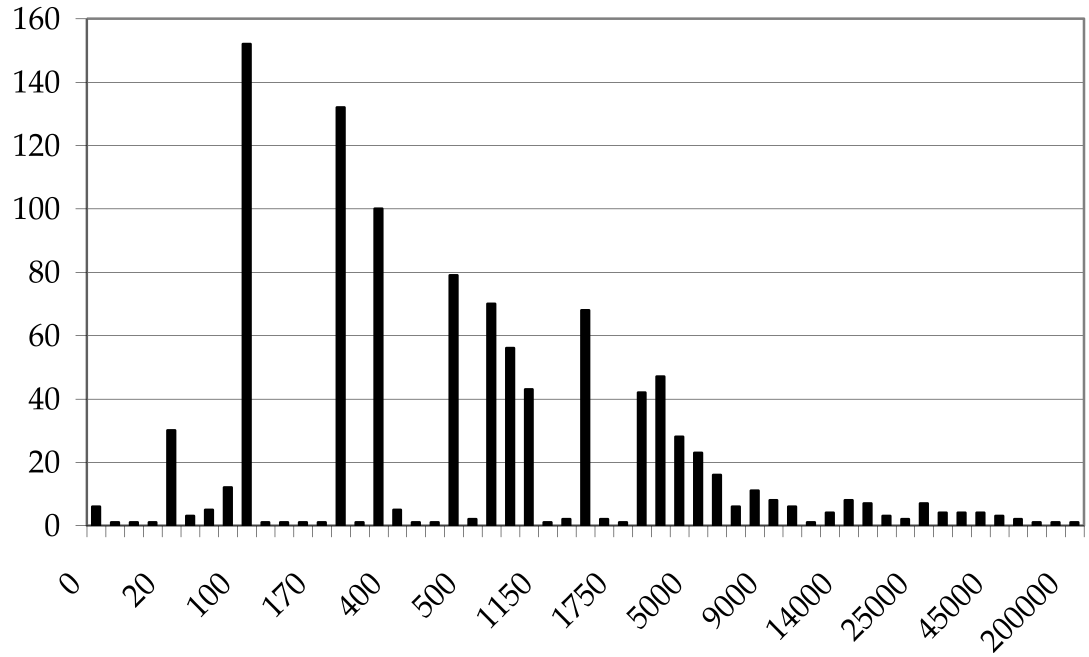
A further weakness of using the probate valuations to infer wealth is the possibility that the probate valuations may miss *inter vivos* gifts, which may include significant transfers of holdings before death, specifically to avoid the payment of death duties (Rubinstein 1991 p.150). A thorough bibliography of critiques of using probate valuations as measures of wealth is given by Owens et al 2006 p.384.

There is a debate in the historical literature over the validity of using probate valuations as true measures of wealth. This debate is illustrated by the exchanges between W.D Rubinstein and M.J. Daunton[90]. However, their differences mainly focused upon the usage of the probate registry for research into the very rich. The closest study the author has knowledge of is the recent paper by Owens et al. (2006). They conclude that the probate valuations are a "reasonably good estimate of true net worth" (p.401), at least for the 1810 to 1840 period.

This study relies on the probate valuations as being strong indicators of true wealth. While the mentioned difficulties may serve to distort individual estimates of true wealth, there is no reason to believe that the sample as a whole should suffer from any significant bias. For the vast majority of the wills used for analysis, a cash valuation was available. To this were added estimates of bequeathed property and freehold land, which were derived from the will itself. The legal and administrative requirements for the cash valuation changed over the sample period, with the major change coming in 1881.

[90] See for example: Daunton 1989 and 1991, and Rubinstein 1991.

Figure 4.10: Observed Gross Value bands for 1858-1880 Wills

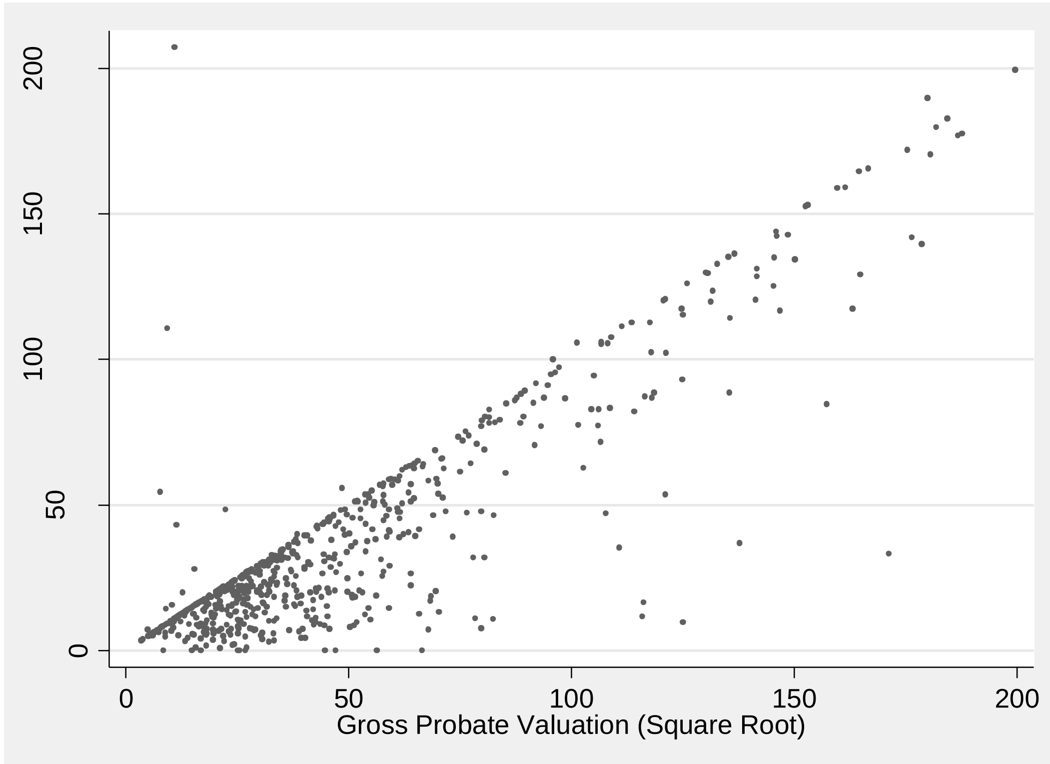


Source: Wills Database

Before 1881 the estimated value of the estate was reported as being under a certain threshold (e.g. under £50, £100) etc. The difference between these bands decreases as the estimated wealth decreases: There are four observed bands between £0 and £100, and there are four observed bands between £50,000 and £100,000. This issue is important as it blurs the differentiation between the 'super rich' at the top of the wealth distribution. However, this analysis is primarily interested in the broad characteristics between different groups in the entire wealth distribution. Therefore wide 'wealth-groupings' are used in the analysis. These wide divisions help to alleviate the inaccuracy of some of the underlying estimates of net worth. Figure 4.10 illustrates the observations at the pre 1881 tax bands.

After 1881, an estimate was made for both gross and net valuations of testator's estates. Gross valuations omitted any account for debts that the testator was liable for at

Figure 4.11: Gross and Net Estate Valuations



Source: Wills Database

the time of his death. The net figure corrected this. What was the impact of accounting for due debts on the valuations of the estates of English testators? Figure 4.11 plots gross wealth against net wealth for 699 post 1881 testators (whom held a gross wealth of under £4000). The strong correlation is confirmed by the results of a simple OLS regression detailed in table 4.5. The gross value of a testator's estate explains over 96% of the variation in net probate values. Further, the gross value of a person's estate is a highly significant predictor of the net value with significance at the 1/1000 of a percent level. The constant could be interpreted as reflecting an average level of debt – although its scale is large. An OLS regression without a constant produced an almost identical result with respect to the variance explained and the significance of the gross value in explaining the net value of estates. This evidence is supportive of arguments made by

Rubenstein[91] (1977, 1991) and Owens et al. (2006) that where net valuations are unavailable, gross probate valuations are acceptable estimates for the true net worth of testators.

These changes had to be accounted for in the calculation of total testator wealth

Table 4.5: OLS Regression on Net Probate Value

Gross Probate Value	0.918***	.907***
Constant	-812.208***	-
Adjusted R-Squared	0.962	.962
Observations	714	

Data source: Wills Database

The best measure of wealth collected was the *net* probate valuation of the personalty (cash/movable goods). However, the pre 1880 wills only contained the gross estimate was available. This was converted to a net measure using the parameters of the observed relationship of gross to net valuations where both were available. A coefficient of .907 (without a constant) explained over 96% of the variation in the relationship between gross and net wealth (table 4.5). For the wills where the probate valuation was reported in terms of a maximum duty band, this maximum was also multiplied by .907. For 110 wills, no probate valuation was available. For these wills, the sum total of all cash bequests and annuities was used to estimate personalty wealth. The relationship between this value and the estimated gross probate was estimated using 163 observations where both were recorded. The OLS regression is reported in table 4.6, and the parameter applied to the sum of cash bequests and annuities was 1.12. Following this, the values were multiplied by .907 to estimate a net wealth measure.

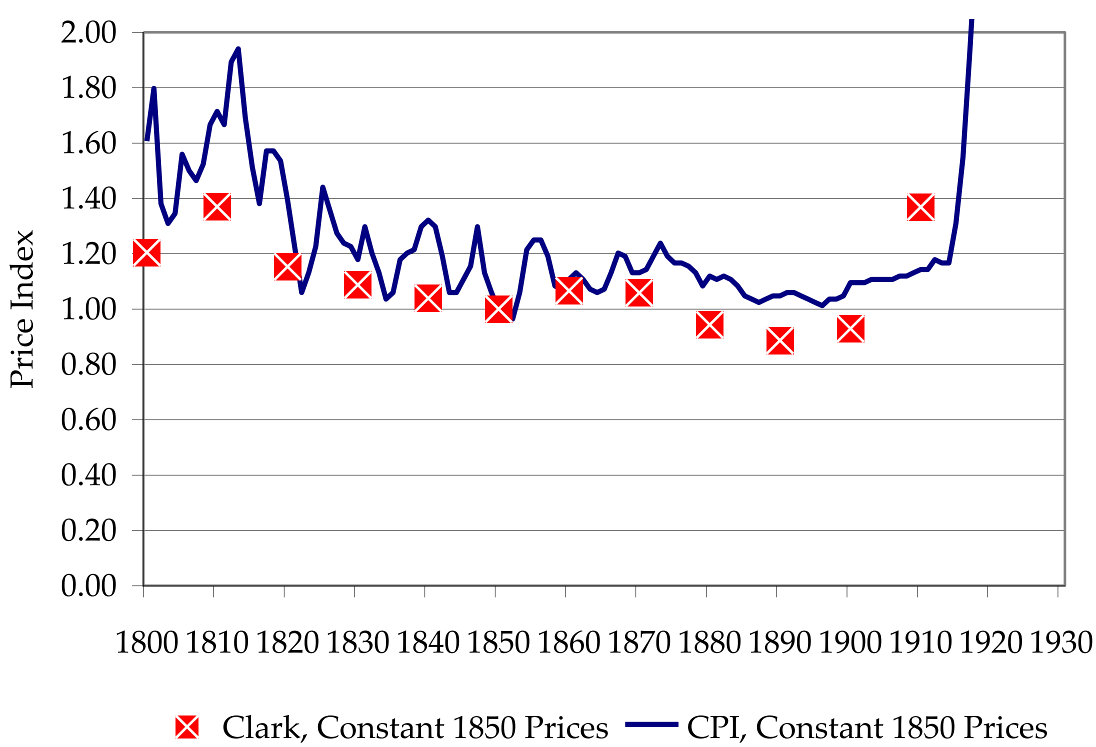
[91] Rubenstein estimates that the difference between the gross and net value of an estate, was on average 5 to 15% (Owens et al 2006 p.387).

Table 4.6: OLS Regression on Gross Probate Valuation

Sum of Cash Bequests And Annuities	1.06***	1.12***
Constant	1671.728	-
Adjusted R-Squared	.780	.793
Observations	163	

The nominal values of the real estate, bequests and estimated personalty were converted to real values using annual price indices from ONS (2009 table 3.6) and decadal values from Clark (2005a). The price indices were adjusted to reflect 1850 prices, and the ONS series was adjusted to equal the Clark series in 1850. The resulting annual Clark adjusted ONS series are used in this analysis. Figure 4.12 illustrates the trends in the prices series used during the 19th century.

Figure 4.12: The Price Series used in the Analysis



Source: Clark (2005) and ONS (2009)

Following this process, estimates of real property and freehold land were added to the cash valuation. As detailed in the first part of this section, wills were read and coded for all mentions of property: the number of houses and land holdings, the size of land areas and the location of these assets was recorded. The houses were multiplied by estimates for the average value of housing in real prices for each decade of the 19th century. A different value was determined by location: London, urban or rural. The source for this house price data was (Clark 2002).

The construction of the database required the coding of 2862 wills. Of these, 1833 were judged to contain reliable and complete information on real property and land held by the testator before death. About 14%, or 257, of the sample testators' bequeathed land. In nearly half of land bequests (108), the area of land was indicated. The area of the remaining 149 land holdings was estimated by relating the observed areas to features coded for in every will. Experimentation was employed to find the best functional form, with a judgment on the goodness of fit made through the proportion of variation explained by the model. The following formulation was employed:

$$Log(Area) = 0.5 + .13 * NLANDHOLDINGS + 0.57 * NPARISHES + \\ 0.01 * SQRTPERSONALITY - 0.061 * DTOWN + 0.21 DFARMER + \sum_i c_i IDSTATUS1911 + \varepsilon$$

Where $Log(Area)$ is the natural logarithm of the area of land bequeathed, $NLANDHOLDINGS$ is the number of land holdings mentioned in the will, $NPARISHES$ is the number of parishes in which land is held, $SQRTPERSONALITY$ is the square root of the cash personalty (in real terms), $DTOWN$ is an indicator variable for town residence, $DFARMER$ is an indicator variable for farming occupations, and $IDSTATUS1911$ are indicator variables of each of the eight 1911 occupational classes (with 9 representing unknowns)[92]. The regression was performed upon 108

[92] The estimated coefficients were: Occupational class I (the highest class and the reference category): 0, class II (which included farmers): 0.69, class III: 0.32, class IV:-0.73, class V:-1.95 and class IX (unknown): 0.56. Classes VI-VIII (textile workers, miners etc) were not represented in the sample.

observations, and had an R^2 of .18. The estimated coefficients were then used to infer land areas for the 149 testators who left land, but gave no indication of the area. The estimated land areas were then converted to a real valuation using Clark's (1998) land price series.

The sum of the price series adjusted cash, property and land valuations represented the total real wealth of the testator. The estimated values are plotted against year of death in figure 4.13[93]. For analysis, this distribution of estimated total real wealth is split into quartiles. This is to allow a non-parametric analysis of the wealth differentials with respect to fertility and nuptiality, age at death and the other demographic variables used in this analysis. Through employing this methodology, a rigid structural form on the relationships between these variables is not imposed. Further, the division of the wealth distribution into quartiles helps to control for the inevitable margin of error in each wealth estimate. A calculated difference in the total real wealth of testators of £100 may not be informative here, but membership of the bottom quartile as opposed to the top quartile indicates a huge difference in real wealth.

An OLS regression of year of death on total real wealth failed to find any significance for a time trend in real wealth over the sample period, as illustrated by the broken line in figure 4.13. The regression had an adjusted R^2 of 0.0003. Because there was no time trend in the data, the pooled wealth distribution was split into quartiles. Table 4.7 reports the summary statistics for these quartiles in constant 1850s pounds.

[93] The square root of real wealth is used to compress the values together for visual representation.

Figure 4.13: Total Real Wealth (Square Root) by Year of Death

Source: Wills Database

Table 4.7: Real Wealth Division, Summary Statistics

Wealth Group	Obs.	Mean Wealth (1850s £)	Standard Deviation (1850s £)	Minimum (1850s £)	Maximum (1850s £)
1	375	142.12	75.90	0.56	272.10
2	339	508.53	145.86	273.78	826.44
3	369	1611.81	567.09	831.09	2721.00
4	345	12784.94	20429.97	2733.12	225842.40

Source: Wills Database

As mentioned in the introduction to this chapter, historical demographers have always found large urban/rural demographic differentials. The location of the testator in this sample is a crucial piece of information and must be controlled for. In assigning testators to urban or rural status, I use a simple cut of above and below a population of 5,000 for the town in which they lived. The median date of death for testators in my sample was 1874, and I cross referenced named towns in the probate/census records with the 1871 census[94]. Those who lived in towns with a population of over 5,000 were coded as urban, those who lived in a town under 5,000 were coded as rural and those who lived in London received a special categorization. Table 4.8 reports the location of the sample testators with respect to this coding. For the sample as a whole, nearly 60% are from urban areas. This figure varies by decade of death, and the variance reflects the changing source counties for the testators, and also the rapidly increasing urbanization in this period. The rates also reflect the addition of the Ipswich testators, who were all urban dwellers.

Table 4.8: Testator Locations

Decade of Death	Rural Ob.	Urban Obs.	Urbanization Rate	Sample Source (County)
1820	103	83	0.45	Surrey
1830	105	86	0.45	Surrey
1840	69	19	0.22	Essex
1850	81	10	0.11	Essex
1860	164	96	0.37	Essex and Ipswich
1870	160	269	0.63	Essex and Ipswich
1880	136	258	0.65	Essex and Ipswich
1890	110	260	0.70	Essex and Ipswich
1900	100	327	0.77	Essex and Ipswich
1910	45	50	0.53	Essex and Ipswich
Total	1073	1458	0.58	

Source: Wills Database

Finally, a year of birth was constructed using the sample data. For the vast majority of wills, it was possible to link testators to the relevant last census before death, and calculate both an actual age at death and an exact year of birth. For 726 wills,

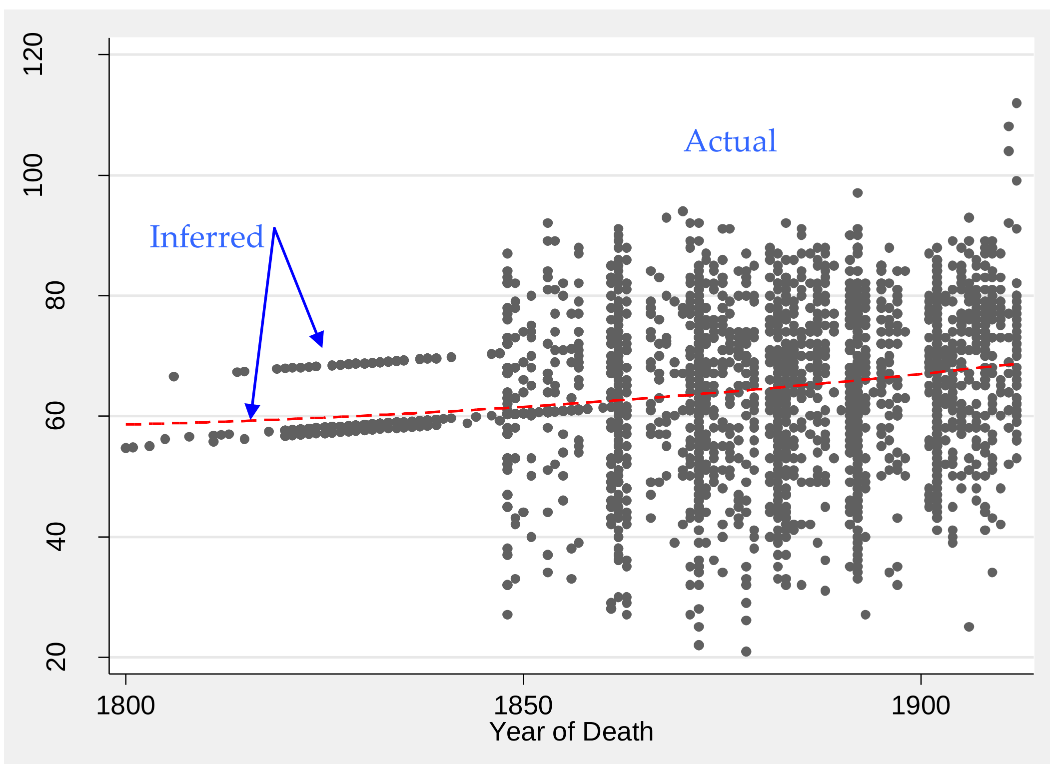
[94] *Table 4 - Area, Houses and Inhabitants, 1861 and 1871, in the Parishes and Places comprised in each Superintendent Registrars District and each Registrars Sub-District*.

this was not possible as they either could not be found in the original enumerator's returns or the link was unsure. For these observations an age of death (and therefore a year of birth) was inferred from the observed relationship between testator characteristics and age at death. Again, the appropriate functional form was chosen by experimentation:

$$AGE = 55.73 - 0.093 * YEARDEATH - 0.975 * DSINGLE + 10.23 * DWIDOWER$$

Where AGE represents age at death, $YEARDEATH$ represents the year of death[95]. $DSINGLE$ is a categorical variable representing single status (never married, no children) and $DWIDOWER$ is a categorical variable representing widowers. The R^2 of this regression was .095.

Figure 4.14: Inferred and Actual Age at Death



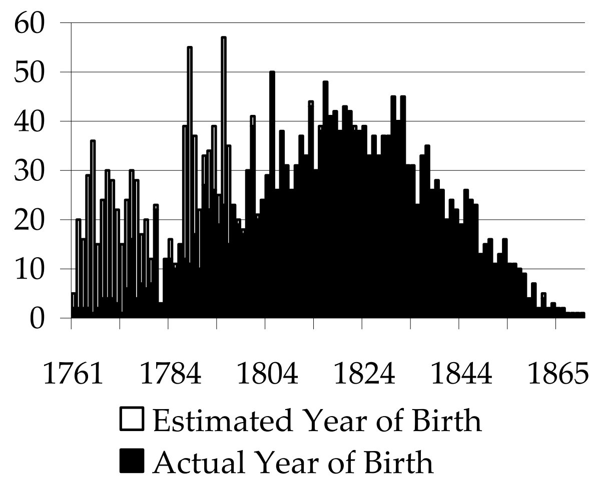
Source: Wills Database

[95] The year of death was adjusted by subtracting 1800.

Figure 4.14 illustrates the inferred and actual values for age at death used in the sample. The vast majority of inferred values are pre 1850, and the trend in these values is constructed (via the application of the regression parameters) to follow the linear trend in age at death post 1850. Being single shifts a testators value down slightly, while being a widower shifts his estimated age at death up significantly. Theses estimated ages at death are used to form birth cohorts for the testators, and the numbers of testators by cohort of birth is reported in table 4.9.

Table 4.9: Numbers of Testators by Year of Birth

Decade of Birth	Observations
1750	23
1760	178
1770	237
1780	230
1790	310
1800	317
1810	382
1820	378
1830	334
1840	211
1850	107
1860	36



Source: Wills Database

Section 4.3.2: Robustness Checks for the Data

This section tests the validity of the data generated by asking five questions. Firstly, how representative are these testators? Following this, I ask if the timing of the wealth valuation biases the estimates – in other words I test the data for the presence of life course wealth accumulation patterns. Thirdly, I check the average time between the writing of a will and death. Most crucially for the fertility analysis, I then ask: Were all children included in the will? Finally, I check the nuptiality patterns for consistency with census estimates.

How Representative are these Testators?

Pre existing evidence on the proportion of the population leaving wills is thin. Fortunately, I was able to reconstruct an estimate for this using Ipswich testators. Complete death registers were extracted from Razzell, Davies and Garrett (2007 *Sociological Study of Fertility and Mortality in Ipswich, 1872-1910* [computer file]). Using this information I cross checked with the indices to the probate registry at First Avenue House in High Holborn, London. I searched for all men who died with an age at death of over 25 years between 1872 and 1910. Table 4.10 reports the results of this exercise:

Table 4.10: Proportion of Ipswich Males Leaving a Will

Decade	Number Searched	Number found	Proportion found
1872-9	1355	161	0.12
1880-9	1449	204	0.14
1890-9	1207	201	0.17
1900-9	1019	116	0.11

Source: Wills Database

The proportion of Ipswich's male population leaving a will ranges from apx. 11%-17%. This estimate must be considered a lower bound. I only searched for deceased males in the probate register for the year of their death. Some testator's wills are proved in the next calendar year after their death. This is particularly likely for those dying towards the end of the year. My own estimates indicate that 2.5% of wills granted are granted in the next calendar year (after the year of death). Further, I searched for males who died over the age of 25. If I had searched for those over 50 or 60, the proportion leaving wills is likely to be substantially higher.

This lower bound of 11-17% is not a random sample of the wider population. As Lindert puts it:

"The probate population is a biased segment of society, over representing the elderly,

the middling agricultural classes, and Merchants"
(1986 p.1133).

One way to compare the characteristics of the sample data is to find nationally available measures. One such measure is the occupational distribution of the population. As mentioned in the introduction to this chapter, the 1911 census of England introduced a 'social class' ladder – a division generated from the occupation category and designed by T.H.C Stevenson[96]. This 'Social Class' system of occupational designation consists of eight classes, and is described in table 4.11.

Table 4.11: Stevenson's Occupational Class System

	Definition	**Examples**
Class I	Upper and Middle class	Commercial and Railway Clerks, Insurance Agents - Not artisans
Class II	Intermediate Class	Shopkeeping trades
Class III	Skilled Workmen	Carpenters, Plumbers, Blacksmith
Class IV	Undetermined (skilled/Unskilled) Working Class	Cooper, Fisherman, Gardener
Class V	Unskilled Workmen	Brickmaker, Labourer, Chimney Sweep
Class VI	Textile Workers	Colthworker, Weaver
Class VII	Miners	Coal Burner, Coke Porter
Class VIII	Agricultural Labourers	Agricultural Labourers,

Source: [Census of England and Wales 1911] (GRO 1923 page lxxvi-lxxvii and Table 30, pp28-143)

As the table show, the class system descends in social order from classes I-V, with classes VI-VIII representing special occupational groups.

Using the 1911 census occupation classification schema, table 4.12 reports the occupational characteristics of the sample data alongside that of the general population

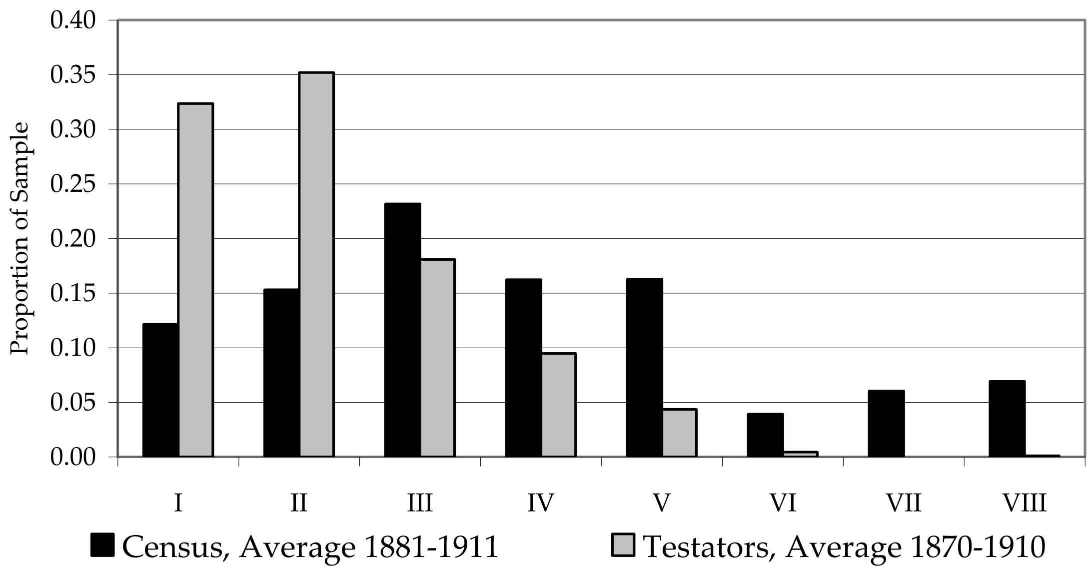
[96] Superintendent of Statistics in the Office of the General Registrar, supervised the analysis of the 1911 census (Haines 1989 p.307).

Table 4.12: The Occupational Distribution of the Sample

1911 Occ. Class	General Population Census Year				Testators Decade of Death			
	1881	1891	1901	1911	1870	1880	1890	1900
I	0.12	0.12	0.13	0.12	0.25	0.34	0.38	0.35
II	0.15	0.15	0.15	0.17	0.40	0.37	0.31	0.30
III	0.23	0.23	0.24	0.23	0.19	0.17	0.14	0.22
IV	0.15	0.16	0.17	0.18	0.10	0.08	0.11	0.10
V	0.17	0.17	0.16	0.15	0.05	0.04	0.06	0.02
VI	0.05	0.04	0.03	0.04	0.01	0.00	0.00	0.01
VII	0.05	0.06	0.06	0.07	0.00	0.00	0.00	0.00
VIII	0.09	0.07	0.06	0.05	0.00	0.00	0.00	0.00
Obs.	Population				272	267	209	170

Source: Wills Database

Figure 4.15: Census and Sample Occupational Distribution



Source: Census - Source: Adapted from Banks 1978 p.223, Wills database

for the census years 1881-1911. Figure 4.15 pools this data and presents it visually. It is of no surprise that the testator group is strongly biased towards those in the high status occupations, classes I and II according to Stevenson’s schema. The testator sample has 2.6 times the number of Class I occupations and 2.3 times the number of class II occupations that you would expect from a random sample of the population. Every other occupational class is underrepresented. The sample has about .78 times the representation of class III, .58 times the representation for class IV and .27 the representation for class V. The 'special' occupational categories, classes VI-VIII are not represented in this sample.[97] The exercise reveals, as expected that the testator sample is heavily biased towards those in the highest status occupations. The empirical solution to this problem is to build as large a database as possible. The methodological solution is to control for each occupational class, and this is performed in the next section.

The Life Course

Economic theory tells us that, on average, people will tend to accumulate wealth over the life cycle. Past a certain age, for example the age of retirement, people will dis-save. Is there evidence for this life course behaviour in the testator database? Figure 4.16 plots the square root of total wealth against age at death. A quadratic fit between the data points is also included. There is a strong and highly significant positive association of age at death and the level of total (cash and real estate) wealth. This is confirmed by the results of an OLS regression of age at death on the square root of real wealth (table 4.13). As figure 4.16 illustrates, the strength of this relationship falls strikingly as age of death rises. There is no evidence for dis-saving from this pooled sample.

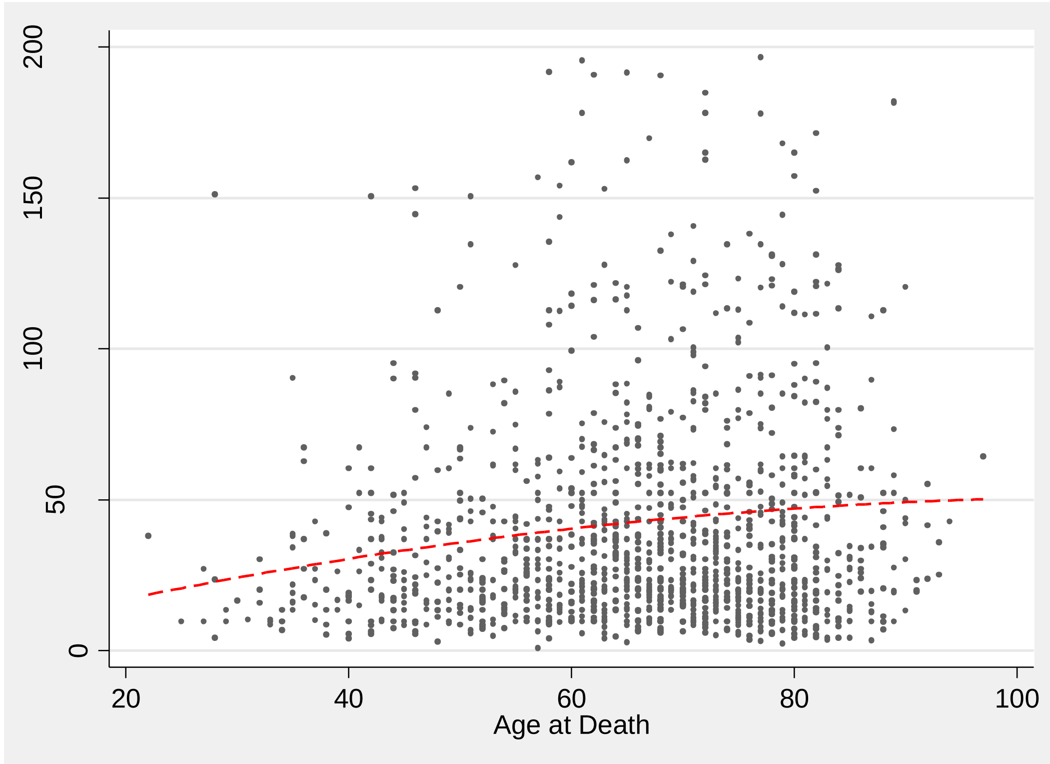
Table 4.13: OLS Regression on Total Real Wealth (Square Root)

Constant	15.93	0.321
Age at Death	0.394***	0.918
Age at Death Squared		-.004
Adjusted R^2	0.013	0.013
Observations	1383	

Source: Wills Database

[97] The representation for class VI in the testator sample is apx. 0.11, but the number of underlying observations is very small to be useful for analysis.

Figure 4.16: The Life Course and Total Wealth



Source: Wills Database

The estimated coefficients for age at death and age at death squared fail to be significant at the 5% level. The implied turning point, or age at death, where the negative association of age at death and wealth 'kicks' in was calculated to be at approximately 114 years. This is an unfeasibly late age for dis-saving to be a serious bias in the reported values of real wealth.

Time between writing will and death

In order to be a justifiable record of completed net fertility (and perhaps accumulated wealth over the life cycle) it is necessary that these wills are written within a short period before death. For a sub-sample of the testator database, I calculated the time (in years) between the writing of the will and the date of death. Table 4.14 reports the results of this exercise. Over 56% of the testators write their will in the year before, or in the year of, death. Only in 12% of testators is this gap longer than 10 years.

Table 4.14: Time between Writing of Will and Death

Number of Years between Writing Will and Death	Proportion of Testators
Same Year	0.36
1 Year	0.21
2 Years	0.08
3 Years	0.05
4 Years	0.05
5 Years	0.05
6 Years	0.04
7 Years	0.01
8 Years	0.02
9 Years	0.02
>10 Years	0.12
Observations	466

Source: Wills Database

Were all children included in the will?

The primary measure for net fertility in this study is the sum total of named children in testator's wills. For this to be meaningful, it is essential that there is no systematic under-reporting, or omission of children for whatever reason, from the will. After reading nearly 3,000 wills, my firm intuition is that omission was minimal. Testators would always mention all surviving offspring. In the extremely rare case where children were estranged from their father, it was noted and some bequest, often much less than the other children, was made. Typically, married daughters would receive less than sons. This may have been due to previous exchanges, such as a dowry at the time of marriage.

An empirical test for omission is to calculate a sex ratio. The sex ratio is the number of males to females, usually quoted as the number of males per female, in a population. If omission was present, we would reasonably expect it to be sex biased, i.e. married daughters would be omitted at the expense of sons. Table 4.15 reports the sex-ratio for named children in testator's wills and that of the general population at the census following the testator's decade of death (e.g. the 1840 value represents the census date of 1851 and so on).

Table 4.15: The Sex-Ratio of Named Testator Children Compared with the General Population

Decade of Death/Census	Boys	Girls	Boys per Girl	Sex Ratio of Population
1820	113	135	0.46	
1830	143	135	0.51	
1840	119	124	0.49	0.46
1850	177	171	0.51	0.49
1860	182	192	0.49	0.49
1870	310	279	0.53	0.49
1880	222	243	0.48	0.48
1890	214	231	0.48	0.48
1900	253	266	0.49	0.48
Total	1733	1776	0.49	0.48 (Average)

Source: Wills database and Rothenbacher

The rising sex ratio in the general population may reflect the decline in infant mortality during this period (which was male biased as infant mortality was always higher for males - a hypothesis derived from observations in James 1987 p.742). It is important to note that the data presented in table 4.15 is not directly temporally comparable. This is because the sex ratio at the census will reflect the sex ratio for the entire population, whereas the sex ratio for the testators represents their offspring – a generational slice which contributes (with other generations) to the observed population sex ratio. The sex ratio for the testators exhibit no tendency towards systematic over or under representation. The rising values between 1820 and 1850 are reflected in the census figures for 1840-1870. For two decades, the testators have a sex ratio corresponding to (slightly) more males than females. Overall the sex ratio for named children in the sample is 0.49, exactly what we would expect from a random sample of the English population during this period. This evidence rules out any sex biased omission from the testator database.

Nuptiality and Wealth

How representative is the nuptiality structure of the testator sample? Tables 4.16 and 4.17 report the proportion of never married testators and the proportion of never married males in the population as a whole. From 1760-1800, the sample over represents unmarried men. This may be due to the potential higher incidence of will writing amongst those with no obvious heir. After 1800, there is a huge fall in the number of unmarried testators. This is due to a slightly different sampling strategy for the post 1858 wills. For the years after 1858, the strategy was to link every observation to a census record. To do this, links would often be based on the first name of a spouse, which would be recorded in both sources. Before 1858, all wills were included in the sample. Figure 4.17 reports the trend in testator nuptiality with respect to decade of birth. This mis-representation must be controlled for, and any simple average calculation must be treated with a high degree of scepticism. The best solution to this problem is to examine *marital* fertility independent of the proportion married for each testator class.

Between wealth groups, there is no consistent pattern. Marriage rates are highest for wealth group 3 overall, but relatively flat between the wealth quartiles. For the period before 1800, the large proportion of testators unmarried is largely confined to the bottom half of the wealth distribution. For comparison, table 4.18 reports the marriage rates of the different occupational classes. Again the variation is relatively minor (apx. 3%), except for occupational class V, the unskilled working class, who have a sharply decreased incidence of marriage (apx. 8%).

Do Richer Men marry Younger Wives?

Over 72% of testators marry younger women than themselves, with 10% marrying women of the same age and 18% marrying older women. Do richer testators

Table 4.16: Proportion Single, Urban and Rural by Wealth Group

		Wealth Group			
	All	1	2	3	4
All	0.10	0.10	0.12	0.08	0.11
Before 1800	0.18	0.24	0.22	0.12	0.13
After 1800	0.06	0.04	0.05	0.05	0.10
Rural	0.14	0.14	0.18	0.09	0.11
Urban	0.07	0.07	0.06	0.06	0.11

Source: Wills Database

Table 4.17: Population Nuptiality Trends from 1851

	Proportion Single		Age at Marriage	
Census	Male	Female	Male	Female
1851	11.36	12.36	26.94	25.77
1861	10.44	12.07	26.39	25.39
1871	9.6	12.18	26.43	25.13
1881	9.52	12.05	26.6	25.3
1891	9.85	12.53	27.06	25.96
1901	10.86	13.78	27.31	26.27
1911	11.91	15.97	27.65	26.25

Source: Wrigley and Schofield, 1981 p.437

Table 4.18: 1911 Census - Proportion Married per 1,000

	Proportion Married[98]	% difference to Average
Population	.824	0.00%
Occupational Class		
I	.829	0.61%
II	.849	3.03%
III	.851	3.28%
IV	.850	3.16%
V	.758	-8.01%
VI	.842	2.18%
VII	.819	-0.61%
VIII	.735	-10.80%

Source: GRO 1923 p.lxxix, table XXXIV, Garret et al. 2001 p.223.

[98] The proportion married at age 45-55.

marry younger women than poorer testators? For 675 observations, it is possible to compare both husband and wives year of birth (actual census observations, not inferred). An age difference is calculated by subtracting wife's year of birth from husband's. Where this is positive, the wife is older, where it is negative, the wife is younger. To determine the association between the wealth groups and the age difference of spouses, an OLS regression was run with spouse age difference as the dependant variable and wealth quartiles as categorical independent variables. Table 4.19 reports the results of this exercise.

Table 4.19: OLS Regression on Spouse Age Difference

	Coefficient	Standard Error
Constant	0.512***	0.570
Wealth Group 1	0 (Ref.)	-
Wealth Group 2	0.512	0.826
Wealth Group 3	-1.180	0.824
Wealth Group 4	-3.508***	0.843
R2	0.033	
Observations	675	

Source: Wills Database

There is a strong and highly significant association between the top wealth quartile and younger spouses. The regression indicates that membership of this wealth group is associated with a wife 3.5 years younger than that of the reference category – Wealth Group 1 – the poorest testators. This effect only seems to apply to those at the very top – the coefficients on Wealth Group's 2 and 3 fail to be significant at the standard levels. Unfortunately, the limitations of the wills database do not allow further investigation. Was this association a result of greater remarriage amongst the wealthier testators? If this were the case, we should expect to find a lower proportion of widowers amongst the testators in the top wealth quartile. A superficial glance at the data does not support this. The proportion of widowers amongst the testators ranges from approximately .20-.28, and is highest for the richest testator group – Wealth Group

4. These results imply that richer testators marry younger wives and the rate of remarriage is unassociated with this observation.

Interestingly, this result diverges from what we would expect from status. The female age at marriage differentials reported by Garret et al. show that, on average, the lower social classes (using the 1911 schema) married younger wives (Table 5.2.1 2001). The difference is striking, with respect to class V, unskilled workers, and class VIII, agricultural labourers marrying women two and three years younger than the population average respectively. The top status groups – the middle and upper classes, professionals, married the oldest wives. This relationship runs in the reverse direction to that of wealth.

Table 4.20: Proportion of Marriages Childless, Urban and Rural by Wealth Group

		Wealth Group			
	All	1	2	3	4
All	0.33	0.37	0.34	0.32	0.28
Before 1800	0.20	0.21	0.18	0.16	0.25
After 1800	0.39	0.42	0.43	0.41	0.29
Rural	0.32	0.40	0.36	0.30	0.24
Urban	0.31	0.35	0.30	0.33	0.27

Source: Wills Database

Table 4.20 reports the proportion of childless marriages for the testator sample. The proportion of testators childless is far higher than what we would expect from a random sample of the population. This pattern cannot be representative of the general population. Calculations of the proportion childless by duration of marriage in England and Wales, from the fertility census of 1911, are reported in table 4.21. For the general married population, the proportion childless is on average about 17%. As testators are more likely to have long marital durations (their fertility is measured at the end of their life), we should expect their childless proportion to be less than 17%. However, about 33% of the married testators are childless. The figure is lower for the pre-1800 era, and in general is greater for the poorer testators. This figure certainly reflects a higher propensity to make a will if a testator had no obvious heirs. Another concern is the possibility that testators wrote a will *before* they had a family. As I have shown however, over 80% of wills were written five or less years before death, and 88% were written under a decade before death. This cannot be the source of the bias. For this analysis, some control must be constructed for this effect.

Table 4.21: Proportion of Marriages Childless (1911 Census)

Duration of Marriage	Proportion Childless
0-5	0.39
5-10	0.16
10-15	0.13
15-20	0.11
20-25	0.10
25-30	0.09
30-40	0.08
40-50	0.07
50+	0.06
All	0.17

Source: Murphy 2008

Section 4.4: Analysis of the Wealth-Fertility Relationship

This section analyses the wealth-fertility relationship. Firstly, the estimated net fertility of the testator sample is compared with published estimates of the net fertility rate for England over the course of the 19th century. Next, raw averages are constructed for each of the wealth quartiles. Following this, negative binomial regressions determine with greater power the statistical significance of the wealth fertility relationship. Finally, the results are analysed.

How well do the Testator Fertility Estimates Match Existing Estimates of Marital Fertility?

Wrigley and Schofield have published cohort based estimates of the Net Reproduction Rate (NRR) in England from 1540 to 1820. This measure adjusts fertility for expected mortality risks. The average number of daughters born per woman (the gross reproduction rate) is multiplied by the probability of a girl reaching maternity. The fertility estimates for the testator sample is based upon named children in the will, who would have survived to near the time of their father's death. Dividing these estimates by two to approximate daughters per testator, we can form direct comparisons with the Wrigley and Schofield Net Reproduction Rates.

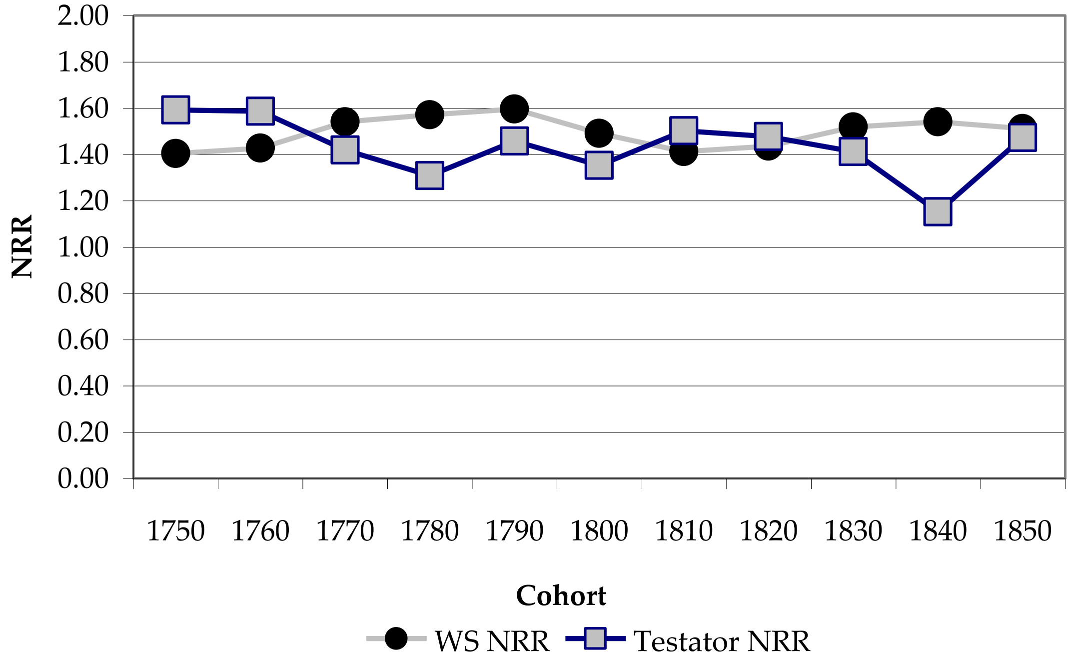
Before this could be done, two adjustments to the testator estimates were required. Preliminary analysis demonstrated that the testator sample over represented childless marriages. To correct for this an average family size was calculated for testators with at least one child. This number was multiplied by 0.92 to correct for the omission of childless marriages[99]. This gave a figure applicable to all marriages. To correct for the omission of single men, this number was then multiplied by 0.9, as 0.1 of the sample were unmarried at death. The small differentials in proportions married between the occupational classes reported in table 4.18 supports the legitimacy of this adjustment[100]. Figure 4.17 charts Testator Fertility and the Wrigley-Schofield NRR estimates for the English population.

The testator fertility rates closely track those of the population NRR estimates. The average difference between the measures for the cohort years of 1750-1850 is slightly over 1%. This evidence confirms the reliability and validity of the testator wills as a source for the calculation of fertility levels.

[99] 0.92 was chosen as 8% of marriages of marital duration of 30-40 years are childless (table 19). Assuming a mean age of marriage of 27 and a later death for the spouse, the mean testator marriage duration was 38.1 years.

[100] This does not apply for occupational class V – unskilled workmen, who were significantly more likely to be single at death than the population as a whole (apx. 24% vrs 17%) Source: As table 4.16.

Figure 4.17: Testator Fertility Compared with Population NRR



Source: Wills Database and Wrigley 1997.

Table 4.23 reports the Raw and unadjusted Averages of completed marital fertility for the four wealth groups before and after 1800 (decade of birth) and for rural and urban testators. The number in parenthesis is the average for testators with at least one child. There appears to be a strong and consistent reproductive advantage for the rich with respect to the raw, unadjusted averages presented here. Relative to the lowest and poorest wealth group, the top wealth quartile has 26% more surviving children over the sample as a whole. This value varies over the period and between urban and rural environments. The differential is only 8% greater before 1800, and is 33% greater after 1800. For rural dwellers, membership of the top wealth quartile is associated with a completed level of marital fertility 63% higher than that of the lowest quartile. The urban differential is far smaller – only 13%. The values calculated for testators with at least one child are higher and follow the same trend as the values calculated over all married testators.

Table 4.22: Urban and Rural Fertility, by Wealth Group

		Wealth Group			
	All	1	2	3	4
All	2.28	2.05	2.12	2.33	2.59
	(3.47)	(3.00)	(3.34)	(3.79)	(3.82)
Before 1800	2.77	2.52	2.74	3.06	2.74
	(3.58)	(3.21)	(3.36)	(3.66)	(3.69)
After 1800	2.04	1.89	1.79	1.95	2.52
	(3.37)	(3.30)	(3.16)	(3.32)	(3.67)
Rural	2.26	1.71	1.93	2.55	2.79
	(3.63)	(3.00)	(3.34)	(3.79)	(3.82)
Urban	2.18	2.12	2.12	2.07	2.41
	(3.32)	(3.39)	(3.17)	(3.24)	(3.55)

Source: Wills Database

Negative Binomial Regressions on Net Fertility

In order to investigate the wealth-fertility relationship on a deeper level than simple averages, this section analyses the wealth-fertility relationship in a regression framework. The dependant variable is net fertility: the number of named children in a testator's will. To account for the over representation of childless marriages, two regressions are run. The first is based on all marriages and the second is based on marriages with at least one child. This methodology can confirm whether perceived wealth effects are acting through differentials in the proportion of childlessness, or are acting on the net total of children directly. To account for the impact of early mortality, a categorical variable is constructed. On average, males married at 27 during the 19th century, and females married at 26. This implies that from the age of 27, men had a potential fertility span of 24 years, assuming female fecundity ends at age 50. This implies that for most men, their fertility life ended at age 51. After this age, additional children are unlikely, based on the potential fecundity of their spouse. However, an age of death earlier than 51 implies that males died during their reproductive span, and because of this early mortality, their net fertility estimate is biased downwards. Some control must be included for this effect. For those men who died before the age of 51, a dummy variable is included in the regression. The inclusion of this variable can also confirm whether any perceived wealth effects act independent of differential mortality between the wealth groups (as noted, there is a significant and positive association between age at death and wealth – see table 4.13). The variable is a rough approximation for the effects of early mortality as for a large proportion of the pre 1850 (year of death) testators, age of death is inferred, and is never less than 51. The variable can only capture the effects post 1850, and its true significance is certainly greater than that revealed in the regression results. A non linear time trend is also included in the model through categorical variables representing the decade of birth (1750-1860).

The wealth effects are included in the model as categorical variables representing each of the wealth divisions or 'groups'. As discussed, these wealth groups are based on even quartiles of the wealth distribution and ascend in wealth from wealth group 1 (the poorest testators) to wealth group 4 (the richest testators). Wealth group 1 is the reference category here, and all coefficients are relative to this poorest testator quartile. Wealth is included as a categorical variable in order to allow a non-linear association with fertility to be modelled. Further, the strength (and direction) of the wealth-fertility relationship is allowed to vary between urban (towns greater than 5,000 people) and rural (towns/villages less than 5,000 people) via an interaction term between the wealth categories and an urban dummy. The results therefore report main wealth effects, an urban effect, and marginal wealth effects for urban dwellings. These coefficients must be summed to understand the true effects. Finally, a negative binomial regression model is used as the dependant variable is a count variable (1, 2, 3 etc.). The model to be estimated is

$$NETF = a + \sum_i b_i DWEALTHGROUP + \sum_i c_i DWEALTHGROUP * DURBAN$$
$$+ DEARLYDEATH + \sum_i d_i DBIRTHDECADE + \varepsilon$$

Where $NETF$ is net fertility, $\sum_i b_i DWEALTHGROUP$ are categorical variables representing the wealth quartiles, $DURBAN$ is an urban dummy, $DEARLYDEATH$

represents death under 51 years and $\sum_i d_i DBIRTHDECADE$ are categorical variables representing the decade of birth (1750-1860). The results of this model are reported in table 4.24.

Table 4.23: Negative Binomial Regression on Net Fertility

	Coefficient (Standard Error)	
	All Marriages **(1)**	At least 1 Child **(2)**
Wealth Group 1	0.00	0.00
Wealth Group 2	0.046	0.086
	(0.155)	(0.108)
Wealth Group 3	0.336*	0.231*
	(0.142)	(0.096)
Wealth Group 4	0.402**	0.228**
	(0.148)	(0.098)
Urban Dummy	0.213*	0.115*
	(0.139)	(0.096)
WG2*Urban	-0.104′	-0.149
	(0.199)	(0.136)
WG3*Urban	-0.47	-0.298
	(0.188)	(0.127)
WG4*Urban	-0.366	-0.201
	(0.191)	(0.127)
Died under 51	-0.441**	-0.186
	(0.139)	(0.105)
Constant	0.973**	1.165***
	(0.307)	(0.182)
Observations	1220	794
Pseudo R^2	0.020	0.009

* *P<0.05*, ** *P<0.01*, *** *P<0.001*

Table 4.24 reports the results of regressions **(1)** and **(2).** Regression **(1)** is based upon all married testators. In order to account for the over representation of childless marriages in the testators' sample, regression **(2)** repeats the same regression, but this time only for marriages with at least one child. This exercise serves as a robustness check for the wealth-fertility patterns exposed by regression **(1)**. The decadal (of birth) categorical variables are included in the regression but not reported, with a decade of birth of 1810 serving as the omitted category.

Early mortality is controlled by the inclusion of a variable representing an age of death under 51 and is negative in both regressions. This early mortality dummy is highly significant in regression **(1)** but not in regression **(2)**. The wealth effects are allowed to be different between urban and rural testators. For rural testators there is a large and significant positive association with net fertility. To more clearly see the wealth and urban rural net fertility differentials, the coefficients from regression **(2)** are exponentiated to give expected numbers of children per wealth group. Further, a constant coefficient representing the average marriage rate and childless rate are applied so that these figures can be readily interpreted as the expected number of children per male in 1810, married or unmarried, and surviving to at least age 51. These values are reported in table 4.25.

Table 4.24: Expected Numbers of Children from Regression

	Wealth Group			
	1	2	3	4
Rural	2.66	2.89	3.35*	3.34**
Urban	2.98	2.80	2.78	3.06

* All coefficients significant at 0.05 level
** All coefficients significant at 0.01 level

There is a clear and significant positive association between wealth and net fertility for rural testators. The richest testators here (Wealth Group 3 and 4) have net fertility levels 25% above those of the poorest (Wealth Group 1). The significance is denoted in table 4.25 by indicators representing the joint significance of all coefficients used to calculate the expected value at the standard levels. These indicators represent a statistically different value for expected children relative to the reference group, wealth group 1. Net fertility rises as wealth quartile ascends in value. Between the top wealth quartiles, there is no evidence here for fertility differentials. For urban dwellers, the picture is very different. There expected values for net fertility in urban areas are statistically indistinguishable between the wealth groups. There is no systematic positive (or negative) relationship between net fertility and wealth in the towns – net fertility is flat as wealth group ascends. Comparing urban and rural net fertility rates, an urban residence was associated with *increased* net fertility for the poorest testators. For the rest, net fertility was lower in the towns than it was in the countryside[101].

For 19th century England, the country side was held in the rigid grip of a Malthusian fertility pattern. In cross section, those who held more resources had greater net fertility than those who had less. Is this result robust? How does this square with the clear (if slight) negative association of net fertility and occupational status in the 1911 census? Table 4.26 reports the results of the same regression, but this time controlling for occupational status. Occupational status is included as a categorical variable, and descends in status from I to VIII. The positive wealth-fertility relationship is confirmed in regressions **(3)** and **(4)**. However, the most interesting outcome of this exercise is the coexistence of a very strong, and highly significant, *negative* relationship of net fertility with occupational status. Net fertility rises as occupational status decreases.

Table 4.27 reports the expected numbers of surviving children per wealth group and occupational status class. This matrix can be used to deduce the varying levels of net fertility within the testator sample. For rural testators, net fertility increases with wealth, and decreases with occupational class. The group with the lowest fertility are

[101] The positive wealth fertility relationship was also confirmed by the inclusion of the square root of real wealth. Despite imposing a parametric relationship upon the data, this variable was highly significant with a *p-value* less than 0.001.

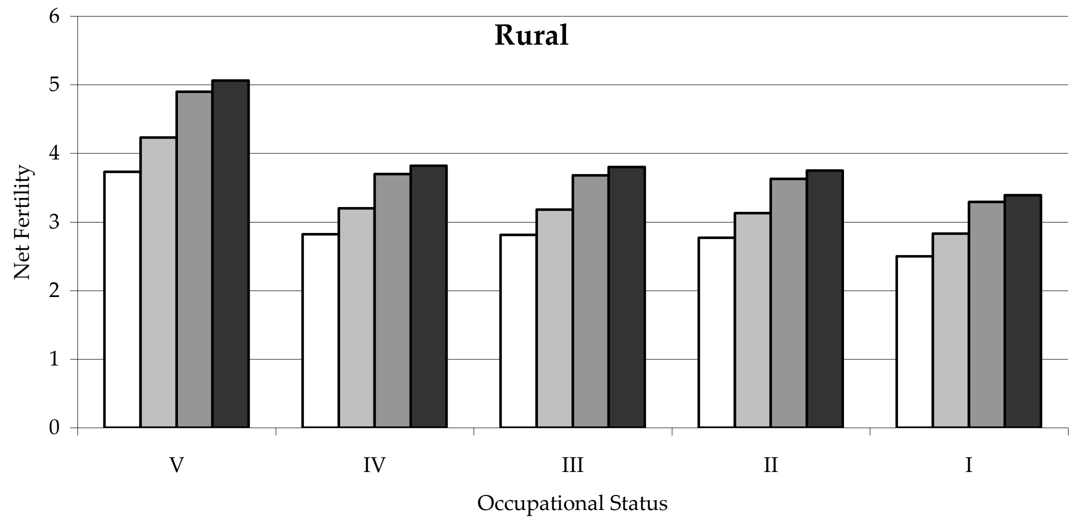
Table 4.25: Negative Binomial Regression on Net Fertility, with Status

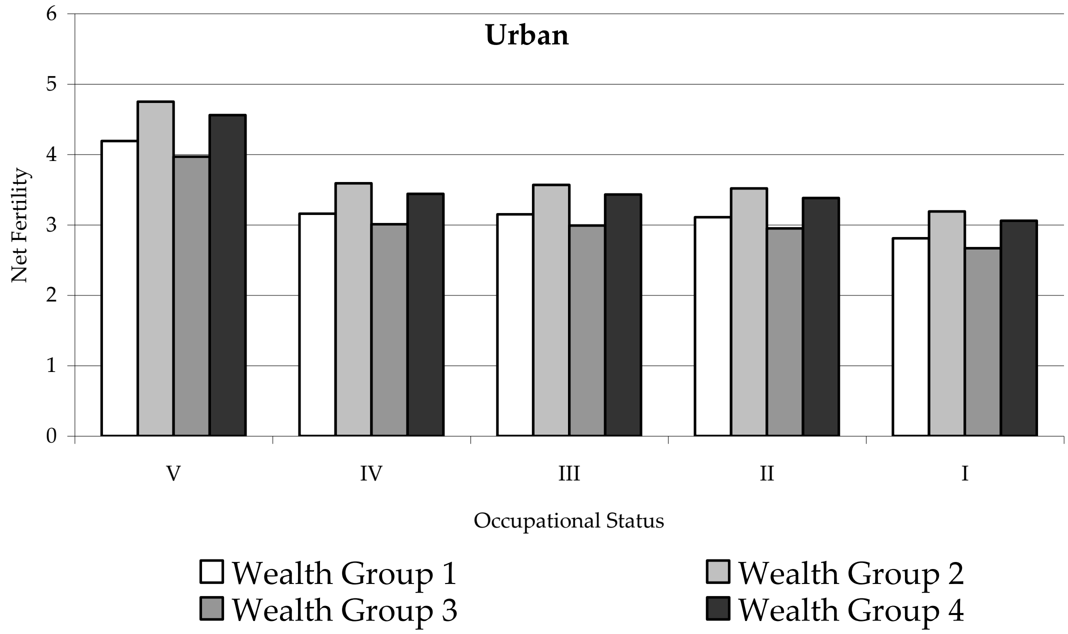
	Coefficient (Standard Error)	
	All Marriages	At least 1 Child
Variable	**(3)**	**(4)**
Wealth Group 1 (Ref.)	0.00	0.00
Wealth Group 2	0.084	0.125
	(0.157)	(0.109)
Wealth Group 3	0.388**	0.272**
	(0.144)	(0.097)
Wealth Group 4	0.543***	0.304**
	(0.152)	(0.101)
Urban Dummy	0.193	0.116
	(0.141)	(0.097)
WG2*Urban	-0.087	-0.171
	(0.2)	(0.137)
WG3*Urban	-0.454*	-0.325*
	(0.188)	(0.128)
WG4*Urban	-0.403*	-0.219
	(0.192)	(0.127)
Occ. Class I	-0.563***	-0.404***
	(0.17)	(0.111)
Occ. II	-0.405*	-0.386***
	(0.164)	(0.106)
Occ. Class III	-0.12	-0.286***
	(0.175)	(0.112)
Occ. Class IV	-0.17	-0.281*
	(0.187)	(0.12)
Occ. Class VI	0.046	-0.172
	(0.464)	(0.277)
Occ. Class V (Ref.)	0.00	0.00
Occ. VIII	-0.300	-0.147
	(0.33)	(0.223)
Died under 51	-0.46***	-0.192
	(0.138)	(0.105)
Constant	1.064***	1.507***
	(0.341)	(0.206)
Observations	1220	794
Pseudo R^2	0.026	0.014

*$P< 0.05$, ** $P< 0.01$, ***$P< 0.001$

Table 4.26: Net Fertility by Wealth and Status

Occupational	Wealth Group			
Class	**1**	**2**	**3**	**4**
Rural				
V	3.73	4.23	**4.90**	**5.06**
IV	2.82	3.20	**3.70**	**3.82**
III	2.81	3.18	**3.68**	**3.80**
II	2.77	3.13	**3.63**	**3.75**
I	2.50	2.83	3.29	3.39
Urban				
V	4.19	4.75	3.97	4.56
IV	3.16	3.59	3.01	3.44
III	3.15	3.57	2.99	3.43
II	3.11	3.52	2.95	3.38
I	2.81	3.19	2.67	3.06




Urban
Net Fertility
0
1
2
3
4
5
6
V
IV
III
II
I
Occupational Status
Wealth Group 1
Wealth Group 2
Wealth Group 3
Wealth Group 4

those testators with the highest status occupations but the lowest wealth. The group with the highest fertility is the richest testators, who also have a low occupational class (Class V – unskilled workmen)[102]. For both urban and rural unskilled workers, net fertility is higher than 3.5 children for all wealth quartiles. For the rest of the urban sample, the wealth effects are more muted than they are for the rural dwellers[103].

Overall however, the result is striking. This analysis has unearthed two strong and significant co-existing effects on net fertility – a large positive relationship with wealth, and a large negative relationship with occupational status.

Section 4.5: Explaining the Pattern

The results for section 4.4 strongly indicate a positive relationship between wealth and fertility and a negative relationship between occupational status and fertility. Establishing the timing of the decline in marital fertility within the testator group is difficult as the data constrains us to examine completed net fertility. As illustrated in chapter 3, marital fertility rates can decline significantly before they impact upon the net fertility rate – the closest existing demographic measure to the calculated testator rates used here.

However, it is entirely possible to isolate social group fore runners of the fertility transition in England via the status and wealth matrix of net fertility. As discussed the highest net fertility levels were those of the richest unskilled workmen in the rural areas (a net fertility of 5.06). As significant departure from these rates can be interpreted (although with caution) of evidence for the initiation of fertility decline.

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[102] The results for occupational classes VI-VIII are omitted here as the observations.

[103] The results are easier to interpret by examining bar charts of the data contained in table 4.24 (charts adjoin the table). Intriguingly, the patterns observed in the rural class-wealth fertility differential correspond exactly to Mace's schematic representation of the relationship between wealth and fertility (2000 p.390, figure 26.2 (d)).

On this logic, the social group forerunners of the English fertility transition were the *poorest* members of each occupational status group above class V – unskilled workers. Further all the members of wealth group 4, the richest testators, could be considered as candidates for the role of social group forerunner of the English fertility decline. The relationship between wealth and fertility has broken down in the urban areas. Perhaps the rural areas represent a pre-transitional equilibrium, and the urban dwellers are further down the line in entering a sustained fertility decline.

What is the reason for this remarkable rural (or pre transitional) pattern? Could the 'positive' wealth effect merely reflect differentials in infant mortality between the wealth groups? The answer is no. The measure of fertility used is *net* of infant and child (and indeed early adult) mortality.

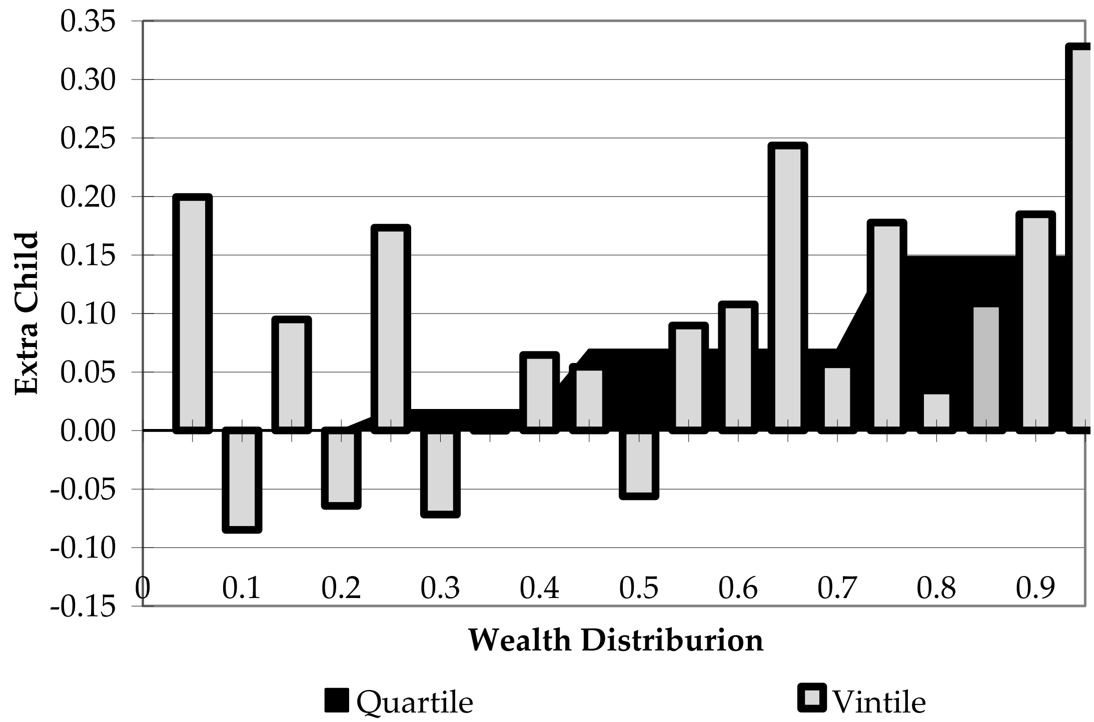
Was this pattern a result of Beckerian dynamics? Do those with lower fertility exhibit evidence of a quantity-quality trade-off? The answer is an emphatic no. In Becker's model, the quantity-quality trade-off is triggered by increased wealth. As wealth increases there should be a threshold level, beyond which people switch from demanding extra children to increasing expenditure per child. If this truly reflects what is happening, we should find a positive effect of wealth at low levels of wealth, and a negative effect thereafter. The effect does not appear in the testator data. For all wealth quartiles beyond the reference category, wealth group 1, there is a positive effect on the associated level of net fertility. Whoever is substituting quality for quantity, it is not the rich in England in the 19th century.

This conclusion is not a result of an arbitrary pooling of testator's into quartiles of the wealth distribution. When the testators are divided into vintiles, the main result still holds. Figure 4.18[104] shows the main quartile wealth effects (in terms of extra children per wealth division, relative to the lowest) alongside the vintile effects.

[104] These are calculated from a similar regression to that presented in table 4.23.

Splitting the testator sample into vintiles introduces more error in the estimated effects, but for those vintiles greater than 10 (the top half of the wealth distribution), the positive wealth effect is strong and consistent.

Figure 4.18: Main Wealth Effects

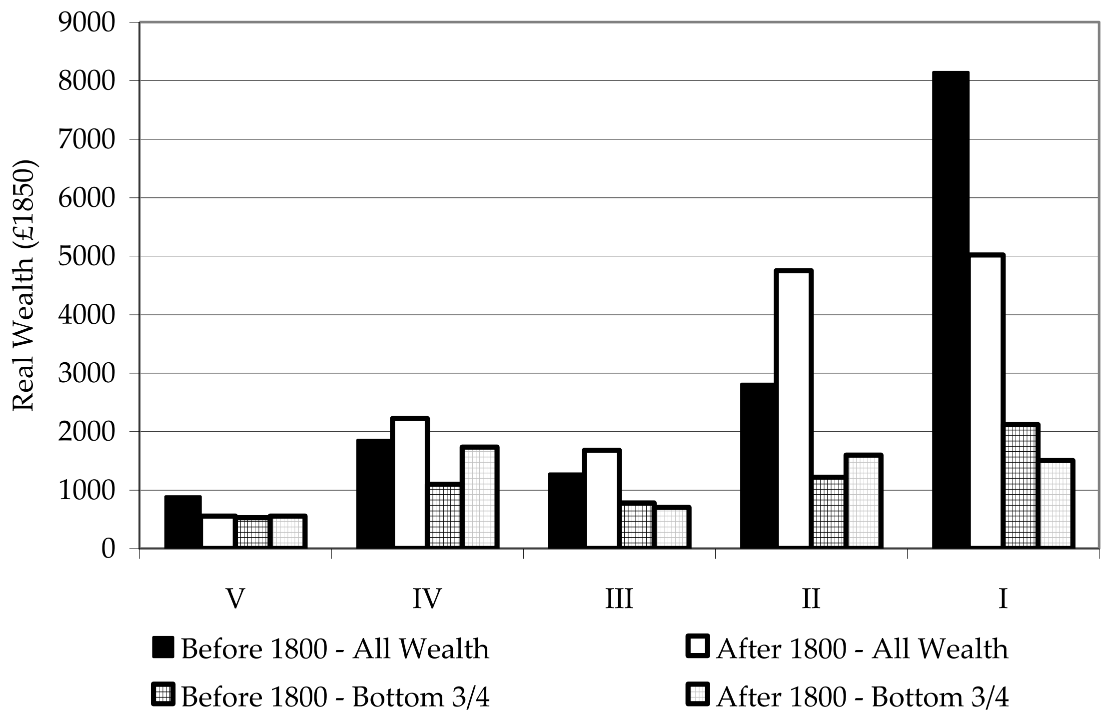


As discussed, the only testators to have an estimated net fertility below three (or very close to 3.00) are either the middle or professional classes (occupational class I), or the *poorest* members of each of the status classes I-IV (wealth group 1). Why are these groups reducing their family size?

It is a reasonable proposal that all of these variables, wealth, status and fertility, are in fact endogenous. Status can determine wealth, wealth and status can determine fertility. What is happening to the relationship between wealth and occupational status in 19th century Britain? The Victorians witnessed the full unleashing of the industrial age. Railway, factories and mining brought huge transformations to the English landscape. The social and economic transformation was enormous. The Industrial Revolution brought new economic opportunities and changed the traditional system of acquiring wealth. Inherited land and status surely meant less at this time than it had before. The old world was gone. Dynamic entrepreneurs could generate wealth for themselves and invest in human capital for their offspring.

What was the relationship between occupational status and wealth? And was this changing over the 19th century in England? Figure 4.19 shows the average wealth, by occupational status class, before and after 1800 (based upon testator year of birth). Two values were calculated – one for the entire wealth distribution, and another for the bottom three quarters. This was done to ensure that outliers, individuals with extremely high wealth, were not driving the results.

Figure 4.19: Wealth and Status, Before and after 1800

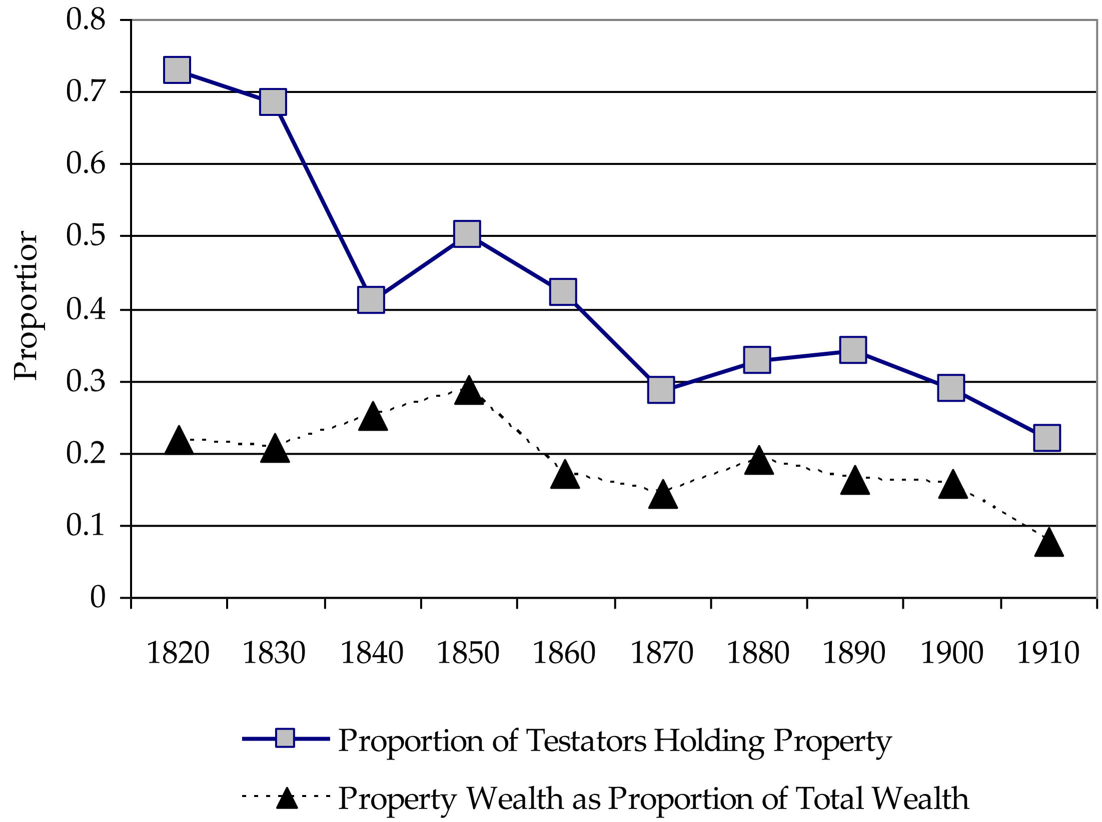


For the top occupational status class, there appears to be a breakdown in the strength of the relationship between wealth at death and occupational status. This is a striking collapse, representing a reduction of apx. 38%. When calculated for the bottom 3/4s of the sample, the reduction is nearly 30%. It is this group which has the lowest fertility in the sample. Could this change, a result of the industrial revolution, be the reason for the reduction in fertility? Within this class, those with high wealth have higher fertility than those who are relatively poorer. Could these poor, high status testators be restricting fertility in order to avoid a dilution in their wealth? In other words, are they motivated by intergenerational concerns over the concentration of wealth amongst their offspring?

Occupational status groups II (shopkeepers, merchants), III (skilled workmen) and IV (semiskilled workmen) all have an increased mean level of wealth associated with their status class. These increases, along with the simultaneous decrease in this value for the highest status group, imply the breakdown of the relationship between inherited status and final wealth at death. More empirical observations from the testator database support the notion that inherited status is declining in importance as a determinant of wealth. Land and property, traditionally the most unequally distributed asset (and especially so in England) is declining in importance as a proportion of wealth, as figure 4.20 illustrates.

In summation: by examining the relationships between wealth, status and fertility, we can see that the most clearly identified fertility decline group, occupational status class I, experience a step decline in the mean value of their estates at death. Within this group, it is the *poorest*, the members of wealth group 1, who have the lowest fertility. It is speculated that this low fertility is a result of a desire to preserve the concentration of wealth within a family and between offspring.

Figure 4.20: Proportion of Testators Leaving Property, 1820-1910



Section 4.6: Conclusion

This chapter has introduced the primary original contribution of my thesis. The testator database has been described in full and thorough robustness checks have been performed upon this new data. For the first time, we can examine the economic correlates of the English fertility decline at the individual level. The analysis has revealed two important and opposing effects on fertility – a positive wealth effect, and a negative status effect. It is speculated, with support from the database, that the low fertility of the jointly highest status and poorest in wealth testators is a result of the desire to avoid downward social mobility. In order to confirm this hypothesis, a formal theory is constructed and tested with the testator data, in chapter 6.

Appendix to Chapter 4

Expected number of Children from Regressions 3 and 4 (4 in parenthesis), no marriage/childless adjustment

	Wealth Group 1	Wealth Group 2	Wealth Group 3	Wealth Group 4
Rural				
Occ Class I	1.65(3.02)	1.79(3.42)	2.43(3.97)	2.84(4.1)
Occ Class II	1.93(3.34)	2.1(3.78)	2.85(4.39)	3.32(4.53)
Occ. Class III	2.57(3.39)	2.79(3.84)	3.79(4.45)	4.42(4.59)
Occ. Class IV	2.44(3.4)	2.66(3.86)	3.6(4.47)	4.21(4.61)
Occ. Class V	2.89(4.51)	3.15(5.11)	4.27(5.92)	4.99(6.11)
Urban				
Occ Class I	2(3.39)	2.17(3.85)	1.87(3.22)	2.3(3.7)
Occ Class II	2.34(3.75)	2.55(4.25)	2.19(3.56)	2.69(4.08)
Occ. Class III	3.11(3.8)	3.39(4.31)	2.91(3.61)	3.58(4.14)
Occ. Class IV	2.96(3.82)	3.22(4.33)	2.77(3.63)	3.41(4.16)
Occ. Class V	3.51(5.06)	3.82(5.74)	3.29(4.8)	4.04(5.51)

Expected Number of Children from regressions 1 and 2, no marriage/childless adjustment

	Wealth Group 1	Wealth Group 2	Wealth Group 3	Wealth Group 4
All Marriages				
Rural	2.65	2.77	3.70	3.96
Urban	3.27	3.09	2.86	3.39
At least 1 Child				
Rural	3.21	3.49	4.04	4.03
Urban	3.60	3.38	3.36	3.70

Nuptiality: Long Run trends

Source: Wrigley and Schofield 1981 p.260

Wrigley and Schofield calculated along run estimate of the proportion never married in England via 'back projection' from information recorded from parish registers. The series reports remarkably high levels for men born in the 17th century, with a peak in 1651 (over ¼ of men born between 1646 and 1661 never married) preceding a large decline until apx. 1736 before a smaller increase to the male cohort of 1811.

Table 1: Testator Sample by Occupational Class

Class	Observations, 1820-1911	Proportion of Sample
I	666	0.23
II	1,015	0.35
III	437	0.15
IV	232	0.08
V	109	0.04
VI	8	0.00
VII	0	0.00
VIII	34	0.01
No Occupation listed	420	0.14
Total	2921	1.00

Source: Wills Database

Table 2: Non Property Holding Testators, Amount of Bequest

Gross Bequest	Observations	Proportion	Cumulative Proportion
<50	43	0.04	0.04
50-100	97	0.10	0.14
100-200	136	0.14	0.28
200-300	93	0.09	0.37
300-400	67	0.07	0.44
400-500	42	0.04	0.48
500-1000	174	0.17	0.66
>1000	343	0.34	1.00
Total	995	1	

Source: Wills Database

Table 3: Age at Death

		Wealth Group			
	All	1	2	3	4
All	65.11	64.89	66.13	67.77	70.16
Before 1800	74.78	75.71	76.3	75.06	76.45
After 1800	62.98	62.72	62.89	65.90	68.52
Rural	64.73	63.98	64.79	66.53	70.50
Urban	65.37	65.53	67.03	68.75	70.03

Source: Wills Database

Chapter 4A: Malthus to Modernity (with Prof. Greg Clark)

The testator database detailed in chapter 4 has been linked to similar data collected by Professor Greg Clark. We have worked together to produce a long run database in order to examine the wealth fertility relationship from 1500-1910.

Abstract

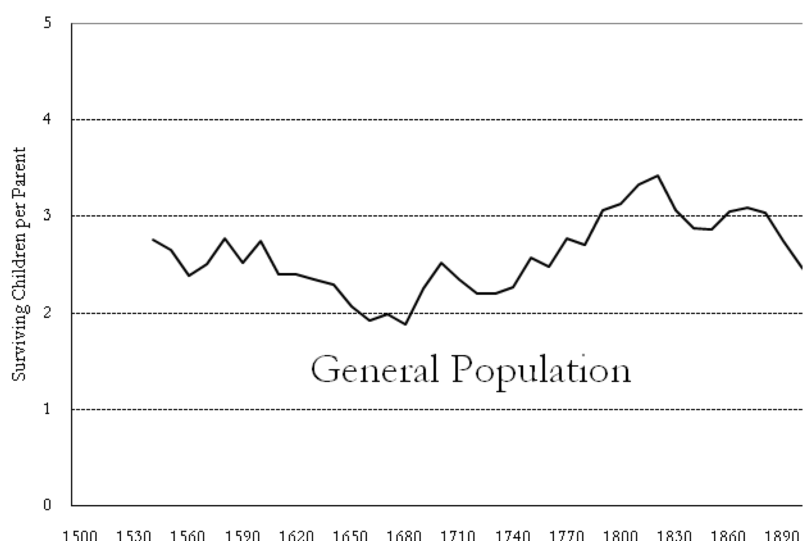
The Industrial Revolution seemingly involved two profound changes, separated by 120 years: the classic *Industrial Revolution* of 1770, and the *Demographic Transition* of 1890. The first was the appearance of higher innovation rates, creating modern output growth. The second was a decline in fertility, first in the upper classes, and then among the masses, that channelled all economic growth into higher living standards. That 120 year chasm has been unbridgeable in unified accounts of the transition to modern growth. Measuring wealth and net fertility from wills we show that the *Demographic Transition* actually began at the same time as the *Industrial Revolution*. Net fertility among the rich fell rapidly towards modern levels for marriages formed after 1800. But aggregate fertility rose in these years, because net fertility among the poor increased to equal that of the rich. Only in the 1890s did aggregate fertility rates begin to decline.

Section 4A.1: Introduction

The two great events that created the modern economic world were the *Industrial Revolution* and the *Demographic Transition*. The *Industrial Revolution* increased rates of growth through the supply for the first time of a constant stream of innovations. Before the *Industrial Revolution*, however, all technological progress had been absorbed in raising the stock of people, not in raising living standards. In the pre-industrial demographic regime, at least in England, higher income groups had substantially higher net fertilities. Had the pre-industrial demographic regime continued then much of the accelerated efficiency advance of the economy would similarly have been consumed in maintaining ever larger populations. Eventually in England, for marriages formed in the 1890s and later there was a substantial decline in gross fertility levels, and hence a dramatic slowing of population growth rates. After 1910 most economic growth went into raising living standards, not increasing populations.

The *Industrial Revolution* can be dated to 1770-1800, while the *Demographic Transition* is a phenomenon of the years 1870-1910. Thus there is a 100 year gap between these two events. Figure 4A.1, for example, shows the number of surviving children per woman in England by decade from the 1540s to the 1910s from Wrigley and Schofield. Only in the late nineteenth century is there any sign of a decline in net fertility. The Industrial Revolution itself is associated with an increase in net fertility which led to an unprecedented fast rate of population growth in England in these years.

Figure 4A.1: Net fertility trends in England, 1540s-1910s



Source: Wrigley and Schofield, 1981, 528-9, table A3, Wrigley, 1969, 196, Table 5.16.

Attempts to develop unified models of the transition to modern economic growth, particularly those that emphasize human capital investment, have grappled unsuccessfully with this huge delay in the onset of the *Demographic Transition*. In particular in England the Industrial Revolution coincided with an increase in fertility, not a decline.

Here we show that starting with the generation born in the 1770s there were in fact significant changes in fertility in *Industrial Revolution* England. In particular economically successful men switched from levels of net fertility of 4-5 children, to levels of 2.5-3, close to the general population. This important switch does not show in the aggregate data because at the same time the net fertility of poorer individuals, the bulk of the society, increased in these years to equal that of the rich.

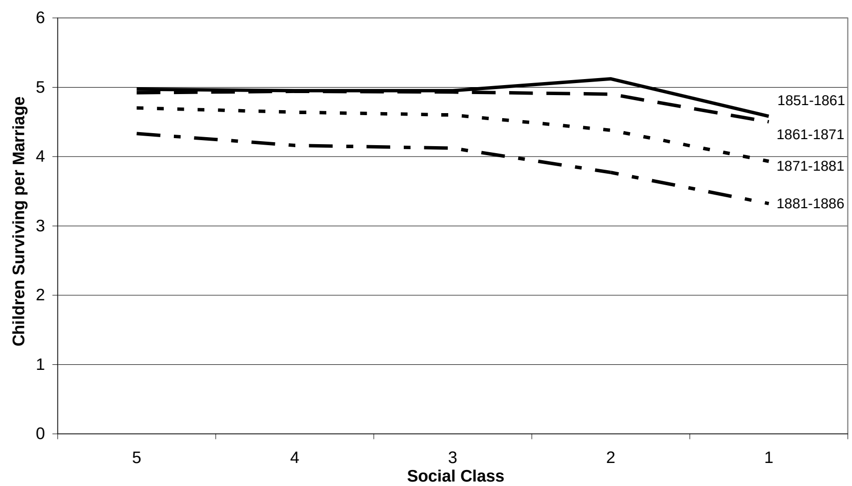
Thus by the time of the onset second fertility transition in 1870-1910 the net fertility of the poor is if anything higher than for the rich. This creates the false impression that the fertility regime of the early and middle nineteenth century somehow represents the entire pre-industrial period. In fact it is a very different regime, and close to that of the modern world. Amazingly, despite the enormous quantities of research into the demographic experience of pre-industrial England, we seem to have missed a profound transformation in the demographic regime that was occurring simultaneously with the *Industrial Revolution.*

Section 4A.2: The Data

We know a lot about aggregates levels of gross and net fertility in England from 1540 onwards from parish records (until 1837), then from general birth registration. Parish records however, reveal nothing of the economic and social status of parents. Thus we have little or no information on both gross and net fertility as a function of wealth and social status before a report associated with the 1911 census that correlated fertility with occupational status for marriages formed from 1851 onwards.

Figure 4A.2 shows what this 1911 report suggests. It shows net fertility for marriages of 25 or more year's duration by social class, where the lower numbers are higher classes, by marriage cohort starting in 1851-60. Before 1871 it seems that there is little or no difference in fertility by social class, with the net fertility of all these groups relatively high. The conventional picture for England before 1871 is thus that fertility within marriage was unregulated for marriages formed before 1871, with only the lat average age of marriage, and the substantial percent never marrying limiting gross fertility. There was only one fertility transition which began sometime after 1871.

Figure 4A.2: Net Fertility by Social Class, Married Men, 1851-86



Source: Census of England and Wales, 1911, Volume XIII: Fertility of Marriage, Part II, p. xcvii.

Here we develop a source which allows us to examine both gross and net fertility as a function of wealth and social class for cohorts born before 1820. This is the wills of male testators. Men only were used since for most of the period women had only residual claims on their property after marriage, and left wills typically only if single or widowed. There are millions of extant wills in England for the years after 1400, and a significant fraction have been transcribed and abstracted. The wills before 1858 come mainly from local Ecclesiastical courts in Essex, Suffolk and Surrey (before

1858 church courts handled all matters of wills and testaments). Some also come from the Prerogative Court of Canterbury, which handled estates of higher value with assets distributed across a wider area. After 1858 the wills come from the records of the Principal Probate Registry in London has all probated wills in the south of England after 1858.

For wills after 1841 we are also able to link many testators to individual census records giving the age of the testator, and their spouse, at death. For the earlier wills we can get the age at death for a subset of the testators from parish records giving baptisms and marriages.

Description of data collection for Wealth and Fertility Project

From 1858 onwards, all wills proved in England are recorded at the Principal Probate Registry in London[105]. For this sample, it was decided to collect data on individuals residing in Essex and Ipswich. For Essex, the Probate year books were searched for males from these counties, who left either a will or probate. This was done for 1862, 1872, 1882, 1892 and 1902. The probate registers allowed the identification of individuals via name, address, occupation and spouse. This information was then used to link each individual to his census entry of the previous year. The original enumerator's returns were used for this purpose[106]. The sample was increased further by linking probate records of 1912 to census records of 1902.

In order to efficiently build a sample with the most information per record, only those testators successfully linked to the census were selected for the sample. As successful linkage was often based upon the name of a spouse, there was a bias towards selecting married men for this period for the Essex half of the sample. For Ipswich, census and registry information was taken from digitized census and vital registration

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[105] For further infor;qtion see http://www.hmcourts-service.gov.uk/infoabout/civil/probate/registries.htm

[106] The census returns were obtained from www.ancestry.co.uk.

data from the UK data archive dataset *SN 5413 - Sociological Study of Fertility and Mortality in Ipswich, 1872-1910* compiled by Ros Davies and Eilidh Garrett[107]. The strategy here was to search only for those individuals who were already linked from the vital register (death record) to the census. Again, there may be a bias here towards an overrepresentation of married men if a criterion for the linking between the census and the death record was the name of the deceased's spouse. Ultimately, 2,000 records from Essex and Ipswich, all containing both probate and census information, formed the post 1858 sample.

Will Coding

The reported gross evaluation of wealth in the probate indices omit any property value held by the testator. Further the census sources lack information on lifetime fertility history. Therefore, each will in the sample was read thoroughly and coded for mentioned property, land and named children. Property was described into the database as being located in towns, in London or if they were business premises (such as grocer's or carpenter's shop). Land acreage was also noted. Surviving children were counted and a judgment was made on whether the will could be considered as a reliable source for both property and family information.

For those testators where we do not have a direct estimate of age at death we can infer this from the observed features of the testator such as their marital status, numbers of children reported in the will, numbers of grandchildren, whether one of their parents is alive, and whether they have a child aged 21 or above. Appendix 1 reports the various methods used to fill in missing values for testators. The regression used to predict age has an R^2 of 0.49. Thus we are able to form cohorts of male testators by birth year.

[107] Associated publications: Drake and Razzell (1997), Garrett and Davies (2003) and Razzell and Spence (2006).

The assets of testators were estimated in two ways. For many wills probated in 1786 and later we get an estimate of the "personalty" – assets other than real estate – from estate tax declarations. We add these to estimates of real estate from houses and land mentioned in the will to get a total value of the bequest. In only about 20% of cases where land was bequeathed was the area of the land indicated. But we are able to approximate the area from other details of the will such as the testator's occupation and cash bequests. Appendix 2 details how the area of land bequeathed was estimated in the remaining 80% of cases.

The major flaws with using probate valuations as true measures of wealth other than real estate are the omissions of settled property and debts and credits (Owens et al 2006, 384). Before 1898, the reported probate valuations are estimates of "the gross value of an individual's unsettled personal property", and were estimated for tax purposes (Owens, Green, Bailey and Kay 2006, 383). After 1898, settled property was included (Rubinstein 1977, 100). The executors or administrators of the wills submitted estimates, and because of a fine for undervaluation "the gross valuation was always likely to be an upper estimate of an individuals worth" (Owens et al. 2006, 386).

This "gross" estimate omitted any debts or credits due by, or to, the deceased individual. For the period after 1881, Rubenstein estimates that the difference between the gross and net value of an estate, was on average 5 to 15% (Owens et al 2006, 387). Before 1881, effects are reported as an approximation, under a certain set threshold level (e.g. under £50, under £100). As Owens et al. noted, the effect of these tax bandings is to inflate the already rough estimates of wealth (Owens et al. 2006, 387).

For earlier years the estimated assets of testators were constructed from the information in wills by adding together the cash payments directed by the testator, with the estimated value of houses, land, animals, grain bequeathed by the testator. For a subset of 506 wills we have both estimates. In these overlapping cases the bequests estimated in the second fashion are 0.66 of the bequests estimated in the first way. For consistency the first set of estimates was thus multiplied by 0.66. All values were deflated to a common price level of the 1630s to get a unified measure of the real bequest over the entire period.

In the course of the years 1500-1914 the real rate of return on assets in England declined significantly. The annual real purchasing power associated with a £1 of assets thus declined significantly over time as interest rates fell. We thus calculated an expected "bequest income stream" for each testator over time as a better way of quantifying the average value of the bequest.

Table 4A.1 summarizes by period the numbers of men for which we have information on assets at death and numbers of surviving children by half century birth cohorts. We have 7,155 wills coded so far, with about 200 per decade for men born between 1700 and 1850.

We also coded the occupations of the testators into seven socio-economic status categories. These differ from the more modern socio-economic status classification because of the prevalence in status descriptions on wills even as late as the late nineteenth century of such terms as "yeoman," "husbandman" and "gentleman." But they do seem to capture socio-economic differences. Table 4A.2 shows for men born before 1770 by socio-economic status average assets, the percent literate (as revealed by a signed will), and average age at death. Average assets and literacy were strongly correlated with the assigned socio-economic status.

There was also some correlation of the estimated age of death, with gentry testators on average dying five years later than labourers.

Table 4A.3 shows similar correlates of socio-economic status with assets and

Table 4A.1: Summary of the Wills Data, by birth period

Period	N	Ave Assets (£)	Ave Asset Income (£)	Ave Age at Death
1450-99	200	246	17.0	53
1500-49	615	440	31.6	57
1550-99	1,943	366	26.2	55
1600-49	267	689	43.7	54
1650-99	553	769	38.6	61
1700-49	1,164	504	26.7	63
1750-99	1,176	1,530	66.5	65
1800-49	1,146	3,240	152.3	66
1850-79	53	2,065	106.7	-*

Note: *The 1850-79 cohort has a censored age distribution.

average age at death for men born after 1770. Again socio-economic status correlates strongly with average assets, and is also correlated with average age at death. Now the average for the gentry is 70, as opposed to 64 for labourers.

Table 4A.2: Social Status, Assets and Literacy, pre 1770 births

Social group	N	Average assets (£)	% literate	Ave Age at Death
Gentry	265	3,882	90	61
Merchants/ professionals	213	1,264	96	57
Farmers	1,586	517	61	61
Traders	497	393	74	58
Craftsmen	942	329	64	59
Husbandmen	639	161	36	57
Labourers /Servants	216	104	23	55

The numbers of surviving children for each testator were estimated from the wills in three ways. First there are wills where all the children were recorded. Here we counted dead children who had produced children of their own as "surviving" children also. Next there were earlier wills where girls tended to be omitted. In wills written before 1550 substantial numbers of daughters are omitted where there is a male heir. Thus the average family which reported one male heir after 1550 reported 1.55 daughters, but before 1550 only 0.89 daughters. We thus have to infer the number of daughters for wills before this date. We do so by multiplying each reported daughter in a will by 1.49, to get an estimated total number of daughters. Finally there are wills where besides the children specified there were also indications of an unspecified number of additional. Where we could determine in a will that the number of children was "≥ n" we estimated the expected number of children from the average of wills in this category (see the appendix).

Table 4A.3: Social Status, Assets and Average Age, post 1770 births

Social group	N	Average assets (£)	Ave Age at Death
Gentry/Independent	187	8,326	70
Merchants/professionals	335	4,392	67
Farmers	368	1,750	66
Traders	465	1,783	64
Craftsmen	350	865	64
Husbandmen	99	457	66
Labourers/Servants	65	253	64

Estimating net fertility from wills will always tend to produce a lower bound estimate, since the errors will typically be the omission of some children from the will. But the wills will show relative net fertility levels by asset wealth, by socio-economic status, and over time.

Table 4A.4: Net Fertility Averages (outside London)

Birth period	N	% Single*	Ave. children married	Ave children all
1450-99	200	3	3.49	3.39
1500-49	589	3	3.40	3.30
1550-99	1,967	11	3.20	2.85
1600-49	236	17	3.15	2.61
1650-99	307	13	3.28	2.85
1700-49	1,083	15	3.07	2.61
1750-99	1,139	17	3.05	2.53
1800-49	1,140	-[#]	2.78	-

Notes: *The percent single includes some childless widowers whose earlier marriage was not revealed by the will.

[#]The sample in these years was collected in such a way that single men were less likely to be sampled.

Table 4A.4 shows by birth half century the percentage of men dying never married, as well as the average number of surviving children per married or widowed man, for men dying outside London.[108] If a man is a widower without any surviving children, then there may be no evidence in the will of his earlier marriage. Thus the estimate of the percentage single is an upper bound. The final column shows the overall implied net fertility for testators. If we compare these net fertility rates to the national totals calculated by Wrigley and Schofield, shown in figure 4A.1, we see that the net fertility of testators is above that of the general population until the 1750-99

[108] London had a distinctive and different demographic regime for men born before 1810.

cohort when it drops substantially below. Below we will derive a more precise estimate of net fertility by decadal birth cohorts for the poorest testators that we can compare to the national averages.

Section 4A.3: Characterising the Wealth Fertility Relationship

For birth cohorts earlier than the 1770s, and thus typically for marriages formed before the 1800s, there is a strong positive association in all periods between wealth at death and net fertility. But with surprising rapidity this association disappears for the generations of men born in the 1770s and later. That disappearance involves both a substantial decline in the net fertility of the richer testators after 1770, but also a modest but quite significant increase in the fertility of the poorest testators.

To demonstrate this we divide testators into rough quartiles, based on the implied income stream from the assets of the sample of testators as a whole. Thus in each period the poorest group are those with an implied asset income below £6 per year (in 1630s prices), the richest are those with implied asset incomes above £31. We then estimate for ever married men the coefficients of the regression

$$N = a + \sum b_j DINCQ_j + \sum c_j D1770 \cdot DINCQ_j + \\ h_1 DLON + h_2 DTOWN + h_3 DFARM + e$$

where N is the number of surviving children, $DINCQ_j$ an indicator for each of the four asset groups, D1770 an indicator for a testator born after 1770, and DLON, DTOWN and FDARM indicators for testators living in London, some other town, or on a farm (with these effects being estimated separately for cohorts born before 1760, 1760-1809, and 1810 or later). Table 4A.5 shows the estimates of these various effects for the whole panel of wills.

Also shown are the implied levels of net fertility for men of the four wealth classes who were resident in country villages before and after 1770. The wealth effect on net fertility is very powerful statistically and quantitatively for men born before 1770, but completely absent for those born after this. Wealthier men born before 1770 also have net fertilities well above those of men in the general population. After 1770 a completely new relationship between wealth and fertility emerges, much more like that of the modern world, where if anything the testators as a whole now have lower fertilities than the general population.

The change in behaviour for both groups is remarkably fast. Table 4A. 6 shows by twenty year periods around 1770 the net fertilities of the richest and poorest testators. The drop in net fertility for the rich is immediate after the 1770 birth cohort. The rise in fertility by the poorest group is potentially a little more protracted. While measured net fertility rose for the 1770-89 cohort, it was not any higher for the 1790-1809 cohort, so that the true date of transition could be anywhere between the 1770 and 1810 cohort.

Table 4A.5: Children per married man by wealth

Coefficient	Estimate	Standard Error	Implied Level
Constant	0.880	.027	
Assets 1	0.000	-	2.41
Assets 2	0.198**	.035	2.94
Assets 3	0.348**	.034	3.41
Assets 4	0.555**	.036	4.20
Assets 1 – 1770	0.191**	.046	2.92
Assets 2 – 1770	-0.039	.055	2.83
Assets 3 – 1770	-0.168**	.051	2.89
Assets 4 – 1770	-0.373**	.041	2.89
DLON pre 1760	-0.675**	.068	
DLON 1760-1809	-0.221	.135	
DTOWN pre 1760	-0.203**	.048	
DTOWN 1760-1809	-0.145**	.051	
DFARM pre 1810	0.122*	.027	

Table 4A.6: Net Fertility by Birth Cohorts[109]

Birth Cohort	Obs	N poor	N Rich
1690-1709	179	2.54	3.78
1710-29	315	2.32	3.79
1730-49	499	2.41	4.20
1750-69	350	2.37	4.29
1770-89	384	**3.17**	**3.06**
1790-1809	459	**2.39**	**2.37**
1810-29	508	**3.05**	**2.97**
1830-49	302	**2.68**	**3.06**
1850-69	46	**2.90**	**2.88**

Table 4A.7: Net Fertility by First Marriage Cohorts

Marriage Cohort	Obs	N poor	N Rich
1720-39	176	2.52	3.89
1740-59	345	2.27	3.74
1760-79	502	2.37	4.42
1780-99	330	2.50	4.15
1800-19	397	**2.98**	**2.97**
1820-39	458	**2.67**	**2.41**
1840-59	528	**2.90**	**2.88**
1860-79	255	**2.83**	**3.17**

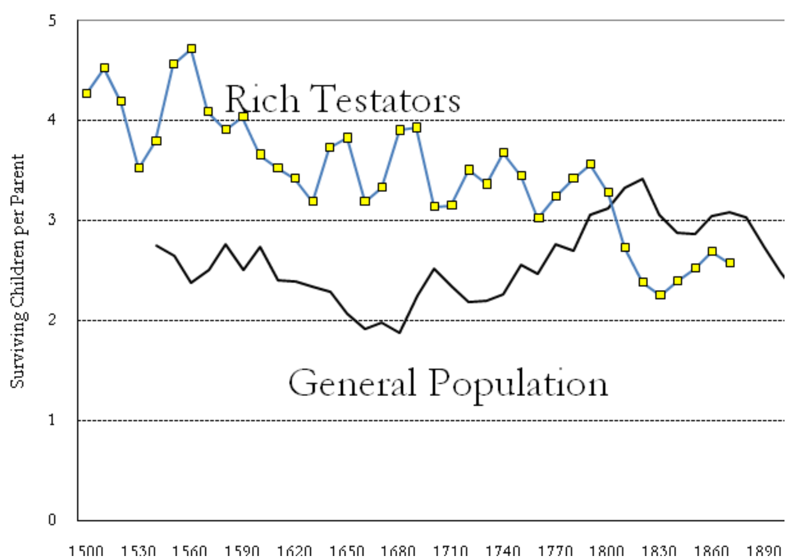
The change is indeed even slightly more abrupt statistically if instead we organize testators by the estimated date of their first marriage. In this case it is marriages formed in 1800 or later which first show the absence of a wealth gradient to net fertility. Table 4A.7 shows the transition measured in terms of first marriage cohorts. Figure 4A.3 shows the implied net fertility of the top quartile by wealth of male

[109] Because N is a count variable the regression was estimated as a negative binomial. The estimated coefficients thus have to be exponentiated to get the fertility levels by asset class.

testators, by decade of marriage, from the 1500s to the 1870s, adjusting for location and the share of men single. In comparison is shown the implied net fertility of all men in England from Wrigley and Schofield. Rich testators have a significantly higher net fertility than the population of England as a whole until the 1800s. Then their net fertility falls below that of the general population. Their fertility falls just as that of the general population increases.

Since wealth was associated with social class, before 1800 high status groups such as the gentry, professionals and farmers had higher fertility than low status groups such as labourers. After 1800 this status differential ends. However fertility seems to attach to social status only because of the average wealth differences between the different groups. Once we control for wealth, status differences in net fertility disappear before and after 1800.

Figure 4A.3: Net fertility, general population and rich testators



Note: The observation for testators for the 1500s is the average of the 1490s and 1500s first marriage cohorts, and so on.

Source: As figure 4A. 1.

The mechanics of the convergence in fertility of rich and poor testators for marriages after 1800 is unclear. Table 4A.8 shows mean ages of marriage for male testators, outside London, by asset class before 1800, and 1800-59. The age of marriage is estimated for this group by matching them to parish and non-conformist records of marriages, births, and baptisms.[110] The age of first marriage did not differ by asset class before 1800. But after 1800 a statistically significant gap opens up between the age of marriage of the poorest and richest testators, with the rich marrying later.

Table 4A.8: Mean Marriage Ages by Asset Class, pre and post 1800 Marriages, Male Testators

Assets	N	Pre	N	Post
1	67	28.1	74	26.8
2	106	27.2	45	27.3
3	101	27.8	46	28.3
4	113	27.7	116	29.8**

** - significantly greater than for the poorest testators, and for rich testators before 1800, at the 1% level.

Table 4A.9: Mean Marriage Ages by Asset Class, pre and post 1800 Marriages, Wives

Assets	N	Pre	N	Post
1	32	24.0	57	23.1
2	46	24.8	34	23.9
3	53	24.0	32	24.1
4	63	23.1	90	25.0*

* - significantly greater than for the poorest testators post 1800, and for rich testators before 1800, at the 5% level.

110 The matching was done using a very imperfect source, the International Genealogical Index. This has a sampling of birth, baptismal and marriage records for English parish and non-conformist registers.

The age of the wife, however, is more important in determining potential births from a marriage. Table 4A.9 shows that similarly for women before 1800 there is no sign of differences in first marriage age by asset class. However after 1800 the first wives of the richest men average 2.2 years older than those of the poorest men, and the difference is statistically significant at the 5 percent level. Thus the timing of marriage can perhaps explain something of these fertility trends, though the effect is not great enough to explain all the change.

Using the link to parish records of births and baptisms we also estimate for a subset of testators, survival rates for children by wealth class for marriages before and after 1800. For each testator we have the number of births identified in the parish records, as well as the number of those children still alive at the time of the will.[111] There will be many missed births in this linkage. Births were not recorded, or people moved between parishes with surviving registers and those without, or people moved between the established church of England. So we just have a sampling of the births for each father.

In this estimation we also control for a number of factors: residence (London, other towns, rural areas, and specific farm residence), gender, time period (pre 1650, 1650-1699, 1700-49, 1750-99), and time since birth. Table 4A.10 shows these estimates.

Before 1800 the higher wealth classes have a significantly better child survival rate, 70% surviving to 15-29 as opposed to about 62% for the poorer. After 1800 this differential disappears, with the survival rate for the children of the poorer testators rising to nearly 70%. We can compare these rates to those estimated from parish burial records. Before 1800 these suggest 65% of those born live to age 20-24. In 1861 that

[111] In this exercise we counted as survivors only children still living at the time of the will, not those dead but with surviving children of their own.

proportion had increased slightly to 69%.[112] Our survival rates underestimate survival, since some surviving children were omitted from wills. But even taking this into account, wealth differences in survival, and changes in survival rates over time, can play little role in explaining net fertility changes after 1800.

Table 4A.10: Survival Rates, 15-29 years since birth, by Asset Class, pre and post 1800

Asset Group	Fathers	Births	Survivors (fraction)	Survival Rate (corrected)
PRE 1800				
1	192	663	0.60	0.63
2	244	951	0.61	0.61
3	293	1,300	0.68	0.69**
4	314	1,469	0.68	0.71**
All	1,043	4,383	0.65	0.66
POST 1800				
1	46	152	0.70	0.71
2	49	159	0.69	0.68
3	64	222	0.68	0.69
4	115	450	0.65	0.66
All	274	983	0.67	0.69

Note: ** = Significantly different than for asset class 1 at the 1% level.

Table 4A.11 shows the gross fertility rates the data in table 4.10 implies by wealth classes before and after 1800. For the richest groups there is still the clear implication that their gross fertility fell significantly in marriages formed after 1800. For the poorest, taking into account better survival, gross fertility seems to have risen modestly.

[112] Wrigley et al.,1997, pp.262, 291. Woods, 1982, 377.

Table 4A.11: Net and Gross Fertility, pre and post 1800

Asset Group	Net Fertility Pre 1800	Gross Fertility Pre 1800	Net Fertility Post 1800	Gross Fertility Post 1800
1	2.37	3.76	2.84	4.00
2	2.96	4.85	2.54	3.74
3	3.46	5.01	2.80	4.06
4	4.25	5.99	2.83	4.29
All	3.26	4.93	2.75	4.45

Section 4A.4: The Mechanics of the Fertility Patterns

Fertility among the rich could have been reduced as a combination of two different forces. The first is "spacing" – adopting practices that increase the interval between births. The second is "stopping" – keeping birth spacings the same but terminating the sequence of births earlier. This could in part arise just as a product of a later age of marriage for women. The demographic transition of the late nineteenth century has been attributed to "stopping" primarily. It is interesting thus to ask which force explained this earlier decline in the fertility of the rich.

For a subsample of testators we can examine spacing versus stopping through observations on the first to second child birth interval, and the interval between marriage and the last observed birth. Table 4A.12 shows these statistics. Given our partial data from links to parish records we estimate only the 1-2 birth interval for first marriages, and the time from first marriage to the last observed birth with the first wife. The 1-2 birth intervals clearly suggest that the differences in gross fertility between rich and poor before 1800, and the declining gross fertility of the rich after 1800, are not explained by any differences in spacing of births. This interval is stable over time, and does not differ between income classes before of after 1800. Earlier stopping, or differences in the age of marriage, must explain the lower fertility of the poor before 1800, and the decline in fertility of the rich after 1800.

Table 4A.12: Birth Intervals, marriages pre and post 1800

Asset Group	N	Interval births 1-2	N	Interval marriage-last	Births observed
PRE					
1	103	2.23	165	9.5	3.9
2	157	2.23	212	11.6*	4.4
3	189	2.36	245	12.0**	4.9
4	192	2.20	244	13.2**	5.5
All	641	2.26	866	11.7	4.8
POST					
1	33	2.19	64	9.5	3.9
2	24	2.40	43	9.6	3.7
3	18	1.99	35	10.5	4.5
4	57	2.21	96	10.5^	4.4
All	132	2.21	238	9.9^	4.1

Note: ** = Significantly different than for asset class 1 at the 1% level. * = Significantly different than for asset class 1 at the 5% level, ^ = Significantly different than for before 1800 at the 5% level.

Given our partial data on birth dates calculating the time to the last birth is much more difficult. If, for example, of n births in a family the timing of only 1 is observed, then on average the calculated fertility span would be half the actual fertility span. Our estimates of this will thus have a downward bias. Since we typically observe for this sample 80 percent of births, that bias will not be too great. The table reports the average time between marriage and the last observed birth. Though an underestimate of the likely true fertility span, but is not far from an analogous figure for the general population reported in Wrigley et al[113]. (1997).

Before 1800 the higher fertility of the rich shows up in a higher fertility span. For asset group 4 this was 13.2 years compared to 9.5 for asset group 1, a quantitatively and statistically significant difference. The lower family sizes of the poorer testators were mainly explained by an earlier cessation of reproduction. Similarly when the fertility of the rich declined after 1800, this was associated with the earlier stopping of births after marriages commence among the rich.

Part of the change might come mechanically from the later age of first marriage among the wives of the richest men after 1800. But we can also estimate, for a much smaller sample, the average age of wives at the last observed birth. This is shown in table 4.13. Again the small numbers make any conclusions tentative. But the average age of wives at last birth fell after 1800, and fell in particular for those in the higher wealth classes. This implies that the declining gross fertility of the rich after 1800 was not only the result of later marriage by wives, but also the result of earlier stopping of fertility. Again for the poorest of the testators there is no sign of any changes in behaviour before and after 1800.

If all of the differences in fertility over time and between wealth classes were caused by differences in starting and stopping behaviour then when we estimate the reproductive span controlling for the number of children these other variables should have no effect. That is if we run the regression

$$SPAN = a_0 + a_1 N + \sum b_j DINCQ_j + \sum c_j D1770 \cdot DINCQ_j + e$$

[113] We infer we observe 80 percent of births in this sample, from the ratio of children in the will with known birth dates to all children in the will. Thus in 80 percent of these cases the last birth observed will be the true last birth. Assuming a constant later birth interval of 2.5 years this implies an average underestimation of just over 0.6 years of the true reproductive span.

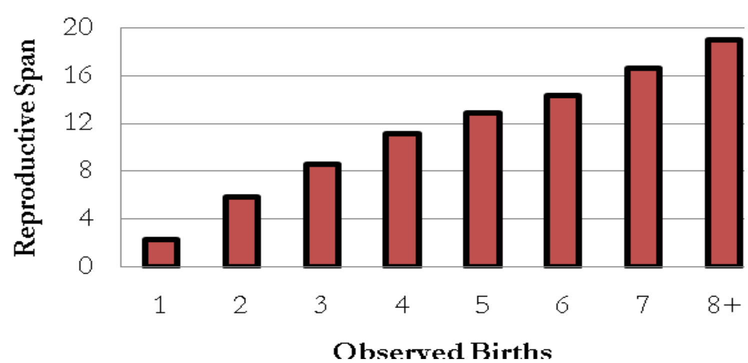
Table 4A.13: Age of wife at last observed birth, marriages pre and post 1800

Asset Group	N PRE	Age of wife at last observed birth	N POST	Age of wife at last observed birth
1	20	34.3	48	33.7
2	42	34.5	31	32.8
3	41	38.1	23	33.1**
4	51	36.8	69	35.2
All	154	36.2	171	34.1**

** - significantly lower than for pre 1800 at the 1% level.

the coefficients b_i and c_i should all be insignificantly different from 0. This indeed is the result we find. Grouping families into those of 1, 2, 3, 4, 5, 6, 7, and 8+ observed children we find the observed reproductive span is heavily dependent on the number of births observed. Figure 4A.4 shows the pattern for the poorest group of testators before 1800. But once observed births are controlled for it does not change for marriages after 1800, and it does not vary across wealth classes. A family with eight or more births observed would have a predicted reproductive span of 19 years for the poorest testators before 1800, and 18.8 years after 1800. For the richest testators before 1800 the predicted span would be 19.2 years, after 1800 19.1 years. Thus the major observed direct correlate of the earlier fertility differences, and the later convergence in fertility, is variations in the reproductive span of marriages.

Figure 4A.4: Observed Births and the Reproductive Span



Section 4A.5: Why Fertility Declined

The wills data clearly indicates that a Demographic Revolution accompanied the Industrial Revolution. Net fertility within marriage fell sharply for the richest testators, starting with marriages commencing in the 1800s. This occurred, however, at a time of generally increasing fertility rates amongst the poorer population, concealing this trend in the aggregate data. The source of the decline in the fertility of the rich implies that it had to be partly a conscious control of fertility, through *coitus interruptus* or other early birth control methods.

Could this just be a product of income? That is, could the general rise in incomes in the Industrial Revolution have led the population into the range where for the richest they entered a level of income beyond which the modern negative association of income and fertility finally emerged?

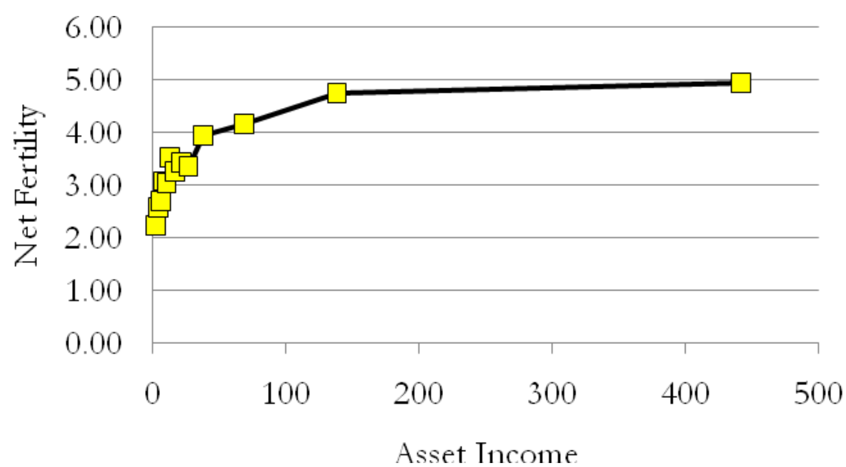
Evidence from the years before 1800 suggests this cannot be the explanation. For these years we can split up the testator population into even finer gradations of assets, and examine whether at very high asset levels even before 1800 net fertility declines. The answer is a resounding "no". For the years before 1800 no matter how high we go in the asset range, net fertility continues to climb. The richest testators before 1800, those with asset incomes exceeding £200 per year (in 1630s prices), had an average of five surviving children, as figure 4A.5 shows. This group had average asset incomes well above the asset group 4 in our sample after 1800, yet they had nearly double the net fertility of that later group. Income alone cannot explain the change in fertility behaviour for marriages 1800 and later.

Further casting doubt on the role of income, estimates of both income per person and real wages suggestion that it was only in the 1820s that there was any significant rise in real incomes and real wages as a result of the Industrial Revolution.

Figure 4A.6 shows the real wages of craftsmen in England for the years 1720-1914. The change in marital fertility clearly predates any significant income increases, and occurs more rapidly than a gradual rise in incomes would induce.

The increasing importance of human capital in the production of income again will not help explain the 1800 Demographic Revolution. For a start, for those whose income depended largely on the possession of land or houses – landed proprietors and rentiers – always had an even stronger incentive to limit fertility if they wanted to maintain the living standard of their children. The family assets would get divided up among the children, so that with more than two children average expected assets per child would decline.[114] In a world where education was the key to income, since there was a maximum cost of education, the richest could afford to have as many children as they wanted and still give them all the maximum possible amount of education.

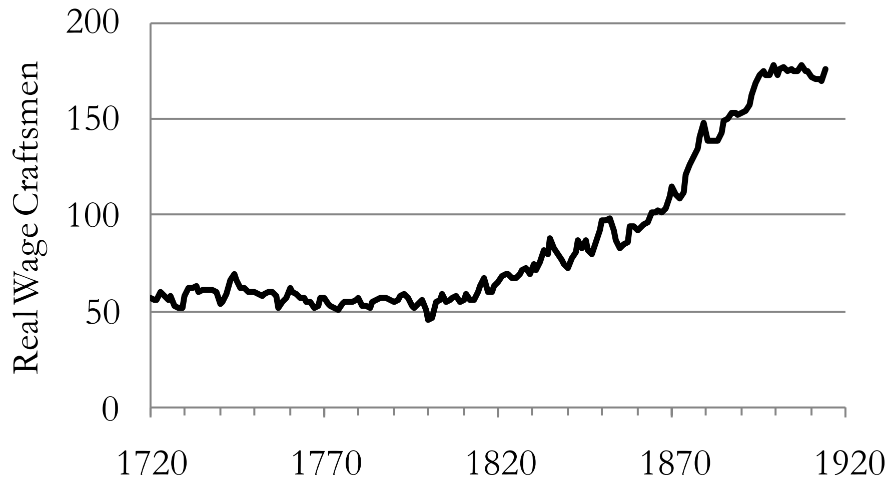
Figure 4A.5: Asset Income and Net Fertility before 1800



Another potential explanation of a decline in net fertility among high income groups is a decline in child mortality. For the testators where we observe ages we see a fairly steady increase between 1580 and 1914 in the average age of death. The average

[114] Spouses would also bring assets to marriages, so that a child with half the assets of a parent would on average end up in a family with assets equal to that of the parental family.

Figure 4A.6: Real Wages of Building Craftsmen, 1720-1914



Source: Clark, 2005.

age of testators rose from about 55 in 1600 to 68 by 1910. However this trend is gradual while the change in net fertility is more sudden. Nevertheless one idea is that in pre-industrial society men had to have as many children as possible in order to maximize the chance of an heir. The hazards of survival meant that even with relatively high net fertility rates a substantial fraction of men would die with no child to inherit. As infant and child mortality declined, eventually families could ensure an heir with many fewer children. There was more certainty that if a child was born he would survive to adulthood. Consequently net fertility declined.

The empirical content of this idea would be that declining net fertility for the rich in the later nineteenth century would be associated with a larger fraction leaving at least one surviving child. Table 4A.14 contains a simple test of this idea. It records the estimated probability of a man leaving a surviving child at different epochs and asset levels. Before marriages commenced in 1800 and later rich men were left without a child as heir far less often than poor men. However after 1800 the chance of a rich man leaving a child as heir declined significantly from around 0.91 to 0.79. Thus the interpretation that the changed behaviour of the rich was a response to declining mortality rates cannot be sustained. As table 4.10 showed there is actually no sign of any improvement of the survival rate of children pre and post 1800.

Table 4A.14: Wealth at Death and Chances of a Surviving Child

Period of marriage	Assets 1	Assets 2	Assets 3	Assets 4
1490-1799	0.81	0.84	0.87	0.91
1800-1859	0.82	0.80	0.81	0.79

Note: These odds were estimated from a logistic regression.

The surprisingly sudden change in the pattern of fertility with wealth makes it hard to explain through economic variables which were all changing only slowly in England in these years, even though it is the period of the Industrial Revolution. This suggests an alternative explanation in the form of some social or ideological movement. One possibility, for example, is that the decline in fertility among the rich was a reaction among the economically successful to the widespread publicity afforded Thomas Malthus's *Essay on a Principle of Population*, first published 1798, but re-issued in five revised editions until the author's death in 1834. It is generally believed that public discussion of birth control in England dated only from the late nineteenth century. It was only in 1876 that Charles Bradlaugh and Annie Besant were prosecuted for republishing Charles Knowlton's pamphlet advocating birth control, *The Fruits of Philosophy.* But the evidence here suggests that there had to be some diffusion of contraceptive practices much earlier than this.

However, interestingly, we would expect such a social or intellectual movement to be associated with occupations or professions more than with incomes. However fertility fell as much among rich farmers in our sample as it did in more urban and professional occupations such as physicians, schoolmaster, clerks, and engineers. Even if we include our seven occupational indicators in the regression, along with the log of asset income, differentiating pre and post 1800, there is still a sharp change in the association between income and fertility after 1800. Before occupations do not have differential fertility, once we control for asset incomes. After the slope on asset income fall to one fifth of its previous level, and occupations remain insignificant predictors of net fertility.

The source of this remarkable change in fertility behaviour around 1800 thus remains largely unidentified. Aggregate fertility declined in France long before anywhere else in Europe. Fertility regimes within differed here by locality to a far greater extent than they did in England (The coefficient of variation in the index of marital fertility for France is 4 to 6 times that of England and Wales for the 19th century).[115] One of the authors, Cummins, has recently analysed the wealth fertility relationship for the period of transition in France (marriages formed 1748-1819). Demographic data from the *Enquete Henry* was linked to wealth at death data from the *Tables des Succsessions et Absensces* for four villages in the nineteenth century. Cummins shows a strong positive association between assets and wealth for villages where aggregate fertility levels were high.[116] Where fertility was declining, the wealth fertility relationship switched from positive to sharply negative.

As with England, these results show that wealth had a large positive effect on reproductive success in the pre-transitional era and fertility limitation by the top wealth category precedes aggregate fertility decline. Thus the transformation witnessed here for England seems likely part of a general transformation occurring in the switch from pre-industrial to modern fertility regimes. The French Fertility transition, however, occurred in the absence of any significant structural change in the economy and with

[115] At the county and *department* level.
[116] The result holds for both 'gross' and 'net' fertility (which takes child mortality into account).

income per capita levels significantly below those of England. The French fertility decline also was associated with the appearance of longer birth intervals, that is of spacing rather than stopping. Cummins' research suggests that movements in economic inequality and relative incomes may have a relationship with the onset of fertility decline.

Section 4A.6: Conclusion

While there is still much work to be done on the precise mechanisms and causes, we demonstrate above that pre-industrial fertility patterns did not survive unchanged in England until marriages of the 1870s as has been conventionally believed. Instead there was an important and rapid change in fertility patterns by wealth, for marriages formed after 1800. Up until then the richest English men were producing five surviving children at a time when men in general produced only 2.5 surviving children. Within a generation the fertility of the rich fell to be no greater than, and perhaps less than, that of the general population. A *Demographic Revolution* thus accompanied fairly closely the *Industrial Revolution*. Now united temporally, the two events may also be more plausibly linked causally.

Appendix to Chapter 4A

Imputing missing values

In forming the data base of fertility, wealth at death and date of birth we had to assign values in a number of cases where data was missing: dates of birth, area of land holding, numbers of children (where only a partial count was given).

1. Ages and marriage dates 1500-1858

Where we cannot locate the information in parish registers or the census we assign each testator a date of birth and marriage date through the following means. For these years we have the following information from parish records on birth dates, marriage dates, and age at first child.

Table 4AA.1: Birth Information

Group	N	Birth date also N
Birth date	841	-
Marriage date	876	335
Age at first child	934	375
At least one of above	1,635	-

This reveals that the average age at marriage was 28, and average age at the birth of the first child 29.1. Using the cases where we could assign age at death years since birth, years since first marriage plus 28, or years since first birth plus 29.1 with some experimentation the following regression was found to be the best fit for age:

$$AGE = 9.42 + 0.0264DEC + 1.174N + 6.92DCHILD{>}21 - 9.625DCHILD{<}21 + 5.62DGRANDCHILD - 6.52DSINGLE + 5.73DWIDOWER - 6.81DPARENT + 6.05*DNEPH$$

$n = 1{,}111$, $R^2 = 0.495$

where DEC = birth decade (1520-1820)

N = number of surviving children

DCHILD>21 = indicator for at least one child known to be more than 21

DCHILD<21 = indicator for at least one child known to be less than 21

DGRANDCHILD = indicator for at least one known grandchild

DSINGLE = indicator for testator never married

DWIDOWER = indicator for testator widower

DPARENT = indicator for at least one parent known to be alive

DNEPH = indicator for a living niece or nephew

2. Ages and marriage dates 1846-1914

Post 1846 we sometimes collected more limited data on relatives and children's ages, in which we estimated missing ages from the regression

$$AGE = 62.37 + 0.08D1870 + 1.15D1880 + 0.79D1890 + 3.00D1900 + 3.20D1910 + 0.36N - 0.79DSINGLE + 9.11DWIDOWER$$

$n = 1{,}497$, $R^2 = 0.11$

where D1870, …D1910 are indicator variables for the death decades 1870-9 to 1910-9.

Land Areas, 1500-1858

While land was bequeathed in 2,108 of the wills in our sample, in only 534 cases, one in four, was the area of the land indicated. To infer the area in the other 1,574 cases we estimated for cases where area was indicated, that area as a function of other features of the will. For wills pre 1860 where we collected information on monetary bequests this was the number of houses bequeathed, the number of additional parishes the land was described as lying in, the total amount of cash and goods bequeathed, an indicator for the literacy of the testator, an indicator for whether the testator lived in a town, an indicator of whether the person engaged in farming, and indicators for each occupational group. The functional form that best fit the observed cases was chosen by experiment. Thus the estimated expression was

$$\log(AREA) = a + b_1 HOUSE1 + b_2 HOUSE2 + b_3 HOUSE3 +$$
$$b_4 MOREPAR + b_3 BEQROOT + b_4 DLIT + b_5 DLITUNKNOWN +$$
$$b_6 DTOWN + b_7 FARMER + \sum_i c_i OCCUP_i + e$$

where HOUSE1 was an indicator set to one if one house was bequeathed, HOUSE2 an indicator for two houses, HOUSE3 an indicator for three or more houses, MOREPAR an indicator for land left in more than one parish, BEQROOT the square root of the value of cash and stock bequeathed, DLIT an indictor for a literate testator, DLITUNKNOWN an indicator for someone whose literacy is unknown, DTOWN an indicator for a town dweller, DFARMER an indicator for someone engaged in farming, and $OCCUP_i$ indicators for the six occupational groups defined above other than labourers. DFARMER was set to one if the testator left farm animals or grain in the will, or left farm implements. There were 408 observations with this complete information, and the R^2 of this regression was 0.52.

To normalize for changes in the price level over the years 1585 -1836 the “BEQROOT” variable in the above equation was constructed using the actual cash bequests in the will normalized by the average price level in each of the decades 1580-9, 1590-9, 1600-9, 1610-9, 1620-9 and 1630-9. To this was added the value of the stock left calculated using a standard set of values normalized to the 1630s: horses £5, cattle £4, sheep £0.5, pigs £2, wheat (bu.) £0.21, barley/malt (bu.) £0.10, oats (bu.) £0.07, peas/beans (bu.) £0.12, silver spoons £0.375, gold rings £1.

Land Areas (1846-1914)

Where we did not collect monetary bequests we estimated areas from the regression

$$LN(AREA) = a + b_1 PAR2 + b_2 PAR3 + b_3 SQRTDUTY + \sum c_i \, OCCUP_i + e$$

PAR2 was an indicator for land in two parishes, PAR3 and indicator for land in three or more parishes, SQRTDUTY the square root of the real value of the personalty estimated in probating the will. There were 173 observations with which to estimate the parameters of this regression, and the R^2 was 0.38.

Real Estate Value (1880-1914)

In some cases we get no information of the real estate in the will, such as when the testator simply leaves all their property to one recipient without specifying the details. In such cases we could still estimate the total value of the real estate from the characteristics of the testator and the probate estimate of personalty. This real estate value, however, is truncated at 0. So we use a Tobit estimate with a lower bound of 0. Where we have probate estimates of the (net) personalty after 1880 the equation estimated was

$$REAL = -162 + 0.273PROBATE + 1069DLON - 225DTOWN$$

n = 333, pseudo R^2 = .006

REAL is the value of real estate (in 1630s prices), PROBATE the personalty (in 1630s prices), and DLON, DTOWN indicators for residence in London or another town. This implies that for testators outside London or a town after 1880, the expected value of real estate is 0 until the probate value of the will is £593 (in 1630s prices). Though REAL is highly significantly associated with PROBATE, as can be seen the Pseudo R^2 is very low. That is, the amount of the variation in REAL that we can explain with the equation is very low.

Real Estate Value (1750-1880)

For 1750-1880 we have estimates of the probate value of the estate, but in terms of tax bands that the value falls within. For this period also occupations were significantly linked to real estate. The predictive Tobit estimation was thus,

$$REAL = -332 + 0.079DUTY + 308DLON - 273DTOWN + 72STAT1 + 268STAT2 + 309STAT3 + 331STAT4 + 303STAT5 - 65STAT6 + 802STAT7$$

$$n = 1{,}804, \text{ pseudo } R^2 = .004$$

DUTY is the maximum of the tax band the personalty fell within (in 1630s prices), and DSTAT1,…DSTAT7 indicators for social status. This implies that for testators outside London or a town before 1880, the expected value of real estate is always positive for gentry, but only positive for other occupations when the duty estimation rises above a certain minimum. Again the Pseudo R^2 is very low.

Table 4AA.2 shows the shares of real estate versus personalty in the total value of the bequest where we have complete information on each element. Though we can estimate real estate values only very poorly from the probate or duty value, fortunately over time real estate was becoming less and less important as a share of bequests. Thus even those wills where we have only the personalty values directly should give a reasonable guide to the total value of the bequest.

Probate Value (1500-1858)

Before 1858 there are many cases where we have no direct information on the value of the personalty from the probate or the duty declaration. In these cases we estimate the value of the personalty from the monetary gifts and goods bequeathed in the will, using the 255 cases where we have both the monetary and goods bequests and the probated value. The only feature of the will that was a good predictor of the probate value was the cash bequeathed within the will. Thus

$$PROBATE = 40 + 1.60CASH$$

$$n = 255, R^2 = 0.23$$

where CASH was the real value of monetary gifts and goods bequeathed within the will.

Table 4AA2: Share of Different Elements in the Total Bequest

Period	Share Real Estate (probate value)	Share Real Estate (duty value)	Share Cash and goods (probate value)
1750-1880	-	0.35	0.28
1880-1914	0.21	-	-

Chapter 5 - Marital Fertility and Wealth in Transition Era France, 1750-1850

Abstract

The spectacularly early decline of French fertility is one of the great puzzles of economic history. There are no convincing explanations for why France entered a fertility transition over a century before anywhere else in the world. This analysis links highly detailed individual level fertility life histories to wealth at death data for four rural villages in transition-era France, 1750-1850. The results show that it was the richest groups who reduced their family size first and that they used 'spacing' strategies to achieve this. In cross section, measures of the environment for social mobility are strongly associated with the fertility decline. The evidence presented here demonstrates that socioeconomic status mattered during the early French fertility decline. This study is a first step towards re-establishing the French experience as paramount in our understanding of Europe's demographic transition.

Resume

La baisse précoce et spectaculaire de la Fécondité des mariages en France reste l'une des grandes énigmes de l'histoire économique. On ne peut expliquer de manière convaincante pourquoi la France entama sa transition de la fertilité plus d'un siècle avant le reste du monde. Cette étude met en relation des données biographiques très détaillées sur les comportements individuels en matière de fertilité avec une base de données sur les niveaux de fortune au décès pour quatre villages en zone rurale durant la phase de transition française (1750-1850.) Les résultats de cette analyse montrent que les catégories les plus aisées de la population furent les premières à réduire la taille de leur famille en ayant recours à un espacement des naissances. Dans notre échantillon, les variables du milieu et de la mobilité sociale sont fortement associées à la baisse de la fertilité. Nos travaux mettent donc en évidence le rôle important du statut socio-

économique dans la baisse de la fertilité. Cette étude constitue un premier pas vers le rétablissement de l'expérience française comme une étape essentielle de notre compréhension de la transition démographique européenne.

Section 5.1: Introduction

Economic explanations for the European fertility transition, such as demographic transition theory (Notestein 1945), micro economic theory (Becker 1960, 1991) and more recently unified growth theory (Galor 2004) have treated the early French fertility decline as 'noise', the extreme tail end of a normal distribution. This is the intellectual equivalent of treating Britain as the exception in explaining the Industrial Revolution[117]. At the time fertility fell (apx. 1800); France was by far the largest country in Europe, excluding Russia, with a population of almost 30 million people representing 27.7% of the total population of Western Europe (calculated from Maddison 2003).

This analysis links highly detailed individual level fertility life histories to wealth at death data for four rural villages in transition-era France. The period of analysis is approximately 1750-1850 (based on those who died 1810-70). The study presented here is the first to analyze the wealth-fertility relationship during the period of the French fertility decline. The quality of the data collected allows for an in-depth investigation of the wealth-fertility relationship between different demographic regimes, the mechanics behind these patterns and also allows the testing of various hypotheses for why fertility declined in France.

Background

Over the past two centuries, fertility in most of the World has undergone a sustained and seemingly irreversible transition. Today, a low fertility regime is the

[117] Comparison borrowed from Van de Walle 1974 p.5.

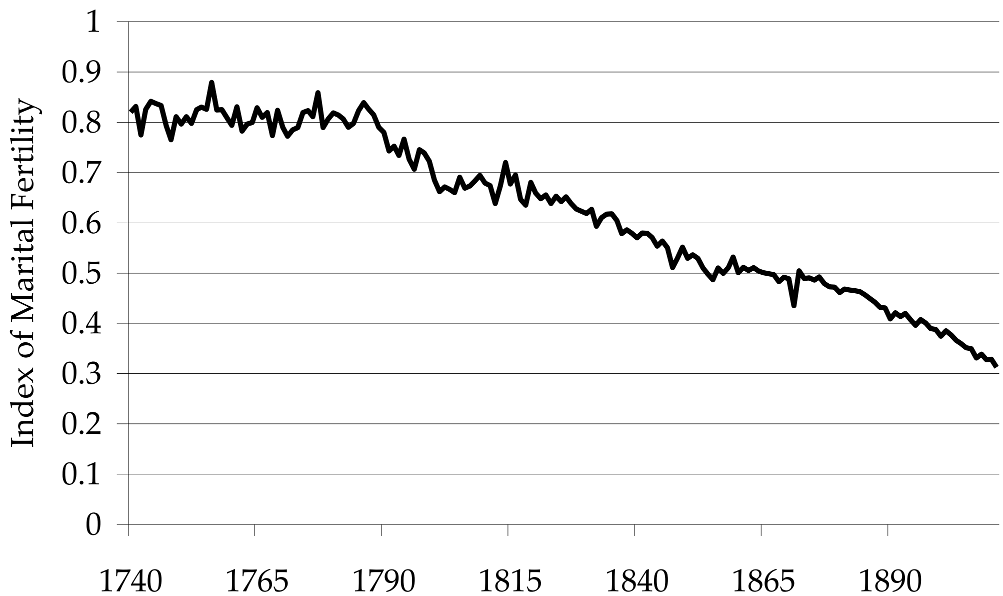
norm in the developed world, with some regions (particularly in Europe) experiencing sub-replacement fertility. This demographic transition enabled the productivity advances of the Industrial Revolution to be transformed into higher living standards and sustained economic growth. Understanding the revolution in fertility behaviour between the Malthusian and the modern eras has therefore been a central research question. Despite this interest, researchers of the transition have not approached a consensus for the causal mechanisms behind the decline of fertility.

The European fertility project (EFP) led by Ansley Coale at Princeton University during the 1970s and '80s set out to provide an empirical base for demographic transition theory. However, the EFP concluded that the decline of marital fertility during the late 19th century was almost completely unrelated to socioeconomic changes (Watkins 1986 p.448). Time (the decade of the 1890s), as opposed to any socio-economic measure, was the best indicator for the onset of sustained fertility decline. Therefore, the transition was an 'ideational change' and not an economic adaptation. Recent criticisms have somewhat diluted the authority of the Princeton view. Brown and Guinnane (2007) argue that the EFP's conclusions were biased by the level of aggregation. The sub-national districts used (departments, counties, cantons etc.) were too large and internally heterogeneous to be useful as distinct fertility regimes. Further, the socioeconomic data collected was not the most relevant to parent's fertility decisions.

The implications for further research are clear: To go beyond the EFP two issues must be addressed. Firstly, the level of aggregation, and secondly, the relevance of the socioeconomic data. The study presented here directly addresses these two concerns via an individual level analysis of fertility behaviour with real wealth information.

A central feature of the European demographic transition is the exceptional early fertility decline of France. The reasons for this spectacular break from the historical pattern and divergence from European trends have never been fully explained. Figure

Figure 5.1: The index of Marital Fertility, 1740-1911, France



Source: Weir 1994 p.330-1

5.1 tracks the trend of the index of marital fertility – fertility relative to an observed maximum (that of an early twentieth century religious group, the Hutterites, who married early and prohibited contraception). From the late 18th century on, fertility appears to begin a steady and consistent decline from very high levels (80-90% of the Hutterites) to very low levels (almost 30% of the Hutterites). Econometric testing for structural breaks in this series places the transition at 1776. This is nearly a century before anywhere else in Europe (Belgium (1874)), and 101 years before England and Wales (1877) (see Cummins 2009 (forthcoming) for details).

There have been relatively few previous studies of the relationship between economic status and family size at the individual level for France at this period. Weir, using the Henry demographic data, examined the income-fertility relationship in Rosny-Sous-Bois, using tax records for 1747. In a cross-sectional analysis, he found no difference in marital fertility behaviour between the income groupings. Fertility was high and varied little between his three income stratifications, although the evidence does suggest a reproductive advantage for his highest group relative to his lowest (7.3 to 6.2 births per family respectively) (Weir 1995 p.15). Weir's sample size was very small however – he only had a total sample of 47 families to analyze. Hadeishi, with a larger sample size and also using tax records, studied the town of Nuits in Burgundy from 1744-1792, and found a positive relationship between marital fertility and income (2003 p.489). My analysis adds to this literature by linking pre-existing historical demographic data to new wealth data collected from various *Archives Departmentales* in France. The geographic and socioeconomic scope, along with the sample size, is far greater than previous studies. This will allow the identification of differential fertility patterns between socioeconomic strata with greater power. Further, there has been no previous study (to the author's knowledge) which has examined the wealth-fertility relationship during the period of the demographic transition in France (post 1790s).

The rest of this chapter is comprised of five sections. Section 5.2 details the data and its summary characteristics. Section 5.3 is a detailed examination of the wealth-fertility associations. Section 5.4 analyses the mechanics behind the fertility patterns, while section 5.5 evaluates explanations for the French fertility transition. Section 5.6 Concludes.

Section 5.2: The Data

The demographic data[118] to be analysed is taken from Louis Henry's national random sample of 41 villages, roughly covering a span of over two centuries, from the late 17th to early 19th centuries (Weir 1995 p.2). This dataset[119] is the result of the application of the techniques of family reconstitution to parish registers and the fruition of this is a goldmine of individual level information on the demographic characteristics

[118] I thank George Alter for providing his version of the Henry dataset.
[119] The summary papers for the INED French family reconstitution are:
Henry (1972), Henry and Houdaille (1973), Houdaille (1976), and Henry (1978).

of historical France. Tens of thousands of observations record linked births, deaths and marriages. However, only 20% of the sample recorded the husband's occupation. As van de Walle has stated "unfortunately, the population of the parishes usually is not clearly stratified and most attempts in finding lags in the dates of fertility decline by socioeconomic groups have failed" (1978 p.264). To understand the relationship between wealth and fertility in France at this period, the Henry dataset must be augmented with more detailed data.

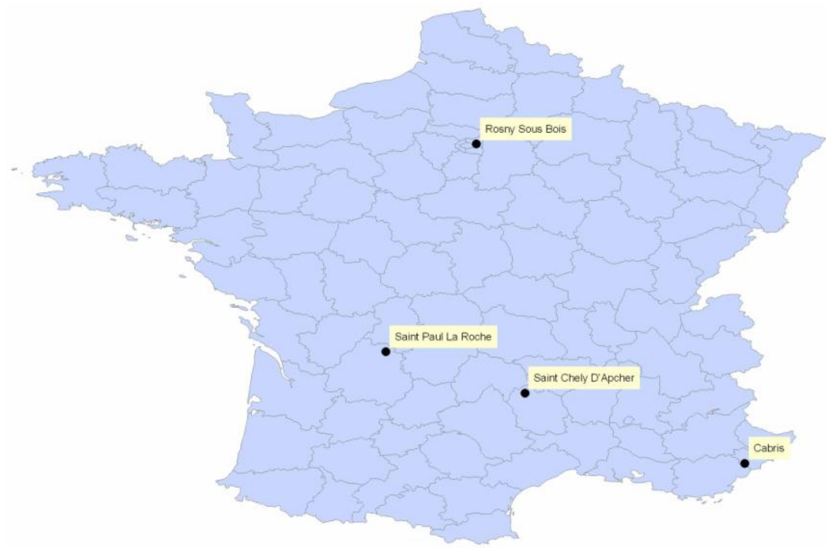
The source for wealth data are the *Tables des Successions et Absences*[120] (TSA), which are stored in the various *Archives Departmentales* in France. The TSAs were originally constructed for tax purposes and recorded all deaths in a locality, along with detailed information on date of death, residence, profession, age at death and marital status. Uniquely, the value of an individual's estate at death was noted, with a distinction between cash and property holdings. Crucially, the TSAs recorded everybody, including those with zero assets at death (typically coded as "rien"). Almost ¼ of the individuals in the sample I use fall into this category.

Due to the fact that the property valuation recorded in the TSAs only covered property held in the locality, it is possible that the values calculated here are underestimates of the true property wealth of individuals. However, this bias only affects a small minority of the sample. According to Bordieu et al, 85% of individuals in the "TRA" sample (also based on the TSAs) had one property record, leaving 15% with two or more (2004 p.7). Attempts to assess the accuracy of the wealth information in the TSAs are limited by the fact that "very few alternative sources exist" (Bourdieu et al. 2004 p.25). However, Bourdieu et al. test the validity of the Tables against other published data and find the TSA to yield consistent results (2004 p.26).

The Henry demographic data set was linked to records from the *Tables de*

[120] In English: "Tables of Bequests and Absent Persons" (Bourdieu et al. 2004 p.4).

Figure 5.2: Villages in the Sample



Successions et Absences. The links were based upon name, profession, sex, age at death and date of death. These criteria serve to place close to 100% certainty in the accuracy of the links. Ultimately, four villages were selected on the basis that they were the best represented after linking. These villages had the properties of holding a significant number of individuals dying after 1810 (when the TSAs start to record estimates of wealth), and also having the TSAs preserved in the relevant *Archive Departmental*.

The sample covers the fertility experience of individuals who died roughly between 1810 and 1870 and were born between the 1720s and the 1820s. The relevant 'fertile period' covered is therefore 1750-1850, roughly speaking. At this time approximately 80% of the French population lived in rural villages of a similar size to those in the sample (Sharlin 1986 p.235). Fertility decline in France cannot be understood without understanding what was happening in these rural villages. However, the sample villages are only 4 out of perhaps 40,000 villages in France as a whole. The occupational distribution of these sample villages closely matched that of the complete Henry Sample (41 villages). The deviations in representativeness are detailed in the appendix. In order to judge how representative the demographic regimes in these villages are, their fertility pattern relative to the National trend is plotted in figure 5. 3.

The National trend in I_g (the index of marital fertility), presented in figure 5.3, shows a sharp decline from high levels in the 1780-99 period. Interestingly, the sample villages display a high level of heterogeneity with respect to the trend in marital fertility. Rosny has exceptionally high marital fertility which then proceeds to decline dramatically from 1760-79 period to the post 1780s. Both Cabris and St Paul have relatively low levels of marital fertility (to the other villages and the National trend), with a trend towards decline evident in Cabris from the 1740-1759 period.

The initial trend towards decline in St Paul stalls after 1760, and along with St Chely, whose fertility remains high throughout, no trend towards sustained decline is evident. The sample villages capture the high level of heterogeneity within France with respect to fertility patterns. Two of the villages – Rosny and Cabris – show clear evidence for decline, while the other two – St Paul and St Chely – do not share the same pattern. Examining the trend from the 1760-79 period to 1800-1819, we see that fertility in Rosny falls by nearly 40% and in Cabris by almost 20%. In St Chely and St Paul, fertility remains relatively constant. Therefore it is possible to identify two demographic regimes amongst the sample villages, a high fertility environment and a declining fertility environment. For the analysis, the data from each village will be pooled and the varying wealth effects will be tested for by demographic regime.

The wealth variable used in this study has the major disadvantage of being measured at death. In aggregate, people tend to accumulate wealth over the life cycle, before dis-saving and intervivos bequests to offspring act to reduce the wealth held. This will have the effect of biasing the estimates from the TSA downward, with respect to true wealth, for those who died after this point. The data I use supports this notion, as the figure 5.4 illustrates (based on 672 male observations).

Figure 5.3: The Index of Marital Fertility, by Sample Village, Contrasted with the National Trend

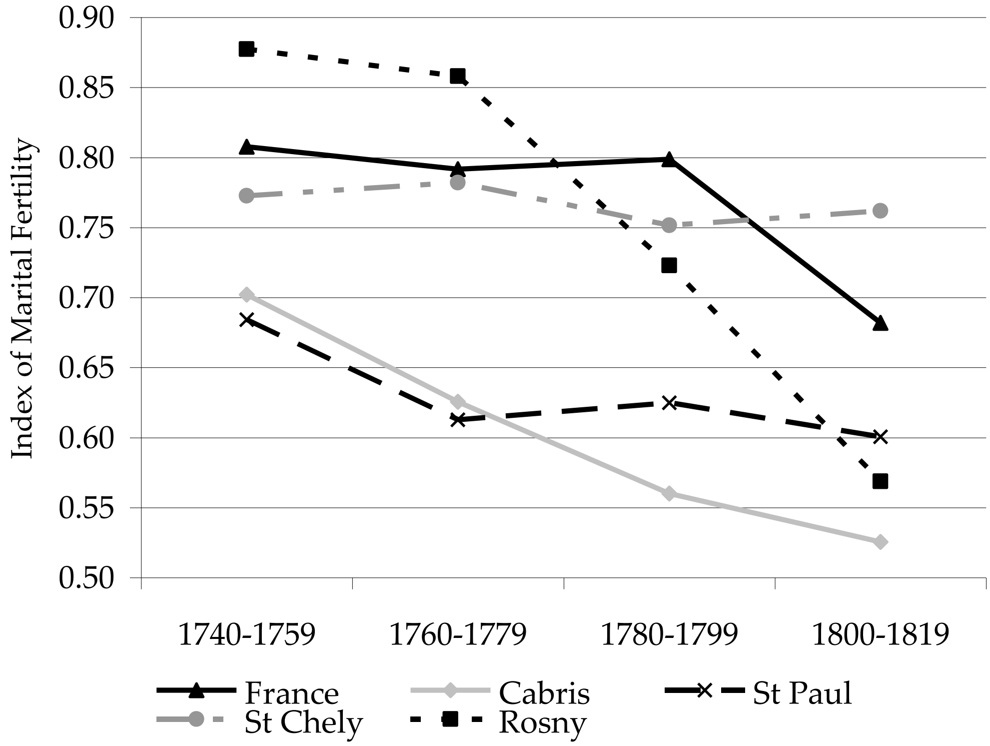
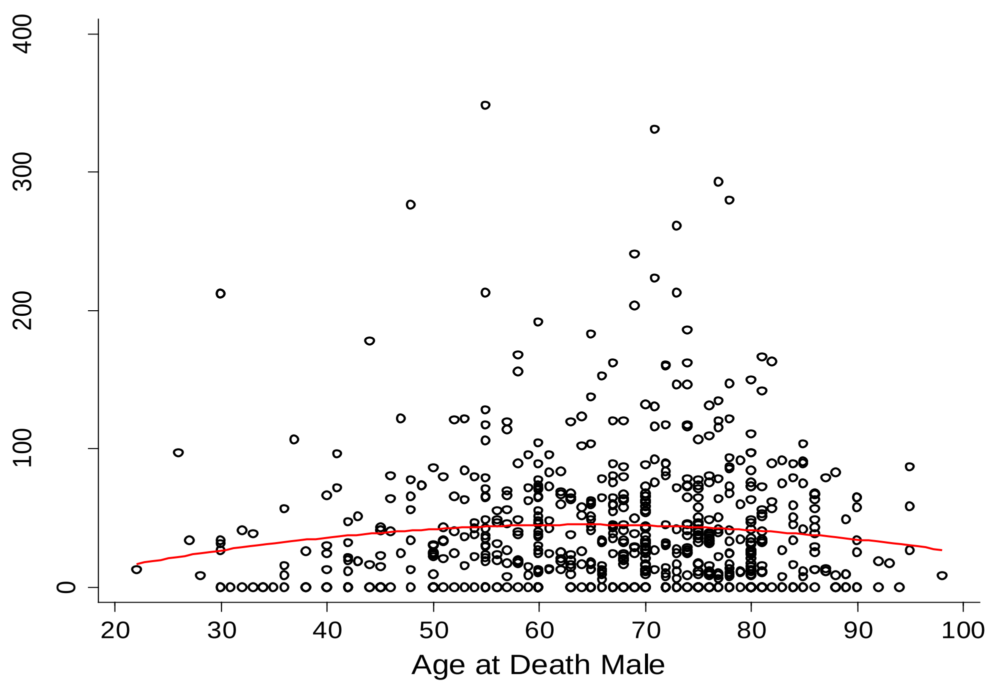


Figure 5.4: Life Course Effects



An OLS regression was run with the Square root of real wealth as the dependent variable, with age and age squared as the independent variables. The results are reported in table 5.1. The reported coefficients on age at death, which are both significant at the 5% level, indicate a turning point age of 63.75[121], beyond which the relationship between wealth and age at death turns negative. There is a possibility that the life course pattern of wealth accumulation and subsequent decline may blur the true level of wealth of an individual in the sample. However, I consider this probability quite small as the slope of the line is so flat. There are no significant negative associations revealed by the analysis of the aggregate data between the level of real wealth and age at death. In total over 60% of the sample died above 64, and taking their value of wealth at death carries a risk of undervaluation due to the life course effects. The OLS regression on the square root of real wealth allows us to calculate an average bias (assuming the true level of wealth is reached at age 64) based on the average life course relationship between wealth and age[122].

Table 5.1: OLS Regression on the Square Root of Real Wealth

Variable	**Coeff.**	**SE**	***P***
Age at Death	2.04	0.96	0.03
Age at Death Squared	-0.016	0.007	0.03
Constant	-20.8	29.5	.48
Adjusted R-Squared		0.004	
Observations		672	

While the majority of the sample is at risk from underestimation of true wealth due to life course effects, any serious bias (>10%) is likely to only affect less than 5% of

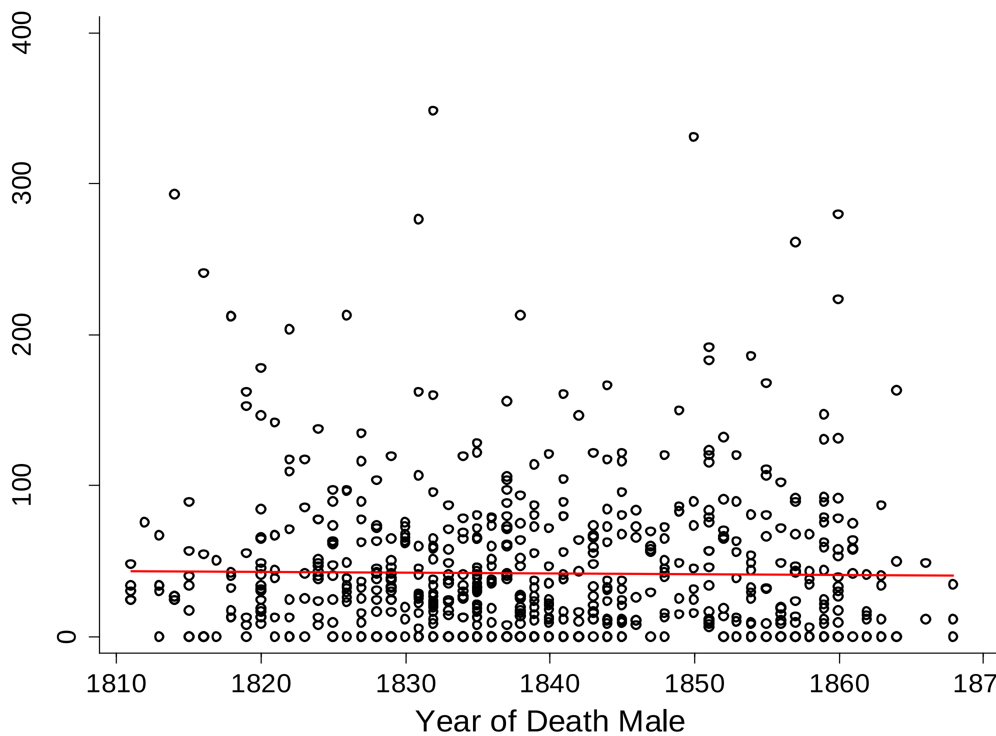
[121] Equivalent to the point on the quadratic fit of the wealth and age observations where the slope is equal to zero. Calculated via differentiating the regression equation of the quadratic fit, setting equal to zero, and solving for age at death.
[122] These numbers are calculated using the deviation of the regression line from a flat line from age 64 onwards.

the sample. Ultimately the analysis presented here will split the wealth distribution in three. The possibility of bias from underestimation must be considered minimal as a result of such a wide division of the sample.

Table 5.2: Estimated Biases from Life Course Effects

Estimated Possible Downward Bias	Affected Age Groups	Obs	% of Sample affected
5%+	64-98	421	61.61%
10%+	86-98	42	4.32%
20%+	95-98	4	0.15%

Figure 5.5: Real Wealth by Year of Death (Males)



There is a statistically insignificant effect of year of death on Real Wealth, with a linear fit completely flat for the sample period (figure 5.5). For analysis, the sample will be split into three wealth groups. As there was no time trend in the evolution of real wealth during this period, the division of wealth is calculated over the entire sample, disregarding sub-period. The choice of three wealth cuts follows Weir (1995) and Gutmann and Watkins (1990), and makes sense when we consider that these villages were primarily agricultural and the socio-economic stratification, as perceived by the population themselves, was probably relatively simple. The division split the sample into even thirds, with those dying with the sum of 0-141 Francs been designated to group 1, those with wealth at death between 141 and 2,100 Francs designated into group 2, and those with a wealth at over 2,100 been designated to group 3. The nominal levels of wealth reported in the *Tables* were converted to real levels using a cost of living index from Lévy-Leboyer & Bourguignon (1990)[123].

Raw Wealth Correlations

Table 5.3 reports the average number of children born and the number of children surviving to 10 ('net family size'). These values represent the actual gross and net reproductive success between the wealth groups. The different demographic regimes have very different wealth-fertility relationships. Where fertility is high and unchanging, the wealth-fertility relationship is positive. The Richest group here has a family size over 21% larger than the poorest (over 30% if we measure this in 'net' terms). Where fertility is declining, the wealth fertility relationship is the reverse. The differential between the richest and the poorest group's family size is now *minus* 30%! (23% in 'net' terms). The varying family sizes of the sample follow a clear and direct wealth-pattern, once we control for the type of fertility regime revealed by the aggregate trends.

The raw averages discussed here say nothing on the mechanics of the fertility differentials between the groups. How was the lower cross sectional fertility of the rich achieved in those villages where fertility was declining? Further, why was fertility so

[123] Which was kindly supplied to me by Pierre-Cyrille Hautcoeur.

Table 5.3: Average Children Born and Surviving to 10 Years, per Wealth Group

	Wealth Group		
	1	2	3
Non- Decline Villages			
Children Ever Born	4.87	5.90	5.93
Net Family Size	3.42	4.03	4.47
Decline Villages			
Children Ever Born	5.50	4.88	3.88
Net Family Size	4.62	4.14	3.57

low amongst the poorest groups in the villages where fertility was not declining? Malthusian logic would immediately propose the female age at marriage, the classic European 'preventative' check as the driver behind these patterns. Also, differential female mortality between the wealth groups could be generating a lot of the variation. Does the perceived wealth effect act through these channels? The following section details regressions designed to detect the wealth effects controlling for these demographic variables and also event dummies such as the French Revolution.

Section 5.3: Deconstructing the Wealth Effects

The equations below detail the components of net family size. Any wealth effects on net family size have to operate through differentials in these values.

$$NetF = CEB - CED$$

$$NetF = MFR * MD - CED$$

$$MD = EU - FAgeM$$

$$EU = \min(MAgeD, FAgeD, FAgeM, 50)$$

Where $NetF$ is net family size, CEB and CED are children ever born and died respectively, MFR is the marital fertility rate, MD is the duration of the marriage,

EU is the end of the union (marriage), $MAgeD$ is the husbands age at death, $FAgeM$ and $FAgeD$ are female age at marriage and death respectively.

Further, it can be expected that other forces, operating at the village level, and also at the national level (for instance the Revolution and the effects of the Napoleonic wars), have an influence upon individual's fertility choices. To examine the specific wealth effects in the sample, a regression framework was established.

The model to be estimated takes the following functional form:

$$CEBf.(C, D, FageM_i, FageD_i, REV, NWARs, IM, Wealth)$$

Where C represents a constant, D is a fertility regime fixed effect, IM represents a measure of infant mortality, and REV and $NWARs$ are categorical variables representing the Revolution and Napoleonic wars respectively. The last mentioned 'event' variables were coded relative to year of marriage, with those with a year of marriage in 1789 or later receiving a Revolution effect, and those married between 1802 and 1814 receiving a war effect. The $Wealth$ variable is included in the regression as a categorical variable in order to account for expected non-linearities in the wealth fertility relationship.

Any analysis of fertility must account for the impact of child deaths upon parent's fertility decisions. Further, these child mortality estimates must take into account the significant likelihood of the omission of child deaths in the death registers. A popular way to detect under registration in death records is to examine the frequency of first name repetition within a family. Typically, later born siblings would be given the name of a previously deceased child. Houdaille has conducted an in-depth analysis of the Henry dataset for these features. However, his results are based on the village level and will tell us nothing on the wealth differentials *within* the villages with respect to infant and child mortality. One result that is relevant here is the completeness of the death records in Rosny, where no under registration was detected at all (Houdaille 1984 p.88).

For this study, I employed a simple version of this technique. First, I counted up the number of repeated names within a family. This was then compared with the number of recorded child deaths. Where the number of repeated names exceeded the number of child deaths, I corrected the child deaths upwards to account for the probable omission of a death from the records. Table 5.4 reports the corrected and non corrected values by fertility regime and wealth division.

There are huge differences in child mortality between the villages. Within those were fertility is high, child mortality is high too. Within the villages, child mortality varies to a far less extent, with almost no differences between the wealth groups where fertility is high. The wealthiest group in the *decline* villages have child mortality far below any other group in the sample, and their rate is half that of the richest group in the *non-decline* villages.

Table 5.4: Child Mortality (until 10 years) by Fertility Regime and Wealth Group, Rates per 1000 births

	Wealth Group		
	1	2	3
Non- Decline Villages			
Corrected	326.8	342.1	335.1
Uncorrected	283.1	320.6	314.2
Decline Villages			
Corrected	201.5	211.0	166.6
Uncorrected	181.2	197.9	162.0

Is the decline in fertility related to a reduction in child mortality at this period? To examine this, I will proceed with a multivariate regression. There is a probable endogenous relationship between fertility and infant mortality. Firstly, the number of child deaths can never exceed the number of births. This induces a positive correlation between fertility and mortality (Guinnane et al. 2006 p. 472). Secondly, parents may choose to replace a deceased infant. Any interpretation of a parent's gross family size must therefore factor in the effects of the mortality experience. Following Guinnane et al., I factor in mortality by including the proportion of children dead as an independent variable in the regression. This removes the structural correlation between mortality and fertility but does not remove the endogenity.

Table 5.5: Negative Binomial Regressions on Children Ever Born

Variable	Coefficient (Standard Error)
Demographic variables	
Age at Marriage, Female	-0.038***
	(0.005)
Age at Death, Female	0.035***
	(0.004)
Proportion of Children dead	0.269**
	(0.001)
Event variables	
Revolution	-0.149**
	(0.059)
Napoleonic Wars	-.043
	(0.054)
Wealth Effects	
Wealth Group1 (ref.)	0
Wealth Group2	0.181*
	(0.049)
Wealth Group3	0.145
	(0.093)
Wealth-Fertility Regime Interactions	
Main Decline Effect	0.085
	(0.078)
Wealth Group1 (ref.)	0
Wealth Group2	-0.291**
	(0.102)
Wealth Group3	-0.397***
	(0.104)
Constant	.945***
	(0.252)
N	411
Pseudo R2	0.088

*** Significant at .001% level
** Significant at .01% level
*Significant at .05% level

As the dependant variable is a count variable and because the data is 'over dispersed' relative to the Poisson distribution, the appropriate method is to use negative binomial regression. The distribution of both gross and net fertility matched the negative binomial distribution closely, and a comparison with the Poisson distribution is detailed in the appendix.

Table 5.5 details the results of a negative binomial regression on children ever born. Female ages at marriage and at death are highly significant and act in the expected directions[124]. The proportion of dead children is also highly significant and its effect is large. Intended to capture the effects of infant mortality, a reduction in this value decreases the number of children born. The Revolution has a significant negative effect on fertility, but the Napoleonic wars are insignificant. The wealth effects are capture by interactions in the model, and their 'net' effects are reported in table 5.6.

Table 5.6: Net Wealth Effects on Children ever born

	Wealth Group		
	1	2	3
Non- Decline Villages	5.95	7.14	6.88
Decline Villages	6.48	5.81	5.04

The 'net' wealth effects on fertility in table 5.6 are calculated from the interaction coefficients in the negative binomial regressions. A constant age at marriage for females (24) and complete life course fertility (surviving to at least 50) is applied for each wealth group[125]. These values represent the wealth effects on fertility 'net' of wealth differentials in age at marriage, death and the proportion of children dead. Once the net effect is calculated for each wealth group, the coefficient is exponentiated (as the beta coefficients of the negative binomial regression are given in logarithms) to give the expected numbers for each wealth group. These numbers can be understood as

[124] Women who marry later should have fewer children for biological reasons, and women who die during their reproductive years should have fewer children.
[125] The average age at marriage for all women in the sample as a whole was 23.8.

representing the net wealth effects controlling for the factors listed in the regression, and ignoring the effects of the Revolution and Napoleonic Wars. In relation to the richest and poorest groups, the strong positive wealth fertility relationship almost completely disappears within the *non-decline* villages. Those in the middle of the wealth distribution in the *non-decline* villages – Wealth Group 2, appear to have the highest marital fertility. Where fertility decline has already begun, the net wealth fertility relationship is still sharply negative, with the richest groups having over 22% fewer births. In summation: Pre-transition villages have a positive wealth-fertility profile, whereas transition villages have a negative wealth-fertility profile. This strongly implies that it is the rich, the top third of the wealth distribution in these rural villages, who are the pioneers of the decline in French fertility.

As mentioned, one feature the regression results highlight is the high relative fertility of Wealth Group 2 in the *non-decline* villages. One postulation on this feature could be that a proportion of the richest groups in the *non-decline* villages are beginning to control their fertility, but this proportion is too small to move the size of the wealth effect below that of the poorest group. The quality of the Henry dataset allows us to examine in fine detail the mechanics of the wealth fertility differentials, and this is described in the next section.

Section 5.4: The Mechanics behind the Fertility Patterns

The results from the regressions demonstrate systematically that economic status mattered during the period of fertility decline in France. What were the mechanics behind these patterns? The regressions indicate that both the gross family size correlations with wealth were independent of marriage age and age at death. The significant negative association, particularly for Rosny and Cabris (the '*decline* regime' villages) for marriages after 1800, must therefore represent an implementation of fertility limitation strategies within marriage. There are two ways for couples to control their desired family size. Firstly, they can stop bearing children once they reach a certain target family size – this is known as 'stopping' behaviour. Secondly, they can increase their birth intervals–'spacing' behaviour. The European demographic transition has overwhelmingly been attributed to 'stopping behaviour' (Alter 1992 p.15). However, the aggregation of those pursuing different reproductive strategies may blur the true picture. As van Bavel has stated; "research explicitly analyzing stopping and spacing has hardly ever differentiated between social status groups" (2002 p.7). The French fertility patterns discussed here are delineated by economic categories, and this section evaluates to what extent stopping and spacing can be attributed.

'Stopping' Behaviour

The Henry demographic dataset allows the calculation of fertility measures such as Age Specific Fertility Rates, Coale's index of marital fertility, the Total Marital Fertility Rate and the Coale and Trussell fertility control measures "M" and "m" (referred to as big and little m respectively). The Coale-Trussell parameters are calculated from the Age Specific Fertility Rates and represent deviations from the age pattern of 'natural fertility'. An M value of 1 and an 'm' value of 0 indicate no fertility control. Typically, researchers look for an 'm' value greater than .200 for an unambiguous sign of a controlling population. M, is harder to interpret, but may catch 'spacing' effects. The appendix details the statistical derivation of the Coale-Trussell parameters. However, these measures have been criticized in the literature and are far from fool proof. Table 5.7 summarizes the calculated Age specific marital fertility rates, Total Marital Fertility Rates and the Coale and Trussell fertility control parameters.

The reproductive advantage of the richest group in the *non-decline* villages is emphasized by the high value for M, 0.927. This means that the richest group here has a fertility level very close to that of the natural fertility schedule. For the *non-decline* villages, M has decreased and the scale of the decrease is, again, closely related to economic status. The richest have the lowest level of fertility and the poorest wealth group have the highest. Focusing on 'm' – the parameter indicating significant deviation from a natural age pattern of marital fertility, the results indicate no unambiguous signs for stopping behaviour in any of the regimes. However, this value is largest for the richest group in the *decline* villages (0.146). Despite failing to be significant and above the 0.200 threshold, the value is indicative of a small proportion of 'stoppers'.

Table 5.7: Demographic Measures by Fertility Regime

	Wealth Group		
	1	2	3
***Non-decline* Villages**			
Age Specific Marital Fertility Rates			
20-25	0.364	0.313	0.373
25-30	0.357	0.360	0.432
30-35	0.302	0.389	0.349
35-40	0.268	0.321	0.303
40-45	0.155	0.176	0.158
45-50	0.008	0.027	0.000
Total Marital Fertility	7.75	8.43	8.70
Coale Trussell Measures			
M	0.802*	0.795**	0.927
S.E.	0.105	0.087	0.092
"m"	0.029	-0.141	0.064
S.E.	0.119	0.095	0.113
***Decline* Villages**			
Age Specific Marital Fertility Rates			
20-25	0.302	0.250	0.216
25-30	0.343	0.313	0.261
30-35	0.313	0.273	0.228
35-40	0.242	0.209	0.164
40-45	0.133	0.100	0.084
45-50	0.009	0.007	0.009
Total Marital Fertility	7.58	6.82	5.86
Coale Trussell Measures			
M	0.768**	0.682***	0.587***
S.E.	0.096	0.085	0.087
"m"	0.058	0.104	0.146
S.E.	0.107	0.099	0.100

Another way to detect 'stopping' behaviour is to look at the average age women have their last birth. These values are reported for the regime and wealth group combinations in table 5.8. The values are calculated only for those women and their husbands who died after 50. The mean age at last birth in populations practicing 'natural fertility' is approximately 40-41 years (Bongaarts (1983) as cited by Kohler et al. 2002 p.28). Amongst the villages where fertility was not declining, there is no significant variation to report. Age at last birth is high, around 37-38 years for all wealth groups. For the villages where fertility was declining, the top 2 wealth groups do show evidence for 'stopping' behaviour; the mean age at last birth is significantly below that of the other groups in the sample.

Table 5.8: Age at Last Birth by Fertility Regime

	Wealth Group		
	1	2	3
Non-Decline Villages	37.81	38.62	36.92
Decline Villages	37.80	35.90	35.37

'Spacing' behaviour

Having established some partial evidence for the presence of 'stopping' behaviour amongst the wealthiest groups in the sample villages, the question of 'spacing' arises. It is far easier to detect 'stopping' behaviour in population sub-groups then it is to detect 'spacing' behaviour. One way to detect spacing is to model the birth intervals directly using a Cox proportional hazards model. The results will describe the effects of the covariate independent variables in terms of a 'hazard rate', which is defined as the instantaneous probability of the event in question (in this case a birth), and is therefore directly related to the length of the birth interval. As the model is intended to reveal differences in spacing behaviour, only closed birth intervals are used. The formulation of the birth interval model follows previous analyses by Alter (1988), Bengtsson and Dribe (2006), Van Bavel (2004a, 2004b) and Van Bavel and Kok (2004). After consideration of the varying inclusion of demographic factors in these studies, it was decided to concentrate on those factors most commonly found to affect the birth interval. This was done with the aim of producing a parsimonious model which could capture the wealth effects (if any) on the duration of the birth interval. The demographic factors included were the age of the mother (in five year age bands), the duration of the marriage, parity, and the life status of the previous born child. In common with the analysis by Bengtsson and Dribe, I include shared frailty at the individual level to control for unobserved family-specific heterogeneity in the sample (2006 p.736).

The Cox proportional hazards model is based on the following identity:

$$h_i(t) = h_0(t)\exp(\beta' x)$$

The hazard rate h for the i^{th} individual is a multiplicative function of the baseline hazard h_0 and the regression coefficients, $\beta' x$ (Cleves et al 2004 p.147-8). The great advantage of the Cox proportional hazard model is that the functional form of h_0 , the baseline hazard, is left unspecified. To account for unobserved heterogeneity at the individual level a frailty component is included. Rewriting the hazard:

$$h_i(t) = h_0(t)\alpha_i \exp(\beta' x)$$

Where α_i represents the shared frailty term, assumed to have mean one and a variance estimated from the data (Cleves et al 2004 p.147-8). This is intended to capture mother specific effects on the birth interval, constant across all the covariates. As mentioned, the results reported in table 5.9 are presented as *hazard ratios*[126]. Where the reported coefficient equals 1, there is no effect of that variable on the hazard of a birth.

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[126] The critical proportional hazards assumption was tested by analyzing the Schoenfeld residuals. Using stata's spthtest revealed that there was a deviation from the proportional hazards assumption in the original formulation of the birth interval model (table 9). Variable by variable analysis indicated that the parity, marital duration and female age grouping variables were driving this violation of the proportional hazards assumption. The analysis was repeated omitting these variables and the new wealth coefficients were compared with the original models. They were extremely similar in both magnitude and significance. Therefore it was decided to report the original model's results. The proportional hazards assumption was also checked graphically using stata's stphplot command.

Table 5.9: Cox Regression on Closed Birth Intervals

	$e^{coeff.}$	$se^{coeff.}$	p
Women's Age			
15-19	0.707	0.177	0.166
20-24	0.976	0.075	0.756
25-29 (ref.)	1	-	-
30-34	0.920	0.063	0.223
35-39	0.743	0.071	0.002
40-44	0.297	0.043	0.000
45-49	0.043	0.020	0.000
Parity	1.108	0.025	0.000
Marital Duration	0.906	0.010	0.000
Infant Alive	0.168	0.015	0.000
Decline Effect	0.868	0.111	0.268
Main Wealth Effects			
Wealth Group 1 (ref.)	1	-	-
Wealth Group 2	1.221	0.152	0.108
Wealth Group 3	1.276	0.170	0.067
Wealth-Fertility Decline Interactions			
Wealth Group 1 (ref.)	1	-	-
Wealth Group 2	0.716	0.121	0.049
Wealth Group 3	0.543	0.095	0.000
Frailty variance	0.298	0.050	0.000
N – Number of birth Intervals	2186		
Likelihood Ratio χ^2	83.77		0.000

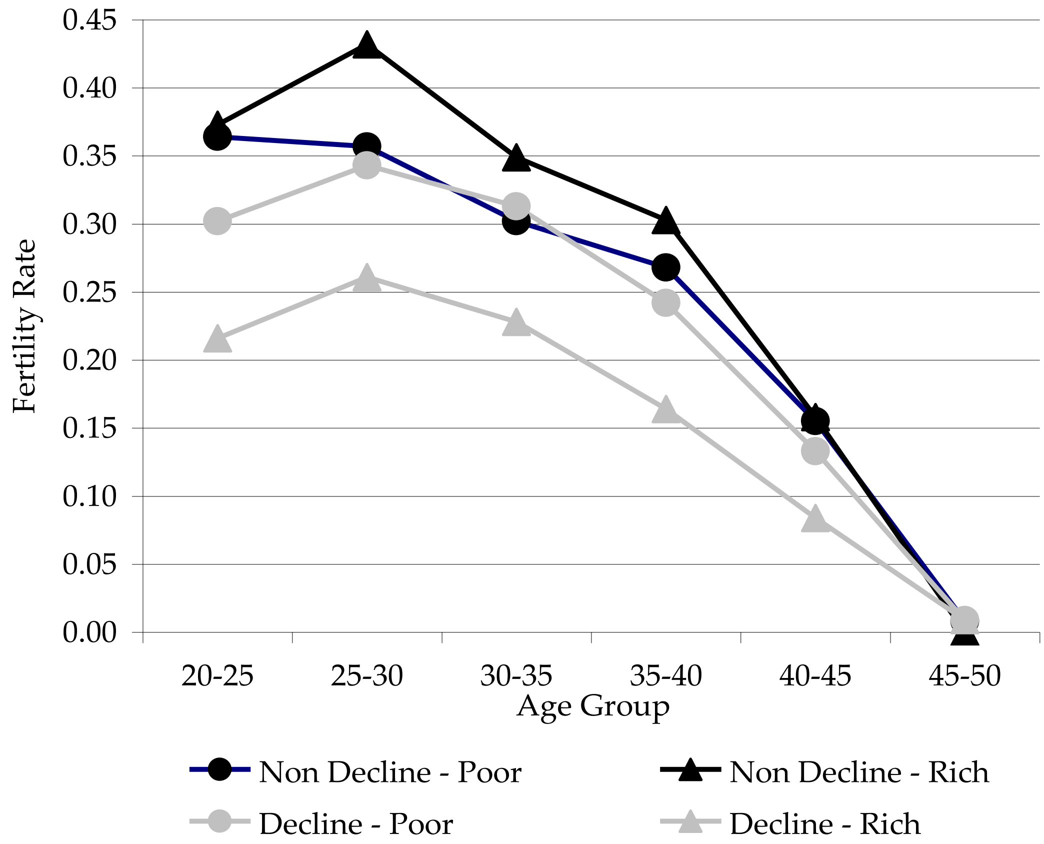
The Cox regressions on the hazard of a birth place attach high significance to parity, marital duration and the presence of an infant. Further, the natural fall off in fecundity is reflected by the falling hazard ratios for age groups past the 25-29 reference category. The wealth effects are reported as interactions in the regression table. In order to calculate the net wealth effects, these values are multiplied, producing the values reported in table 5.10. The wealth effects are large. For the *non-decline* villages, the hazard ratio for a birth increases with the wealth category, indicating that the top 2 wealth groups have significantly shorter birth intervals than the poorest group. For the *decline* villages, the opposite is true. The richest here have much longer birth intervals than the poorest group. The mean birth interval for each wealth group varies with the hazard rates, and are also reported in table 5.10. These results strongly indicate that spacing played a substantial role in the declining fertility of the richer groups in the sample. In comparison with the Coale-Trussell measures and the age at last birth calculations, it appears that spacing played a substantial role in the French fertility decline.

Table 5.10: Net Hazard Ratios and Mean Birth Interval (Months) by Fertility Regime and Wealth Group

	Wealth Group		
	1	2	3
Non-Decline Villages			
Hazard rate	1.000	1.221	1.276
Interval	30.60	27.74	27.57
Decline Villages			
Hazard rate	0.868	0.760	0.602
Interval	32.08	33.23	36.41

Figure 5.6 illustrates the age pattern of marital fertility for the richest and poorest groups in both fertility regimes (the top and bottom thirds of the wealth distribution respectively). As the Coale-Trussell estimates indicated, the age pattern of marital fertility does not vary to a large extent between these sub-groups. However, the level of the fertility rate at each age group varies enormously. There is a large positive 'upward shift' in the age fertility schedule between the poorest and richest wealth groups in the *non-decline* villages. For the *decline* villages, this shift is downward. The Cox model reveals that the lower cross-sectional fertility of the richer groups in the *decline* villages is overwhelmingly a result of spacing practices. This is also implied by figure 5.6, where the level of fertility at each age group is significantly lower for the richest group in the *decline* villages.

Figure 5.6: The Age Pattern of Marital fertility for Rich and Poor



Section 5.5: Why did fertility decline in France?

Any socioeconomic explanation for early French fertility decline must consider that England, with a higher level of GDP per capita, a smaller agrarian sector and a larger urbanization rate lagged behind French fertility trends by over 100 years. This fact undermines demographic transition theory, the microeconomic theory of fertility and unified growth theory[127]. All of these theories rely on changes in income, modernisation and the labour force structure of the economy in initiating a substitution of child quantity for quality. None of them can explain why France was first.

The French themselves have long been preoccupied with the unusual

[127] At least in explaining the fertility transition.

characteristics of their demographic history. An intellectual climate obsessed with depopulation and the decline in French fertility arose around the turn of the 20 century. Van de Walle briefly discusses this mostly forgotten literature, criticizing its "outdated and weak statistical content", and states that the work amounted to a no more than a series of hypotheses (1974 p.6). Some of these hypotheses have survived to today, and I focus upon those forwarded by Tony Wrigley and David Weir[128].

Neo-Malthusian Explanation

Wrigley sees the early adoption of family limitation in France as "a variant form of the classic prudential system of maintaining an equilibrium between population and resources to which Malthus drew attention". Essentially, the preventative check now operated through marital fertility directly and not indirectly through age at marriage. The net reproduction rate in France from the late 18th to late nineteenth century was always close to 1, suggesting that the population was still finely constrained by available resources (Wrigley p.55 1985). As previously mentioned, almost 80% of the French population were rural, and nearly 70% lived off farming at the time of the decline (Chesnais 1992 p.335). Chesnais also points out that "farming remained primitive" and that there were numerous indicators of overpopulation (such as increase in wheat prices from the 1760s-1820s) (1991 p.336). These features certainly lend themselves to a Malthusian interpretation of the fertility pattern.

The testable implication of this hypothesis, as stated by Weir, is that there should be a strong positive relationship between real income and fertility (1984a p.31). However, this 'neo-Malthusian' reasoning for the early decline for French fertility fails

[128] Another popular explanation for the French fertility decline is the change in the inheritance laws which accompanied the Revolution. The Napoleonic code replaced primogeniture with equal partition. In order to preserve a concentration of wealth within the family, parents now had to curb their family size, as wealth could not solely be assigned to the eldest male. Chesnais questions this interpretation by pointing out that other countries adopted the same principles but didn't experience a fertility decline. Further, primogeniture was not practised widely in the North, except amongst the aristocracy, and the South-West of France, where primogeniture was common, had relatively low fertility in the *Ancien Regime*, and followed the same fertility pattern elsewhere post Revolution (1991 p.338).

to be supported by the individual level data collected in this analysis. If the restriction on births was a response to an economic constraint, we would expect those closest to subsistence to initiate fertility control. This is clearly not the case for the four villages in the sample. Where fertility is declining, the wealth-fertility relationship is negative. Fertility decline here is more pronounced for the richer groups; they are the first to employ this new variant of the preventative check, but this is not a 'neo-Malthusian' response.

The Revolution

Many scholars (Weir 1984b, and more recently Murphy and Gonzalez-Bailón 2008) have explicitly linked the Revolution to the fertility decline. At a superficial (and highly aggregated) level, the events are near simultaneous (see figure 5.1). However, econometric tests on the aggregate fertility rate place the decline in fertility before the Revolution (1776, see Cummins 2009). Further, it is widely accepted that many localities began their fertility transition long before 1789 (Chesnais 1992 p.338). In the data collected for this analysis, Rosny and Cabris have substantially declining fertility rates before the Revolution (see figure 5.3). However, the ideological and socioeconomic causes of the Revolution were germinating long before 1789. Could these forces have also contributed to the fertility revolution as well as the political?

An economic rationale for the decline in French fertility, associated with the Revolution has been forwarded by Weir. He states "evidence on fertility by social class is scarce, but tends to support the idea that fertility control was adopted by an ascendant "bourgeois" class of (often small) landowners" (1984b p.613). The Revolution enabled an element of the rural population to increase their control over the land, while others lost out and became more reliant on wage labour. For the new rural bourgeoisie, children became "superfluous as labourers and costly as consumers" (Weir 1984b p.613). The decline of fertility in France in the early to mid 19th century was primarily due to the decline of the demand for children by this new class. It was only after 1870 when France joined the rest of Europe in a fertility transition which transcended the social order (Weir 1984b p.614).

The results of this analysis support Weir's hypothesis on the French fertility transition. The new class of landowners created by the Revolution would certainly lie within the top wealth category as constructed here. The results clearly show, as Weir expected, that fertility decline was initiated by this wealthy group. Further, the effect of the Revolution on family size is large, negative and significant (see table 5.11). This is captured in the negative binomial regressions by coding a categorical variable for those who married after 1789. A more precise testable implication of Weir's hypothesis is that those who have greater property wealth should have the lowest fertility. Further, the cash component of total wealth at death should be an insignificant predictor for family size. By splitting the wealth measures into the property and cash components we can test for this in the sample data. Once the value is separated, the distribution is split into even thirds with respect to cash and property separately[129]. Table 5.10 reports the results of a negative binomial regression, similar to the previous exercise, but this time dividing wealth into its constituent parts.

The results agree exactly with Weir's predictions. The wealth category which has significantly fewer children is composed of the richest property owners. However, the driving factor in his hypothesis is the changing cost of children, due to the substitutability of wage labour by poorer socioeconomic groups. This does not uniquely identify a particular French characteristic as this process must surely have been existed in other countries. At this time, the English population was far less reliant on the agricultural sector and children must have been as expensive, if not more so, as they were in France.

[129] The division for property was all those with 0 value at death in group 1, all those with property over 0 and less than 2000 Francs in group 2, and all those with over 2000 Francs property wealth going to group 3. For cash, all those with 0 wealth at death were designated to group 1, those with over 0 and under 155 Francs in group2, and all those over 155 in group 3. A matrix describing the various groups in terms of observations is reported in the appendix to this chapter.

Table 5.11: Negative Binomial Regressions on Children Ever Born with the Components of Wealth

Variable	Coefficient (Standard Error)
Demographic variables	
Age at Marriage, Female	-0.036*** (0.005)
Age at Death, Female	0.034*** (0.004)
Proportion of children dead	0.305** (0.102)
Event variables	
Revolution	-0.127* (0.052)
Napoleonic Wars	-0.008 (0.054)
Property Wealth Effects	
Wealth Group1 (ref.)	0
Wealth Group2	-0.000 (0.055)
Wealth Group3	-0.157** (0.058)
Cash Wealth Effects	
Wealth Group1 (ref.)	0
Wealth Group2	0.024 (0.057)
Wealth Group3	0.053 (0.061)
Constant	0.948*** (0.243)
N	372
Pseudo R2	0.069

*** Significant at .001% level
** Significant at .01% level
*Significant at.05% level

In France, however, serfdom had disappeared by the 18th century, and most peasants owned their own land, in contrast to most of Europe (Chesnais 1992 p.336). The fertility decline originated amongst the wealthiest of this property holding class.

According to Chesnais, almost 63% of the population was represented by landowners and their families in 1830 while the comparable figure for Britain is 14% (1991 p.337). The widespread ownership of land amongst the rural population is a unique feature of the French socio-economic landscape at this time. Because of this, economic inequality was lower in France than in England during the 19th century (Piketty et al. 2006 p.250). This implies that the environment for social mobility was more fluid in 18th and 19th century France than anywhere else in Europe. Arsene Dumont, writing a century after the onset of the transition, placed social mobility as the 'raison de etre' of the French fertility decline and termed "social capillarity" as the phenomenon driving the limitation of family sizes (Dumont 1890). The Revolution served "to increase the thirst for equality and stimulate the social ambition of families, both for themselves and their progeny" (Chesnais 1992 p.334). The old social stratifications under the *Ancien Regime,* where hereditary rights had determined social status, were weakened by the Revolution. All of this served to facilitate individuals' social ambition, and the limitation of family size was a tool in achieving upward social mobility. This phenomenon, while associated with the Revolution, originated before the political climax of 1789.

The testable proposition of this hypothesis is that fertility should be negatively related to the opportunities for social mobility. A crude proxy for the social mobility environment is the level of economic inequality. In a society with a large rural, landless majority and a small group of elites, the prospects for social mobility are limited. It makes no sense to control fertility if family size has no impact upon a family's relative social standing. The economic distance between the bottom and the top status groups is too great, and therefore upward social mobility is unattainable for the majority of the population. However, changes in the distribution of wealth/income between groups in the population reflect a changing environment for the possibility of social mobility. As economic inequality declines, fertility is induced to decline also, as parents now realize that social mobility is possible and the prospects for it are affected by family size.

One way to evaluate the strength of this hypothesis is to examine the level of economic inequality in cross section in the individual wealth data collected for transition era France. Table 5.12 reports gini coefficients based on total real wealth, by village, for the sample. The levels of inequality are very high, and typical of the pre-industrial era. For the villages where fertility is declining, the gini coefficient is significantly lower than where it is not. This suggests that the level of inequality was associated with the onset of the fertility transition.

Table 5.12: Gini Coefficients by Village

	Gini Coefficient (based on deaths 1810-1870)
Non-decline Villages	
St Paul	.861
St Chely	.818
Decline Villages	
Cabris	.705
Rosny	.722

Another way to test the social mobility environment is to examine the relationship between father and son's wealth at death. Where the environment for social mobility is more open, father's wealth should have less importance in the determination of son's wealth, than would be the case where social mobility is limited. For a very small subsample, I was able to investigate this relationship. Table 5.13 reports the results of an OLS regression on son's wealth, with father's wealth as an independent variable.

Where fertility is high and not declining, father's wealth is a highly significant predictor of son's wealth. This relationship appears to be far weaker where fertility is declining. The effective coefficient on father's wealth in the determination of son's wealth in these *decline* regimes is one quarter of that of the villages where fertility is stagnating (0.864 vs. 0.195). When both father and son's family size are controlled for, the coefficient on father's wealth in the *non-decline* villages is ten times its corresponding value in the *decline* villages (0.798 vs. 0.074). This result strongly implies that the strength of the intergenerational transmission of wealth, it's 'stickiness' within families, and the social mobility environment this implies, is associated with the presence of fertility decline.

Table 5.13: Father's Wealth as Determinant of Son's Wealth

Decline Regime Villages	56.56*	35.42
	(24.47)	(33.89)
Fathers Wealth (Sqrt)	0.864***	0.798***
	(0.177)	(0.210)
Fathers Wealth*Decline Regime	-0.669*	-0.724*
	(0.305)	(0.349)
Son's Family Size		-3.761
		(3.854)
Father's Family size		-3.300
		(3.394)
Constant	2.13	62.38
	(20.99)	(52.38)
Observations	42	40
Adj. R^2	0.346	0.320

*** Significant at .001% level
** Significant at .01% level
*Significant at.05% level

As I have stated before, demographic transition theory, the microeconomic theory of fertility and unified growth theory cannot explain why French fertility fell first in Europe because they all predict that fertility should have declined in England before anywhere else. Wrigley's neo-Malthusian response cannot be valid as it was the richest groups who reduced their fertility, and Weir's explanation, again, does not uniquely identify France. What was unique to France was the pattern of landholding and relative affluence (to the rest of the world). There are many good reasons to suspect that social mobility may be a factor behind the decline. The level of inequality and the perseverance of wealth within families, both highly related to the social mobility environment were both found to be negatively associated with the presence of declining fertility.

Section 5.6: Conclusion

Through linking the Henry demographic dataset to individual measures of wealth, the socioeconomic correlates of the fertility transition have been examined in this chapter. The principal result is the major shift in the wealth fertility relationship at the individual level. Where fertility is high and non-declining, this relationship is positive. Where fertility is declining, this relationship is negative. It is the richest groups who reduce their fertility first. This result contributes to a revisionist interpretation of the European fertility decline. In opposition to the EFP's conclusions, this disaggregated analysis finds strong socioeconomic correlates for the decline of fertility in France. The second principal result of this chapter is that spacing strategies in combination with stopping strategies, played a substantial role in achieving a lower family size for the richest groups, for the villages where fertility was declining. Thirdly, existing theories on why fertility declined in France failed to be supported by the empirical data collected. However, a fresh look at an old hypothesis, does receive some support. Social mobility, as proxied by the level of inequality in the villages and the perseverance of wealth within families, is strongly associated with fertility decline.

The evidence presented here demonstrates that socioeconomic status mattered during the early French fertility decline but cannot, of course, claim to have cracked one of the greatest unsolved puzzles in economic history. The root causes behind the World's first fertility decline are still poorly understood. It is perhaps time to reassess conceptual models of the fertility transition. Empirically, a comparative analysis with other European countries based upon detailed individual level information can hopefully illuminate the mystery of the early French fertility decline. This study is a first step towards re-establishing the French experience as paramount in our understanding of Europe's demographic transition.

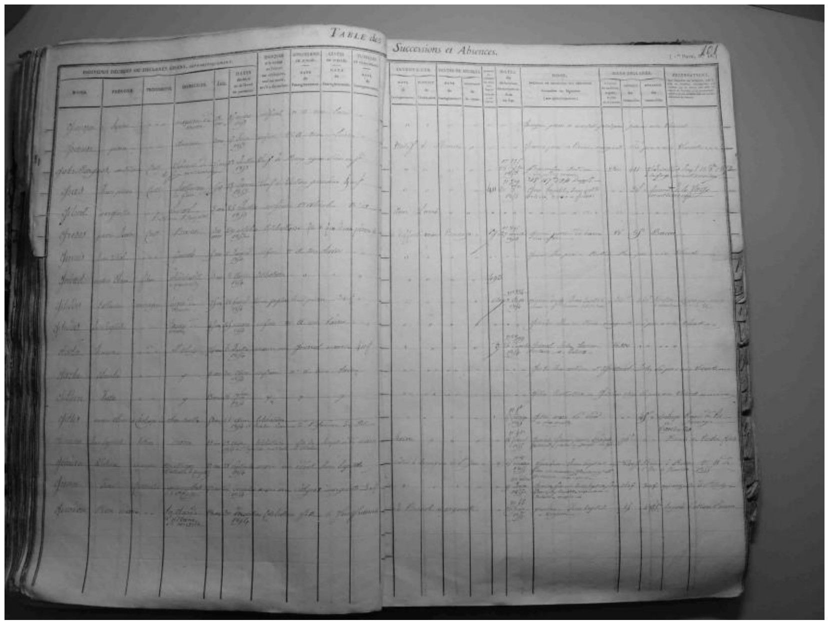
Appendix to Chapter 5

<u>Contents</u>

Index of Tables in this Appendix

Section 5A.1: The Source Material

Figure A1: The Source Material



The TSAs were photographed and coded, above is a representative page.

Section 5A.2: Age Specific Fertility Rates by Wealth grouping and Village

Table 5A.1: Fertility Differentials by Wealth, Whole Sample, Before 1800

	Wealth Group 1		**Wealth Group 2**		**Wealth Group 3**	
	Exp.	Births	Exp.	Births	Exp.	Births
Exposure and Births						
20-24	155	59	241	89	246	93
25-29	255	93	325	121	368	139
30-34	283	94	322	108	392	124
35-39	287	76	323	87	395	89
40-44	272	44	315	49	396	60
45-49	261	8	308	10	384	3
Age Specific Marital Fertility Rates						
20-24	0.381		0.369		0.378	
25-29	0.365		0.372		0.378	
30-34	0.332		0.335		0.316	
35-39	0.265		0.269		0.225	
40-44	0.162		0.156		0.152	
45-49	0.031		0.032		0.008	
Total Marital Fertility	7.67		7.67		7.28	
Coale-Trussell Measures						
M	0.841		0.841		0.857	
S.E.	1.092		1.077		1.074	
"m"	0.029		0.027		0.142"	
S.E.	0.098		0.087		0.084	
Age at Marriage, Female	25.2		22.8		23.8	
Infant Mortality Rate, per 1000 births Corrected	131.1		145.7		136.0	
Net Reproduction Rate (Implied)	2.11		1.80		2.15	

Table 5A.2: Fertility Differentials by Wealth, Whole Sample, After 1800

	Wealth Group 1		Wealth Group 2		Wealth Group 3	
	Exp.	Births	Exp.	Births	Exp.	Births
Exposure and Births						
20-24	114	42	138	54	142	49
25-29	203	67	253	100	243	87
30-34	231	69	286	101	245	66
35-39	225	57	281	73	236	46
40-44	208	18	273	34	230	8
45-49	182	1	247	2	207	1
Age Specific Marital Fertility Rates						
20-24	0.368		0.391		0.345	
25-29	0.330		0.395		0.358	
30-34	0.299		0.353		0.269	
35-39	0.253		0.260		0.195	
40-44	0.087		0.125		0.035	
45-49	0.005		0.008		0.005	
Total Marital Fertility	6.71		7.66		6.04	
Coale-Trussell Measures						
M	0.842		0.945		0.912	
S.E.	1.101		1.091		1.100	
"m"	0.235″		0.199″		0.555***	
S.E.	0.123		0.102		0.128	
Age at Marriage, Female	23.4		25.1		22.6	
Infant Mortality Rate, per 1000 births	149.9		113.3		163.5	
Net Reproduction Rate (Implied)	1.77		1.91		1.60	

Table 5A.3: Fertility Differentials by Wealth, Cabris, Before 1800

	Wealth Group 1		**Wealth Group 2**		**Wealth Group 3**	
	Exp.	Births	Exp.	Births	Exp.	Births
Exposure and Births						
20-24	63	26	129	46	136	45
25-29	89	29	166	63	210	74
30-34	90	30	163	47	227	67
35-39	90	21	159	34	226	47
40-44	86	9	150	22	221	29
45-49	84	3	145	4	218	3
Age Specific Marital Fertility Rates						
20-24	0.413		0.357		0.331	
25-29	0.326		0.380		0.352	
30-34	0.333		0.288		0.295	
35-39	0.233		0.214		0.208	
40-44	0.105		0.147		0.131	
45-49	0.036		0.028		0.014	
Total Marital Fertility	7.23		7.06		6.66	
Ig	0.65		0.65		0.61	
Coale-Trussell Measures						
M	0.888		0.824		0.787	
S.E.	1.155		1.112		1.105	
"m"	0.221		0.127		0.142	
S.E.	0.177		0.129		0.117	
Age at Marriage, Female	21.9		21.2		23.1	
Infant Mortality Rate, per 1000 births	139.78		146.95		95.38	
Net Reproduction Rate (Implied)	2.50		2.25		1.95	

Table 5A.4: Fertility Differentials by Wealth, Cabris, After 1800

	Wealth Group 1		Wealth Group 2		Wealth Group 3	
	Exp.	Births	Exp.	Births	Exp.	Births
Exposure and Births						
20-24	37	13	34	12	48	15
25-29	62	20	81	31	83	19
30-34	70	18	102	28	95	22
35-39	70	13	105	22	88	11
40-44	70	5	105	9	89	2
45-49	70	0	100	0	82	0
Age Specific Marital Fertility Rates						
20-24	0.351		0.353		0.313	
25-29	0.323		0.383		0.229	
30-34	0.257		0.275		0.232	
35-39	0.186		0.210		0.125	
40-44	0.071		0.086		0.022	
45-49	0.000		0.000		0.000	
Total Marital Fertility	5.94		6.53		4.60	
Ig	0.53		0.58		0.40	
Coale-Trussell Measures						
M	0.826		0.913		0.736	
S.E.	1.212		1.185		1.202	
"m"	0.425		0.402*		0.690**	
S.E.	0.238		0.198		0.251	
Age at Marriage, Female	23.6		26.4		26.7	
Infant Mortality Rate, per 1000 births	142.3		137.68		124.53	
Net Reproduction Rate (Implied)	1.80		1.55		1.25	

Table 5A.5: Fertility Differentials by Wealth, St Paul, Before 1800

	Wealth Group 1		Wealth Group 2		Wealth Group 3	
	Exp.	Births	Exp.	Births	Exp.	Births
Exposure and Births						
20-24	43	11	27	8	36	9
25-29	49	17	36	14	40	13
30-34	41	12	35	16	40	9
35-39	39	11	35	13	37	8
40-44	31	5	35	5	35	5
45-49	27	0	35	0	34	0
Age Specific Marital Fertility Rates						
20-24	0.256		0.296		0.250	
25-29	0.347		0.389		0.325	
30-34	0.293		0.457		0.225	
35-39	0.282		0.371		0.216	
40-44	0.161		0.143		0.143	
45-49	0.000		0.000		0.000	
Total Marital Fertility	6.69		8.28		5.80	
Ig	0.62		0.77		0.53	
Coale-Trussell Measures						
M	.648		0.836		0.606	
S.E.	1.231		1.246		1.267	
"m"	-0.177		-0.111		-0.046	
S.E.	0.251		0.246		0.281	
Age at Marriage, Female	19.6		22.6		17.3	
Infant Mortality Rate, per 1000 births	45.5		120.6		148.1	
Net Reproduction Rate (Implied)	2.35		2.1		2.25	

Table 5A.6: Fertility Differentials by Wealth, St Paul, After 1800

	Wealth Group 1		**Wealth Group 2**		**Wealth Group 3**	
	Exp.	Births	Exp.	Births	Exp.	Births
Exposure and Births						
20-24	32	9	34	12	23	7
25-29	49	15	37	14	30	13
30-34	56	10	35	15	26	8
35-39	55	15	31	8	25	4
40-44	48	4	30	0	22	0
45-49	42	1	27	0	16	0
Age Specific Marital Fertility Rates						
20-24	0.281		0.353		0.304	
25-29	0.306		0.378		0.433	
30-34	0.179		0.429		0.308	
35-39	0.273		0.258		0.160	
40-44	0.083		0.000		0.000	
45-49	0.024		0.000		0.000	
Total Marital Fertility	5.73		7.09		6.03	
Ig	0.53		0.66		0.58	
Coale-Trussell Measures						
M	0.637		0.976		0.973	
S.E.	1.256		1.228		1.283	
"m"	0.049		0.405		0.670″	
S.E.	0.261		0.288		0.381	
Age at Marriage, Female	23.1		20.6		26.0	
Infant Mortality Rate, per 1000 births	76.9		46.0		100.0	
Net Reproduction Rate (Implied)	1.4		2.05		1.75	

Table 5A.7: Fertility Differentials by Wealth, St Chely, Before 1800

	Wealth Group 1		Wealth Group 2		Wealth Group 3	
	Exp.	Births	Exp.	Births	Exp.	Births
Exposure and Births						
20-24	25	12	59	25	43	26
25-29	60	24	80	30	71	35
30-34	84	25	79	29	75	32
35-39	88	22	84	29	80	27
40-44	85	18	85	15	85	20
45-49	80	3	83	1	77	0
Age Specific Marital Fertility Rates						
20-24	0.480		0.424		0.605	
25-29	0.400		0.375		0.493	
30-34	0.298		0.367		0.427	
35-39	0.250		0.345		0.338	
40-44	0.212		0.176		0.235	
45-49	0.038		0.012		0.000	
Total Marital Fertility	8.38		8.50		10.49	
Ig	0.74		0.78		0.94	
Coale-Trussell Measures						
M	0.875		0.896		1.197	
S.E.	1.204		1.156		1.152	
"m"	0.013		-0.025		0.113	
S.E.	0.193		0.162		0.158	
Age at Marriage, Female	27.3		23.3		25.0	
Infant Mortality Rate, per 1000 births	240.0		233.3		208.3	
Net Reproduction Rate (Implied)	1.55		1.85		2.5	

Table 5A.8: Fertility Differentials by Wealth, St Chely, After 1800

	Wealth Group 1		Wealth Group 2		Wealth Group 3	
	Exp.	Births	Exp.	Births	Exp.	Births
Exposure and Births						
20-24	42	18	57	26	48	22
25-29	78	26	102	45	87	45
30-34	87	35	114	48	79	31
35-39	80	24	110	39	78	26
40-44	70	7	108	21	74	5
45-49	50	0	94	2	68	1
Age Specific Marital Fertility Rates						
20-24	0.429		0.456		0.458	
25-29	0.333		0.441		0.517	
30-34	0.402		0.421		0.392	
35-39	0.300		0.355		0.333	
40-44	0.100		0.194		0.068	
45-49	0.000		0.021		0.015	
Total Marital Fertility	7.82		9.44		8.92	
Ig	0.72		0.87		0.82	
Coale-Trussell Measures						
M	0.947		1.023		1.231	
S.E.	1.172		0.128		1.147	
"m"	0.164		0.004		0.377*	
S.E.	0.189		0.141		0.176	
Age at Marriage, Female	25.5		25.4		24.3	
Infant Mortality Rate, per 1000 births	188.7		209.8		240.7	
Net Reproduction Rate (Implied)	1.8		1.9		1.75	

Table 5A.9: Fertility Differentials by Wealth, Rosny, Before 1800

	Wealth Group 1		**Wealth Group 2**		**Wealth Group 3**	
	Exp.	Births	Exp.	Births	Exp.	Births
Exposure and Births						
20-24	24	10	26	10	31	13
25-29	57	23	43	14	47	17
30-34	68	27	45	16	50	16
35-39	70	22	45	11	52	7
40-44	70	12	45	7	55	6
45-49	70	2	45	0	55	0
Age Specific Marital Fertility Rates						
20-24	0.417		0.385		0.419	
25-29	0.404		0.326		0.362	
30-34	0.397		0.356		0.320	
35-39	0.314		0.244		0.135	
40-44	0.171		0.156		0.109	
45-49	0.000		0.000		0.000	
Total Marital Fertility	8.51		7.33		6.72	
Ig	0.80		0.67		0.59	
Coale-Trussell Measures						
M	0.959		0.821		0.956	
S.E.	1.205		1.245		1.223	
"m"	0.033		0.069		0.481″	
S.E.	0.198		0.249		0.255	
Age at Marriage, Female	25.1		22.2		22.9	
Infant Mortality Rate, per 1000 births	133.8		66.7		69.0	
Net Reproduction Rate (Implied)	2.5		2.45		2.5	

Table 5A.10: Fertility Differentials by Wealth, Rosny, After 1800

	Wealth Group 1		Wealth Group 2		Wealth Group 3	
	Exp.	Births	Exp.	Births	Exp.	Births
Exposure and Births						
20-24	3	2	13	4	23	5
25-29	14	6	33	10	43	10
30-34	18	6	35	10	45	5
35-39	20	5	35	4	45	5
40-44	20	2	30	4	45	1
45-49	20	0	26	0	41	0
Age Specific Marital Fertility Rates						
20-24	0.667		0.308		0.217	
25-29	0.429		0.303		0.233	
30-34	0.333		0.286		0.111	
35-39	0.250		0.114		0.111	
40-44	0.100		0.133		0.022	
45-49	0.000		0.000		0.000	
Total Marital Fertility	8.89		5.72		3.47	
Ig	0.69		0.52		0.31	
Coale-Trussell Measures						
M	1.240		0.733		0.563	
S.E.	1.499		1.354		1.351	
"m"	0.536		0.267		0.703″	
S.E.	0.459		0.360		0.409	
Age at Marriage, Female	25.8		23.4		23.8	
Infant Mortality Rate, per 1000 births	111.1		135.3		120.0	
Net Reproduction Rate (Implied)	1.8		1.335		1	

Section 5A.3: Occupation and the Sample

Table 5A.11: Occupational Structure of Sample by Year of Marriage

Code	Freq.	Percent
Year of Marriage<1801		
1	6	2.63
2	40	17.54
3	54	23.68
4	128	56.14
Total	228	100
Year of Marriage>1801		
1	3	1.76
2	27	15.88
3	48	28.24
4	92	54.12
Total	170	100

The Representativeness of the Sample Villages: Occupational Structure

The Henry dataset contained 617 unique occupation descriptions. To compare the occupational structure of the sample villages with the national trend, these occupations were sorted into 4 categories; elites, professional and land owner class, middle and low grade occupations and finally labourers and farmhands. The distribution of the whole Henry sample with respect to these divisions is reported in the following table.

Table 5A.12: Occupational Classifications for Sample as a Whole

Code	Definition	Frequency	Percentage
1	Elite	318	3.0%
2	Professional/Owners	998	9.5%
3	Middle/Lower Occupations	3490	33.1%
4	Labourers/"Cultivators'	5723	54.4%

The occupational distributions for the villages used in this study are given below. There are a number of notable deviations from the national pattern. Cabris contains significantly fewer professionals and landowners while St Paul and Rosny have significantly higher labourers and farm workers. Most interestingly however, is the relatively small proportion of the bottom occupational division (labourers and farm workers) in St Chely. However, the recording of male occupations in the Henry dataset was not consistent and the proportion registering an occupation was low. Differences in willingness to record occupation, whether by region or by occupational class may serve to bias the observed distributions. For this analysis, only the wealth measures are used.

Table 5A.13: Real Wealth by Occupational Coding

Occ. Group	Obs.	Mean	Standard Deviation	Min	Max
1	7	17,045	20,474	46.8	58,096.93
2	46	4,201	6,069	0	28,340.14
3	64	1,903	4,418	0	30,995.29
4	142	1,844	5,898	0	63,270.06
None listed	417	2,479	6,960	0	74,463.3

Table 5A.14: Occupational Structure by Village (blanks are omitted)

Village	Code	Freq.	Percent
Cabris			
	1	3	1.73
	2	43	24.86
	3	20	11.56
	4	107	61.85
	Total	173	100
St Paul			
	2	2	3.92
	3	9	17.65
	4	40	78.43
	Total	51	100
St Chely			
	1	5	4.76
	2	18	17.14
	3	63	60
	4	19	18.1
	Total	105	100
Rosny			
	1	1	1.45
	2	4	5.8
	3	10	14.49
	4	54	78.26
	Total	69	100

For the sample I have collected, there was no significant change in occupational structure over time (based on year of marriage before and after 1800 –table in appendix). The potential inaccuracies of using occupation as a proxy for socioeconomic status are illustrated by analysing the distribution of real wealth within the occupational classifications. As the following table reports, there is a high degree of variance in real wealth at death within the groups.

Section 5A.4: The Construction of the Coale-Trussel Parameters

Coale-Trussell Fertility Model

In the Coale-Trussell fertility model, the shape of the age specific marital fertility schedule in relation to that of a population practising natural fertility (*m)* is interpreted as a measure of fertility control. It takes the following form:

$$R_{ia} = n_a.M_i \bullet \exp(m_i \bullet v_a)$$

Where R_{ia} is the expected marital fertility rate for the *a*th age group of the *ith population,* n_a is the standard age pattern of natural fertility v_a , is the typical age specific deviation of controlled fertility from natural fertility. With these definitions it follows that M_i represents the *i*th populations fertility level and m_i measures fertility control. (Xie and Pimentel 1992 p.977).

Where M_i is close to 1, the population in question has the same age pattern of fertility as a population practising natural fertility. Where m_i is close to 1, the population is a standard controlling population. Where m_i is close to zero, the population is practising natural fertility. A "justifiable rule of thumb" is to take positive values of m_i >.2 as evidence for fertility control, with values below .2 as inconclusive (Okun 1994 p.200). Xie and Pimentel (1992 p.977) discuss the development of this model into a statistical model via the identity:

$$R_{ia} = T_{ia} \bullet B_{ia}$$

Where

T_{ia} is the total exposure time in woman years and B_{ia} are the total births for the age group

In combination, and taking the natural log of both sides we arrive at the following:

$$\log(B_{ia}) = \log(T_{ia} \bullet n_a) + \log(M_i) + m_i \bullet v_a$$

As Xie and Pimemtel discuss (1992 p.977): Where n_a and v_a are known, M_i and m_i can be calculated as the constant and the slope coefficient in a log-linear regression of births in age group *a,* population *I* on v_a. The $\log(T_{ia} \bullet n_a)$ term is included in the regression with its coefficient restricted to 1. It is assumed that births follow an independent Poisson distribution in each age interval. The distribution here will differ from family size over all women in the sample, but the legitimacy of assuming a Poisson distribution for each sub-sample of ASFRs is untested at this stage.

For each village, wealth group and period combination, I have calculated Age specific Marital Fertility Rates (ASMFRs). The periodisation for the demographic analysis is based upon year of birth of child, with the dividing year being 1800.Following this I have measured the level and scale of fertility control via the Coale-Trussell index of fertility limitation I use Coale and Trussell's estimated values for n_a and v_a (listed in Xie and Pimentel 1992 p.979). The Stata code for the Poisson regression used was deduced from the SAS and S-Plus code discussed in Schmertmann 1999 http://www.demographic-research.org/Volumes/Vol1/5/html/3.htm .

Section 5A.5: Extra Summary Statistics

Table 5A.15: Summary Characteristics of the Data Set, by Village

Village	Department	Region	Pop. 1821[130]	Total Obs.	Male Only Obs.	Female Only Obs.	Both Wealth Obs.
Cabris	Alpes-Maritime	SE	1,737	360	115	147	98
St. Paul	Dordogne	SO	1,692	314	146	126	42
St. Chely	Lozere	SE	1,764	258	85	94	79
Rosny	Seine – St. Denis	NE	822	168	57	57	54
Total				1,100	403	424	273

Table 5A.16: Summary Statistics, by Year of Marriage and Village

Village	Male Real Wealth	Age at Death		Age at Marriage		Children ever born
		Male	Female	Male	Female	
	Year of Marriage 1748-1800					
Cabris	3883.1	70.0	69.9	26.1	22.1	5.2
St Paul	2575	67.7	59.4	22.4[131]	20.1	5.8
St Chely	5207.3	68.3	69.7	27.8	24.5	5.6
Rosny	2549.2	66.5	69.6	24.9	23.7	5.9
	Year of Marriage 1801-1819					
Cabris	3848.3	68.5	63.2	29.4	25.2	3.5
St Paul	2602.3	59	55.2	28.0	22.5	4.3
St Chely	5601.2	59.5	58.3	30.1	24.8	5.3
Rosny	8005.4	59.5	61.6	25.2	23.7	3.1

[130] Source: Houdaille 1984 p.88.
[131] This unusually low figure is based on 23 observations from St Paul which contain the male age at marriage for this period, and the values range from 15-36.

Note on **Summary Statistics, by Year of Marriage and Village:**

The drop in age at death for both male and females between the sample periods reflects the sharp drop in Life expectancy during the Napoleonic Wars (Life expectancy from birth dropped to under 30 years). For all villages, age at marriage also increases. These trends contribute to the declining levels of gross fertility in all of the villages – although the decline is more evident for Rosny and Cabris than St Paul and St Chely. The following section details regressions designed to detect the wealth effects in cross section in each of these villages.

Table 5A.17: Real Wealth Division for Analysis

Division	Min.	Max.	Mean
1	0	140.2	27.5
2	140.3	2,099.6	941.3
3	2,113.2	120,837.8	11,477.3

Table 5A. 18: Observations by Property and Cash Wealth Groupings

	Cash Wealth Group			
Property Wealth Group	1	2	3	Total
1	154	45	12	211
2	59	85	60	204
3	39	33	135	207
Total	252	163	207	622

Section 5A.6: Village Level Analysis

The decision to pool the villages into two distinct groups was made after work examining the wealth-fertility relationship within each village. This section reports the results of the village level analysis. The methodology is identical to that in the main text of the chapter, with village level dummies replacing the decline/non-decline categorisation used previously. The results are consistent with the analysis in the main text and serve to support the categorisation used.

The omitted categories in the following negative binomial regressions are St Chely (for Village) and Wealth group 1. The rationale for this is simple: St Chely is the closest village in the sample to a community practicing "natural fertility" (total marital fertility is highest here, and the calculated Coale-Trussell measures reveal small insignificant and deviations from both level and pattern of fertility (see Figure 5.3). The results for the wealth categories listed in tables 11a-c should be read as deviations from a sample maximum. The dependant variable is either gross fertility (children ever born) or net fertility (children ever born minus children died before 10). The three models are applied to each. Village level fixed effects are also included, but not reported.

Table 5A.19: Cash-Wealth Split, Observations

Wealth Group	1	2	3	Total
Non-decline Villages				
Cabris	52	74	77	203
St Paul	101	26	35	162
Total	153	100	112	365
Decline Villages				
St Chely	47	65	52	164
Rosny	30	30	51	111
Total	77	95	103	275

Table 5A.20: Negative Binomial Regressions: Fixed Effects and Interaction Models on Gross Fertility

Model #	1	2
Year of Marriage	-0.011*** (0.003)	-0.010* (0.004)
Demographic variables		
Age at Marriage, Female	-0.065*** (0.006)	-0.062*** (0.005)
Age at Death, Female	0.010*** (0.002)	0.010*** (0.001)
Age at Death, Male	0.001 (0.002)	0.001 (0.002)
Event variables		
Revolution	0.121 (0.091)	0.111 (0.087)
Napoleonic Wars	0.105 (0.070)	0.154* (0.076)
Wealth Effects		
Wealth Group1 (ref.)	0	
Wealth Group2	-0.008 (0.062)	
Wealth Group3	-0.162** (0.062)	
Village Effects		
Cabris		0.003 (0.160)
St Paul		-0.023 (0.203)
St Chely (ref.)		0
Rosny		0.311* (0.145)
Wealth, Village, Period Interactions	No	Yes – See table11c
Constant	3.255*** (0.236)	2.886*** (0.257)
N	447	447
Pseudo R2	0.092	0.110

*** Significant at .001% level
** Significant at .01% level
* Significant at .05% level

Table 5A.21: Negative Binomial Regressions: Fixed Effects and Interaction Models on Net Fertility

Model #	3	4
Year of Marriage	-0.012*** (0.004)	-0.010* (0.004)
Demographic variables		
Age at Marriage, Female	-0.063*** (0.006)	-0.059*** (0.006)
Age at Death, Female	0.011*** (0.002)	0.011*** (0.001)
Age at Death, Male	0.004 (0.002)	0.004 (0.002)
Event variables		
Revolution	0.191* (0.097)	0.180* (0.091)
Napoleonic Wars	0.111 (0.076)	0.190* (0.085)
Wealth Effects		
Wealth Group1 (ref.)	0	
Wealth Group2	-.031 (0.067)	
Wealth Group3	-0.133* (0.067)	
Cabris		0.240 (0.180)
St Paul		0.250 (0.220)
St Chely (ref.)		0
Rosny		0.500** (0.160)
Wealth, Village, Period Interactions	No	Yes – See table11c
Constant	2.615*** (0.215)	2.150*** (0.283)
N	447	447
Pseudo R2	0.087	0.106

*** Significant at .001% level
** Significant at .01% level
* Significant at .05% level

Table 5A.22: Negative Binomial Regressions, Interactions between Village, Period and Wealth Group

	Gross Fertility	Net Fertility
Model #	3	6
Marriage before 1800		
Wealth Group 1 (ref.)	0	0
Wealth Group 2	0.020	0.018
	(0.148)	(0.174)
Wealth Group 3	0.177	0.291
	(0.144)	(0.165)
Marriage after 1800		
Wealth Group 1	0.228	0.242
	(0.190)	(0.215)
Wealth Group 2	0.297	0.254
	(0.175)	(0.200)
Wealth Group 3	0.111	0.078
	(0.188)	(0.215)
Cabris		
Wealth Group 2, before 1800	-0.140	-0.175
	(0.201)	(0.225)
Wealth Group 3, before 1800	-0.421*	-0.520*
	(0.195)	(0.215)
Wealth Group 1, after 1800	-0.527*	-0.563*
	(0.224)	(0.246)
Wealth Group 2, after 1800	-0.530**	-0.532*
	(0.206)	(0.227)
Wealth Group 3, after 1800	-0.607**	-0.578*
	(0.221)	(0.245)
St Paul		
Wealth Group 2, before 1800	0.139	-0.065
	(0.277)	(0.307)
Wealth Group 3, before 1800	-0.441	-0.464
	(0.271)	(0.287)
Wealth Group 1, after 1800	-0.493	-0.641*
	(0.266)	(0.291)
Wealth Group 2, after 1800	-0.250	-0.288
	(0.258)	(0.279)
Wealth Group 3, after 1800	-0.245	-0.408
	(0.293)	(0.324)

Table 5A.23 ctd.

Rosny		
Wealth Group 2, before 1800	-0.384	-0.314
	(0.215)	(0.238)
Wealth Group 3, before 1800	-0.525*	-0.514*
	(0.212)	(0.230)
Wealth Group 1, after 1800	-0.636*	-0.677*
	(0.284)	(0.309)
Wealth Group 2, after 1800	-0.769**	-0.723**
	(0.251)	(0.279)
Wealth Group 3, after 1800	-1.123***	-1.166***
	(0.252)	(0.287)

*** Significant at .001% level
** Significant at .01% level
* Significant at .05% level

Results

For both gross and net fertility, both female age at marriage and at death are highly significant and the coefficients highly consistent across all variations of the model. The effects of these variables act in the expected directions. Women who marry later in life should have lower fertility for biological reasons, and those women who die before 50 should contribute significantly to the positive fertility-female age at death relationship. The time trend (as measured by year of marriage) is generally significant.

Wealth Effects

Model 1 constructs gross fertility as a function of the relevant demographic variables, village level fixed effects, event dummies (the Revolution and the Napoleonic Wars) and categories for wealth (three as discussed previously). Relative to the omitted category (the bottom wealth group), the reported coefficients for Wealth groups 2 and 3 are negative and increase in scale relative to the wealth group – suggesting a negative wealth-fertility relationship. However, the coefficient on wealth group 2 fails to be significant at the 5% level. On the other hand, we see a large and statistically significant effect of wealth group 3 on gross fertility. This effect remains – although its strength diminishes when this model is run with net fertility as the dependant variable (model 3). Pooling the data results in a significant *negative* wealth-fertility relationship (at least for the top wealth category relative to the bottom).

There is a considerable likelihood that this model misrepresents the true wealth-fertility relationship. As the period as a whole is one of transition and declining fertility, surely there is a need to account for time in this analysis. The included time trend, based on year of marriage does not allow for the possibility that the Wealth fertility relationship is changing over time. Models 3 and 6 account for period changes in the wealth-fertility relationship via interaction terms between wealth group, locality and period. Period is categorised by splitting the sample in 2 based on year of marriage (1801).

Table 5A.23 reports the specific wealth-village-period effects. These values are standardised for female age at marriage (25) and age at death (both 60 for male and female) and are net of the effects of the revolution and the Napoleonic wars. They can be interpreted as the net wealth effects on marital fertility. These values are a product of the regressions and are calculated by adding the coefficients and exponentiating the sum. They give the expected number of children for each wealth group by period of marriage. For the period as a whole, there is a negative association of wealth and net fertility.

Table 5A.23: Wealth Effects on Family size

Village	Marriage	Wealth Group 1	Wealth Group 2	Wealth Group 3
All	All	4.9 (3.3)	4.8 (3.2)	**4.1 (2.9)**
Cabris	Pre1800	4.8 (3.3)	4.1 (2.2)	**3.7 (2.7)**
	Post1800	**3.5 (2.4)**	**3.8 (2.5)**	**2.9 (2.0)**
St Paul	Pre1800	4.7 (3.4)	5.5 (3.2)	3.6 (2.8)
	Post1800	3.6 (2.3)	4.9 (3.2)	4.1 (2.4)
St Chely	Pre1800	4.8 (2.6)	4.9 (2.7)	5.7 (3.5)
	Post1800	6.0 (3.3)	6.4 (3.4)	5.3 (2.8)
Rosny	Pre1800	4.4 (3.2)	4.5 (3.2)	**4.6 (3.5)**
	Post1800	**4.3 (2.8)**	**4.1 (2.7)**	**2.4 (1.5)**

For some village-period-Wealth group combinations, the negative binomial models fit significantly lower numbers of children (both gross and net) than others. For period 1, only those in the top wealth division in Cabris and Rosny register a significantly lower family size than the reference group. Moving to period 2, the variables for which all coefficients (both gross and net) are significant are all the wealth groups in Cabris and Rosny. The direction of the wealth fertility relationship is negative (at least between the bottom and top wealth groups in Cabris). This result is interesting because it suggests that fertility reduction by the top wealth division predicts fertility reduction by the rest of the population, in aggregate. This observation also constitutes what Gutmann and Watkins term "an early warning system" for aggregate fertility decline – the warning being the lower cross sectional fertility by certain groups, in this case the top third of the wealth distribution (1990).

In aggregate, fertility appears to be negatively related to wealth at death. This is revealed by the lower fertility of the top wealth division, Wealth Group 3 and the observation holds for both gross and net fertility. However, the relationship diverges between localities, once the calculations are performed for each village individually. For Cabris, St Paul and St Chely the relationship appears either negative or flat (more often flat when infant mortality is taken into account). The fertility relationship is strongly negative in Rosny and Cabris for marriages post 1800. These are also the villages and periods where fertility decline has unambiguously taken hold, as the fertility index calculations graphed in figure 5.3 indicate. The outlier to the negative/flat fertility trend is St Chely, where a strong positive relationship is evident in terms of both gross and net fertility. Figure 5.3 also indicates that this village does not experience any decline in marital fertility during the sample period. The preliminary observations are stark: Where fertility is declining, we observe a negative wealth-fertility relationship. Where fertility is not declining, the relationship is strongly positive. This suggests that it is the richer groups in each village which reduce their family size first.

Village Level Mechanics

The pooled sample estimates of the Coale-Trussel fertility control parameters for all wealth classes show increasing values for the scale parameter of the age fertility schedule, M, along with increasing values for 'm' – the fertility control parameter, between the earlier and later periods of this analysis. This implies that as fertility is increasing at younger ages, the deviation from the natural schedule is increasing towards that of a standard controlling population. The decrease in fertility through a higher *m* value outweighs the increase in M, as the total marital fertility rates are falling for all wealth classes. The evidence for unambiguous fertility control, as indicated by an *m* value greater than .200, is present for the top wealth categories in the pooled sample, Cabris, St Chely, and Rosny (all after 1800)[132]. For this category in Rosny, fertility declines for both older and younger women, according to the movements in the Coale-Trussel parameters.

[132] The *m* coefficient for Wealth group 3 in Rosny is only significant at the 10% level, but can bet taken as unambiguous as it is so large (0.703).

Table 5A.24: Summary of Coale-Trussell Measures, by Village

Whole Sample	**Wealth Group 1**	**Wealth Group 2**	**Wealth Group 3**
Year of Marriage before 1800			
Total Marital Fertility	7.67	7.67	7.28
M	0.841	0.841	0.857
S.E.	(1.092)	(1.078)	(1.075)
"m"	0.029	0.027	0.142
S.E.	(0.098)	(0.087)	(0.084)
Year of Marriage after 1800			
Total Marital Fertility	6.71	7.66	6.04
M	0.842	0.945	0.912
S.E.	(1.110)	(1.092)	(1.100)
"m"	0.235	0.199	0.555***
S.E.	(0.123)	(0.102)	(0.128)
Cabris			
Year of Marriage before 1800			
Total Marital Fertility	7.23	7.06	6.66
M	0.888	0.824	0.787
S.E.	(1.155)	(1.112)	(1.105)
"m"	0.221	0.127	0.142
S.E.	(0.177)	(0.129)	(0.117)
Year of Marriage after 1800			
Total Marital Fertility	5.94	6.53	4.60
M	0.826	0.913	0.736
S.E.	(1.212)	(1.185)	(1.202)
"m"	0.425	0.402*	0.690**
S.E.	(0.238)	(0.198)	(0.251)
St Paul			
Year of Marriage before 1800			
Total Marital Fertility	6.69	8.28	5.80
M	0.648	0.836	0.606
S.E.	(1.232)	(1.240)	(1.267)
"m"	-0.177	-0.111	-0.046
S.E.	(0.251)	(0.246)	(0.281)

Table 5A.24 ctd.

	Wealth Group 1	Wealth Group 2	Wealth Group 3
St Paul			
Year of Marriage after 1800			
Total Marital			
Fertility	5.73	7.09	6.03
M	0.637	0.976	0.973
S.E.	(1.256)	(1.228)	(1.283)
"m"	0.049	0.405	0.670
S.E.	(0.261)	(0.288	(0.381)
St Chely			
Year of Marriage before 1800			
Total Marital			
Fertility	8.38	8.50	10.49
M	0.875	0.896	1.197
S.E.	(1.204)	(1.156)	(1.152)
"m"	0.013	-0.025	0.113
S.E.	(0.193)	(0.162)	(0.158)
Year of Marriage after 1800			
Total Marital			
Fertility	7.82	9.44	8.92
M	0.947	1.023	1.231
S.E.	(1.172)	(0.128)	(1.147)
"m"	0.164	0.004	0.377*
S.E.	(0.189)	(0.141)	(0.176)
Rosny			
Year of Marriage before 1800			
Total Marital			
Fertility	8.51	7.33	6.72
M	0.959	0.821	0.956
S.E.	(1.205)	(1.245)	(1.223)
"m"	0.033	0.069	0.481
S.E.	(0.198)	0.249)	(0.255)
Year of Marriage after 1800			
Total Marital			
Fertility	8.89	5.72	3.47
M	1.240	0.733	0.563
S.E.	(1.499)	(1.354)	(1.351)
"m"	0.536	0.267	0.703
S.E.	(0.459)	(0.360)	(0.409)

Table 5A.25: Age at last birth

Village	Marriage period	Wealth Group 1	Wealth Group 2	Wealth Group 3
All	*Before 1800*	39.30	38.73	38.78
	After 1800	37.26	37.43	34.84
Cabris	*Before 1800*	39.00	38.48	38.55
	After 1800	36.64	37.00	34.43
St Paul	*Before 1800*	40.00	41.28	38.50
	After 1800	37.70	36.66	34.00
St Chely	*Before 1800*	38.93	38.50	40.86
	After 1800	37.40	38.90	36.93
Rosny	*Before 1800*	39.84	38.00	37.00
	After 1800	37.75	34.80	32.44

Table 5A.25 reports the age at last birth for women dying after the age of 49 for the sample as a whole and also by village and period. The mean age at last birth in populations practising 'natural fertility' is approximately 40-41 years (Bongaarts (1983) as cited by Kohler et al. 2002 p.28). Only wealth group 3 deviates from this 'natural' pattern in the pooled sample. By locality, the differentials are stronger. The top wealth category in Cabris and St Paul in the post 1800 period and the top 2 wealth categories in Rosny in this period have significantly lower ages at last birth than what we would expect from a population practising natural fertility. This is strongly suggestive of 'stopping' behaviour. As with completed fertility, the direction of the wealth–age at last birth relationship is negative where fertility is declining.

The Coale Trussel fertility control parameter *m* and the mean age at last birth strongly indicate that 'stopping behaviour' was employed by those groups in the sample who engaged in fertility control.

'Spacing' behaviour

Having established evidence for the presence of parity-specific fertility control amongst the wealthiest groups in the sample villages, the question of 'spacing' arises. It is far easier to detect ‘stopping’ behaviour in population sub-groups then it is to detect ‘spacing’ behaviour. One way to detect spacing is to model the birth intervals directly using a Cox proportional hazards model. The results will describe the effects of the covariate independent variables in terms of a ‘hazard rate’, which is defined as the instantaneous probability of the event in question (in this case a birth), and is therefore directly related to the length of the birth interval. As the model is intended to reveal differences in spacing behaviour, only closed birth intervals are used. The formulation of the birth interval model follows previous analyses by Alter (1988), Bengtsson and Dribe (2006) and Van Bavel (2004a, 2004b) and Van Bavel and Kok (2004). After consideration of the varying inclusion of demographic factors in these studies, it was decided to concentrate on those factors most commonly found to affect the birth interval. This was done with the aim of producing a parsimonious model which could capture the wealth effects (if any) on the duration of the birth interval. The demographic factors included were the age of the mother (in five year age bands), the duration of the marriage and the life status of the previous born child. Where a mother had a child less than 2 years at the time of conception of her next child this was coded for. In common with the analysis by Bengtsson and Dribe, I include shared frailty at the individual level to control for unobserved family-specific heterogeneity in the sample (2006 p.736). As the previous analyses indicated the importance of period and locality in understating the wealth-fertility relationship, the same interactions are included again.

Table 5A.26: Cox regression on Closed Birth Intervals, Village Level

	$e^{coeff.}$	$se^{coeff.}$	p
Women's Age			
15-19	0.85	0.20	0.481
20-24	1.01	0.07	0.850
25-29 (ref.)	1.00		
30-34	0.89	0.05	0.056
35-39	0.73	0.06	0.000
40-44	0.31	0.04	0.000
45-49	0.05	0.02	0.000
Marital Duration	0.97	0.01	0.000
Infant Alive	0.18	0.02	0.000
Villages			
Cabris	0.93	0.15	0.667
St Paul	1.11	0.26	0.636
St Chely (ref.)	1.00	-	-
Rosny	1.37	0.22	0.044
Main Wealth Effects			
WG 1, P 1	1.00	-	-
WG 2, P 1	1.23	0.18	0.166
WG 3, P 1	1.64	0.25	0.001
WG 1, P 2	1.34	0.21	0.062
WG 2, P 2	1.47	0.21	0.008
WG 3, P 2	1.31	0.20	0.080
Marginal Wealth Effects			
Cabris, WG 2, P 1	0.80	0.16	0.250
Cabris, WG 3, P 1	0.62	0.12	0.015
Cabris, WG 1, P 2	0.64	0.13	0.034
Cabris, WG 2, P 2	0.51	0.10	0.001
Cabris, WG 3, P 2	0.44	0.09	0.000
St Paul, WG 2, P 1	1.02	0.29	0.954
St Paul, WG 3, P 1	0.41	0.12	0.002
St Paul, WG 1, P 2	0.55	0.15	0.030
St Paul, WG 2, P 2	0.63	0.17	0.089
St Paul, WG 3, P 2	0.80	0.23	0.448
Rosny, WG 2, P 1	0.87	0.19	0.513
Rosny, WG 3, P 1	0.46	0.10	0.001
Rosny, WG 1, P 2	0.51	0.13	0.008
Rosny, WG 2, P 2	0.31	0.07	0.000
Rosny, WG 3, P 2	0.25	0.05	0.000

Table 5A.27: Net Interaction Hazard Ratios

Village	Marriage	Wealth Group 1	Wealth Group 2	Wealth Group 3
Cabris	before 1800	0.93	0.92	0.94
	after 1800	0.80	0.69	0.53
St Paul	before 1800	1.11	1.39	0.74
	after 1800	0.83	1.04	1.17
St Chely	before 1800	1.00	1.23	1.64
	after 1800	1.34	1.47	1.31
Rosny	before 1800	1.20	1.47	1.04
	after 1800	0.94	0.63	0.44

Table 5A.27 reports the net wealth effects on the hazard of a birth within a give interval.

Village Level Regressions based on Year of Birth Periodisation.

Period 1: Female birth cohort: 1729-1776

Period 2: Female birth cohort 1777-1829

Table 5A.28: Negative Binomial Regression based on Birth Cohort Periodisation

Variable	Gross Fertility	Net Fertility
Year of Marriage	-0.016* (0.004)	-0.016*** (0.004)
Age at Marriage, Female	-0.061*** (0.006)	-0.062*** (0.006)
Age at Death, Female	0.011*** (0.002)	0.012*** (0.002)
Age at Death, Male	0.001*** (0.002)	0.003 (0.003)
Revolution	0.139 (0.087)	0.209* (0.094)
Napoleonic Wars	0.049 (0.074)	0.086 (0.083)
Wealth Group2, P1	0.152 (0.141)	0.12 (0.167)
Wealth Group3, P1	0.181 (0.142)	0.267 (0.164)
Wealth Group1, P2	0.59** (0.189)	0.534* (0.217)
Wealth Group2, P2	0.57*** (0.173)	0.471* (0.199)
Wealth Group3, P 2	0.438* (0.183)	0.35 (0.211)
Wealth, Village, Time Period Interactions	Yes, see next page	Yes, see next page
Constant	3.026*** (0.249)	2.386*** (0.277)
N	446	446
Pseudo R2	0.1083	0.1000

Table 5A.29: Interaction Coefficients based on Birth Cohort Periodisation

	-0.262	-0.275
Cabris, WG2, P1	(0.194)	(0.219)
	-0.449*	-0.525*
Cabris, WG3, P1	(0.192)	(0.214)
	-0.654**	-0.653*
Cabris, WG1, P2	(0.227)	(0.252)
	-0.609**	-0.568*
Cabris, WG2, P2	(0.207)	(0.231)
	-0.633**	-0.557*
Cabris, WG3, P2	(0.214)	(0.239)
	0.244	0.142
St Paul, WG2, P1	(0.296)	(0.327)
	-0.45	-0.459
St Paul, WG3, P1	(0.272)	(0.291)
	-0.633*	-0.726*
St Paul, WG1, P2	(0.269)	(0.299)
	-0.409	-0.457
St Paul, WG2, P2	(0.258)	(0.284)
	-0.219	-0.348
St Paul, WG3, P2	(0.294)	(0.328)
	-0.481*	-0.394
Rosny, WG2, P1	(0.21)	(0.234)
	-0.62**	-0.609**
Rosny, WG3, P1	(0.213)	(0.234)
	-0.785**	-0.802*
Rosny, WG1, P2	(0.298)	(0.329)
	-0.852***	-0.774**
Rosny, WG2, P2	(0.253)	(0.283)
	-1.066***	-1.016***
Rosny, WG3, P2	(0.242)	(0.273)

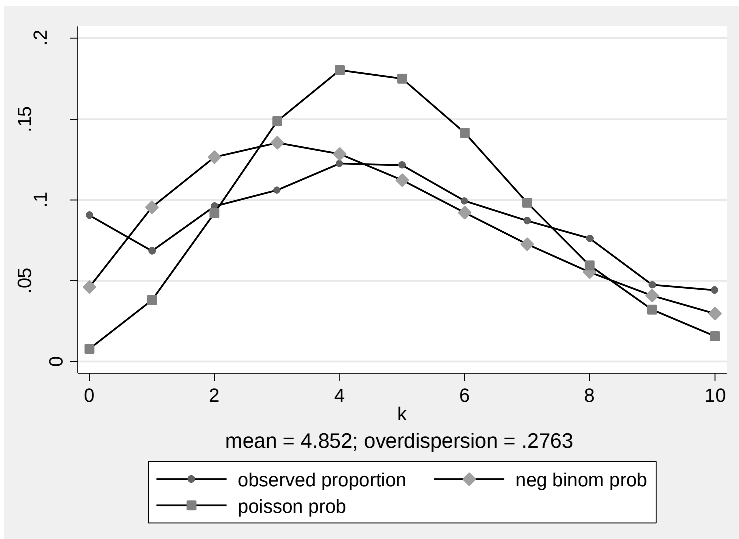
* *P*<.05
** *P*<.01
*** *P*<.001

The results are consistent with the year of marriage division.

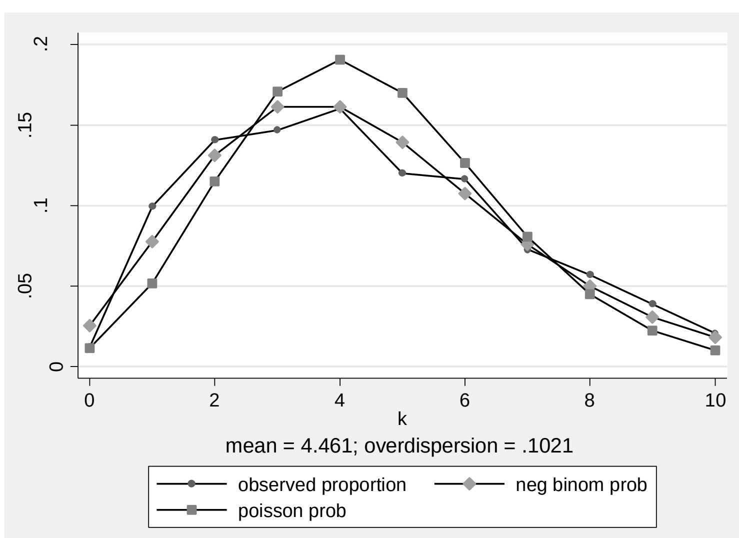
Section 5A.7: The Negative Binomial Distribution

The following graphs illustrate how gross fertility and net fertility fits both the Poisson and negative binomial distributions: The graphs plot the variable against a Poisson distribution with the same mean, and a negative binomial distribution with the same mean and variance (Stata Library 2008).

Figures A2 and A3: Gross fertility



Net Fertility



Chapter 6 – Relative Status, Inequality and Fertility Decline: A Simple Model and Empirical Test

"A promiscuous intercourse to such a degree as to prevent the birth of children seems to lower, in the most marked manner, the dignity of human nature"
Thomas Malthus 1798 p.13.

Section 6.1: Introduction

Malthus may not have liked the technology employed but he would have been overjoyed to witness the widespread implementation of family limitation which occurred within a century of the publication of his famous essay. Why the population of Europe embarked upon this new strategy is less well understood than how. The focus of this thesis has been to re-examine the economic correlates of the decline at the aggregate and individual level. This chapter takes a different approach to the preceding chapters and presents a new interpretation of the theoretical foundations behind the European fertility decline. The variables and relationships behind Becker's microeconomic theory, outlined in depth in chapter 2, are adjusted to reflect the idea that parents will aim to maximize both their own, and their children's relative socioeconomic status. The implications of the model are discussed. Following this, a joint analysis of the new micro level wealth-fertility datasets is conducted with reference to the theory.

As discussed earlier in this thesis, the European Fertility Project (EFP) of the 1970s and 80s, under the directorship of Ansley Coale at Princeton University, set out to provide an empirical basis for 'demographic transition theory'. This theory attributed the decline in fertility to modernisation, broadly defined. The conclusions to the project are published in a summary volume (Coale and Watkins 1986), in which the editors strongly reject any causal relationship between modernisation and fertility decline. They proposed that cultural forces and the diffusion of new knowledge concerning contraceptive techniques were the crucial elements in this story.

However the legacy of the EFP has not silenced those who propose economic reasons for fertility change. Recently, there has been a revisionist attack upon the conclusions to the EFP, with some arguing that the EFP's methodology was flawed. Perhaps the lack of closure in this debate is related to the rejection of demographic transition theory and the failure to replace it with any concrete alternative.

"A massive twenty year project with substantial resources and collabouration by a large number of first rate demographers did not result in a substantial improvement in theory" (Burch 2003 p.25).

The work of Becker has been highly influential in our understanding of how utility maximizing parents substitute child quantity for quality. However, as discussed in chapter 3 and 5, Becker's theory relies on the level of income to initiate this 'trade off'. How can we reconcile this with the empirical record? As discussed in chapters 3 and 5, fertility decline in France preceded that of England by over 100 years. Any explanation for the decline in fertility must be able to coherently explain why fertility fell first in France. This feature is central to Europe's demographic transition.

The rest of this chapter is comprised of five sections. Section 6.2 provides an account of the intuition behind the simple status fertility model. Section 6.3 is a first formulation of the said model. Section 6.4 demonstrates how a fertility decline occurs within the model, while section 6.5 examines the micro data introduced in chapters 4 and 5 for patterns that are either consistent or inconsistent with the simple status fertility model. Section 6.6 Concludes.

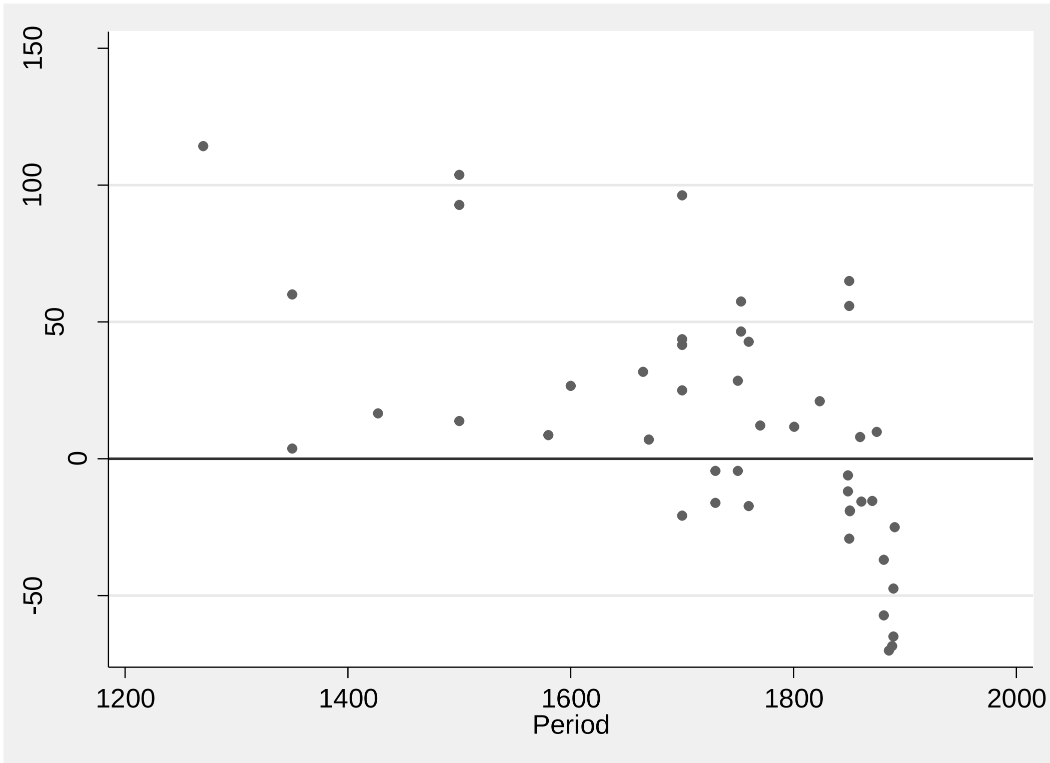
Section 6.2: The intuition behind the Model

The traditional economic model of fertility as proposed by Becker (1960, 1991), focuses on the roles of full income and the cost of children in determining parent's fertility choices. At a certain threshold, the initially positive effect of income acts to depress fertility rates via a quality-quantity trade-off. As I have mentioned, this model offers no explanation for why fertility in France declined long before that of her richer and more industrial neighbour, Britain. Further, fertility declined in France preceded any significant structural change in the economy which could have induced parents to substitute child quantity for quality. The evolutionary biology literature on human fertility emphasizes the importance of relative status and social competitiveness in human fertility decision making (see chapter 2 for a brief literature review). In this chapter, I develop an economic model of fertility which includes the role of 'relative socio-economic status'. I propose that parent's perception of the possibilities for social mobility for themselves and their offspring can be proxied by measures for economic inequality.

What was the relationship between status or wealth and fertility over the long run of human history? Typically, hunter gatherer societies are egalitarian relative to settled societies. The adoption of settled agriculture during the Neolithic revolution 10-12 thousand years ago was accompanied by the introduction of extra somatic wealth and its inheritance. This led to a "variance in male quality based on the resources each could control" (Kaplan and Lancaster 2003 p.190). As opposed to depending upon natural skill in hunting and surviving, male's access to brides and their ultimate reproductive success now depended upon the resources they could control, their wealth. Until a few centuries ago, fertility success was highly related to wealth.

Skirbekk (2008) presents a meta-analysis of the wealth/status-fertility relationship consisting of 879 samples from 129 sources, from 1270 to 2005. He standardises the data by computing the relative fertility differential of the highest status group to the lowest. Pre 1800, the overwhelming trend is of higher reproductive success by higher status groups. This trend begins to turn negative by the beginning of the 19th century and predates the aggregate decline in fertility. The data relating to the pre-1850 period and of European origin are graphed in figure 6.1. Before the demographic transition, the status-fertility relationship is overwhelmingly positive.

Figure 6.1: The Wealth Fertility Differential, 1200-1850



Source: Skirbekk 2008.

The evidence suggests that the attainment of high social status via the accumulation of wealth led to higher reproductive success than average. This mechanism has been in place since the Neolithic Revolution and has surely influenced human psychology in a major fashion. Turke (1989) argues that humans have evolved to strive for economic and social success and will "nearly always take steps that increase their and their children's" relative position (1989 p.66). Starting in France in the 18th century and in the rest of Europe over a century later, the status-fertility relationship is reversed.

My proposition is that Europe's fertility transitions were adjustments by populations to changes in the socioeconomic environment which made the advancement or preservation of families' relative status inextricably linked to family size. This trend was initiated by the rich in order to preserve their relative status and avoid the downward social mobility of their offspring. The trend in the fertility of Europe's 'super rich' pre-dated the aggregate declines in European countries by several centuries (see figure 6.5). Once the rich adopted a small family size norm, this trend diffused down the social order. However, this only diffused once the level of economic inequality fell so that it made rational sense for other groups to control their fertility.

If humans are predominantly motivated by increasing their families' relative social status and controlling fertility is a means to achieve this, why wasn't there a fertility transition thousands of years ago? As mentioned previously, hunter gatherer societies are very egalitarian, so there is therefore no incentive to decrease fertility. With the presence of extra somatic wealth in settled societies, inequality increases and substantial fertility differentials are observed between those of different statuses. However, unequal settled societies have existed for the past 12,000 years, yet fertility has only declined within the past three centuries. I believe the answer is the changing level of economic inequality over time. Economic historians generally accept that pre-modern societies were highly unequal with respect to income and wealth distributions. However, historical evidence on this point is thin. Lindert et al. (2007) is the most recent study to analyse this issue and conclude that "compared with the maximum inequality possible, today's inequality is *much* smaller than that of ancient societies" (p.19) (their italics).

In a society with a large rural, landless majority and a small group of elites, the prospects for social mobility are limited. It makes no sense to control fertility if family size has no impact upon a family's relative social standing. The economic distance between the bottom and the top status groups is too great, and therefore upward social mobility is unattainable for the majority of the population. However, changes in the distribution of wealth and income between groups in the population reflect a changing environment for the possibility of social mobility. As economic inequality declines, fertility is induced to decline also, as parents now realise that social mobility is possible and the prospects for it are affected by family size.

In both England and France, inequality was rising during the 19th century. After 1867, there is suggestive evidence for declining inequality in England, roughly simultaneous with the onset of aggregate fertility decline (Lindert 2000 p.187). However the data here is weak. During this period, France had a lower level of inequality than England[133]. I propose that despite having a lower level of material income per person than England, France entered a sustained fertility transition because economic inequality had dropped to a level low enough to stimulate the control of family size as a tool to aid families' relative social advancement. Once a low fertility trend is adopted by some members of a socioeconomic group, others must adopt the same strategy if their children are to be socially and economically competitive. There is no possibility of reversing a fertility transition, even if inequality rises after the transition, and none has ever been observed.

In essence, much of this hypothesis does not diverge dramatically from the traditional 'quality-quantity' trade-off proposed by Becker's theory[134]. The crucial distinction is the explicit link between fertility control, social ambition and economic inequality. I propose that downward shifts in economic inequality stimulate the spread of a low fertility trend. Recently, the issue of social mobility and relative status in understanding Europe's fertility decline has been coming to the fore. Skirbekk (2008) and Van Bavel (2006) discuss the issue explicitly. Van Bavel finds a negative relationship between family size and children's subsequent socioeconomic status (2006

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[133] This was due to the extremely narrow concentration of land ownership in England (Piketty et al. p.250 2006).

[134] It is consistent in spirit with Dumont's social capillarity hypothesis concerning early French fertility decline (discussed in the last chapter) and also the *Wohlstandstheorie* of the early German transition theorists (Knodel 1974 p.127).

p.15) and suggests that these intergenerational motivations may be important in understanding the fertility transition (p.16).

The empirical analyses of chapters 4 and 5 strongly suggested that the environment for social mobility was related to the decline in fertility. In England, fertility decline was initiated by the poorest members of the top occupational status groups. This feature was accompanied by a decrease in the strength of the association between status and wealth, suggesting that status driven economic inequality was decreasing, and social mobility (via the accumulation of wealth) was increasing. In France, it was the wealthiest residents of certain villages who employed fertility control consistently. This was associated with lower economic inequality in these villages, and also a far lower degree of intergenerational correlation of wealth at death. For both England and France, where the underlying level of economic inequality is decreasing, and therefore signalling that upward social mobility is more attainable, fertility limitation is initiated.

The next section represents a first formulation of a very simple economic theory of fertility which relates economic inequality and relative socioeconomic status to parent's decisions concerning family size. The approach is derived Becker's microeconomic theory of fertility (1960, 1991) where rational actors are assumed to maximise a utility function which expresses their preferences. The key difference here is in the form of this utility function, where I define the nature of the goods differently, and hence there is a different interpretation on the cost parameters, and also on the interpretation of the relationships in the model. I develop the analysis to explicitly formulate the relationship between economic inequality and fertility decisions.

Section 6.3: A First Formulation of a Status-Fertility Model

Chapters 1 and 2 of this thesis gave a very brief summation of an extensive literature. The division in the literature has been discussed in order to highlight the need for further research. With that in mind attention has been turned to economic models of fertility, and in particular, the income-fertility relationship. However, I believe that existing theory neglects an essential component of people's welfare, namely their *relative socioeconomic status.* I define this as a person's desired rank within their desired socioeconomic group. In relation to fertility decisions, parents also hold a desired social rank for their offspring. Designing a utility function with these two 'goods' in mind, and dropping the assumption that parents *always* wish to maximise family size, I develop this analysis, and relate it to economic inequality in this section.

Quite simply, this theory supposes that parents will try to maximize their own, and their children's relative socioeconomic status. The utility function takes the form:

$$U = U(S_p, S_c)$$

Where S = relative socioeconomic status, and the subscripts $_p$ and $_c$ denote parents and their children. Relative socioeconomic status is defined as the desired rank of parents, for themselves and for their offspring, relative to other members of their community or population. Subject to available income and price constraints, parents will strive to maximize these 'goods'. The natural contrast is with Becker's model, which supposes parents maximize both quantity and quality of children, and also quantities of other goods, irrespective of relative status.

$$U = U(n, q, Z_1, ..., Z_m)$$

Where n is the number of offspring, q is 'child quality' (or expenditure per child) and $Z_1, ..., Z_m$ represent a range of competing purchases (such as consumer goods, lifestyle expenditures etc. The analogies in this adjusted model are as follows:

$$S_p \approx f(Z_1, ...Z_m)$$

$$S_c \approx f(q)$$

In Becker's model, utility increases with n, the number of children. Today parents are the richest in human history, yet net fertility rates are also the lowest in history. Is it reasonable to assume that utility always increases with *n*, the number of offspring? Here we leave the Beckerian world. I propose that this is not necessarily true. Evolutionary thinking can move us away from rigid and perfectly rational economic actors towards actors who aim to maximize their family's *relative* status, S_p and S_c. This theory is designed to accommodate the reasonable hypothesis that parents will choose *n* to maximize their and their children's socioeconomic (relative) status. Family size, n is chosen where $U(S_{p,}S_c)$ is maximized, subject to the family size being greater or equal to one:

$$U = U(S_p, S_c) \text{ s.t. } n \geq 1$$

The budget constraint is represented by:

$$P_1 S_p + P_2 S_c n = Y$$

Where P_1 represents the cost of a unit of S_p (this could mean a consumer good/luxury expenditure), and P_2 represents the cost of a unit of S_c (such as education, training, etc). The fixed cost of children, the bare minimum required to raise a live child via expenditure on food, shelter and clothing is represented by $P_2 S_c = 1$, where $S_c \neq 0$ but is very small.

<u>Proposition:</u> *n is chosen where S_p and S_c are maximized.*

Where parent's are free to choose n, the budget constraint can be re-arranged to express the factors determining the choice of family size:

$$n = \frac{\lfloor Y - P_1 S_p \rfloor}{P_2 S_c} = \frac{Y^A}{P_2 S_c}$$

Where $Y^A = \left[Y - P_1 S_p \right]$ (available income).

In words this corresponds to:

The desired number of offspring is equal to the amount of income available after parent's consumption and relative statuses desires have been satisfied, divided by the total cost of getting a future child to the desired socioeconomic status.

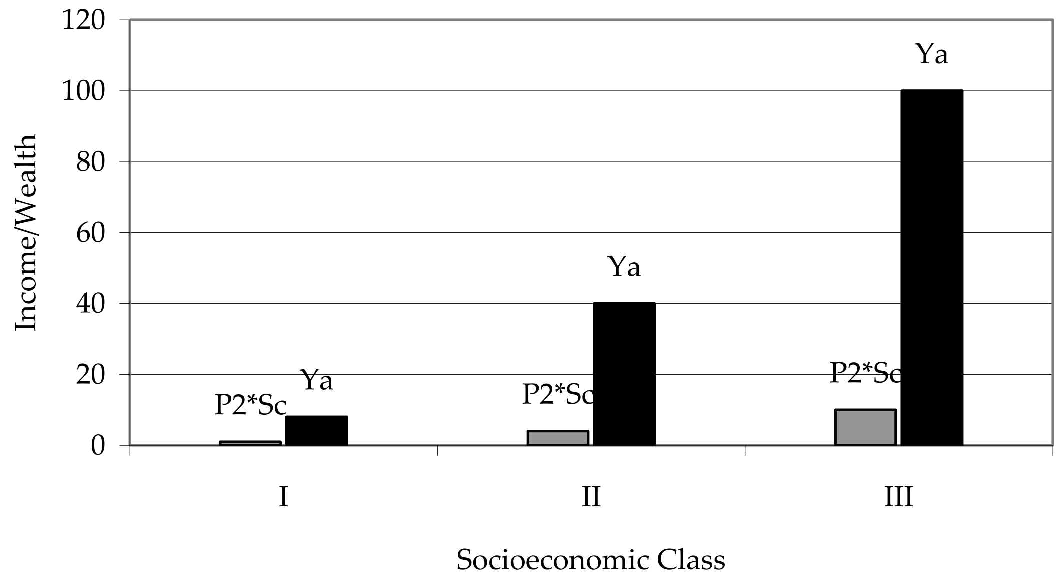
The number of children demanded (n) depends on the surplus income once parents have satisfied their own social status desires. Where this is rising, the quantity of children demanded will rise. This can account for the overwhelming positive wealth-fertility association (pre-1800) described by Skirbekk (2008). Similarly, we have an identity for the determination of S_c:

$$S_c = \frac{Y^A}{P_2 n}$$

Parents do not simply maximize S_c in the usual way; because if they did, the optimal number of children to maximize S_c would equal 1. However, because of the interplay between S_c, P_2 and Y^A, S_c is not simply maximized in a linear fashion. Instead parents choose a level of S_c based upon the minimum level of status investment required for their children to join the desired socioeconomic class. The value S_c of demanded depends upon discrete values of P_2. The relationship is nonlinear. For example, take a hypothetical three class society with an ascending level of socioeconomic status from I-III. Figure 6.2 illustrates the relationship between P_2 and S_c for each of the classes, and the accompanying table provides a numerical example.

Consider the case of highly altruistic parents of class I. They will strive to increase their children's status subject to the constraints discussed in order for their children to become members of class II or III. However, they will only be able to this if $P_2 Sc^{II} < Y^A$. In this hypothetical example, parents in class I can afford to invest in $S_c^{\ II}$ as $P_2 S_c^{\ II} n < Y^A$ ($n = 1$) but cannot afford to invest in $S_c^{\ III}$ as $P_2 S_c^{\ III} n > Y^A$ ($n = 1$). In this situation, parents of class I will choose $n = \frac{Y^A}{P_2 S_c^{\ II}}$. They will only then choose to

Figure 6.2: Example of the Interplay of the Variables in the Model



Class	P_2Sc	Y^A
I	1	8
II	4	40
III	10	100

maximize their offspring, subject to the minimum cost of obtaining a suitable status for each child and the available income.

Depending on preferences, individual parents (j) of class i will choose a level of S_c that satisfies the identity $Sc^i \geq Sc_j^i \leq Sc^{i+1}$. They will invest at least as much in their children as is required to keep them in the status group of their origin and at most will invest as much in their children that will ensure upward social mobility (simplified to a '1' unit increase in their socioeconomic class here). Further investment beyond Sc^{i+1} is avoided as this will not appreciably raise the status of their children. This results in a threshold upon child investment and explains why $n \geq 1$. In the example parents belonging to class I will choose a level of S_c greater or equal to $S_c{}^I$ and less than or equal to $S_c^{\ II}$.

In combination with individual preferences, parents will choose a level of fertility subject to $\dfrac{Y^A}{P_2 S_c^{\ i}} \leq n \leq \dfrac{Y^A}{P_2 S_c^{\ i+1}}$ and $Y^A > P_2 S_c^{\ i+1}$. In words:

Parents will choose a level of family size that allows an appropriate level of child investment for each child to stay in the status group of origin at a minimum, and allows each child to increase their relative social status level, at a maximum.

In this example, parents of class I can afford to raise 2-8 children (2 with maximum status investment, 8 with minimum), class II can afford 4-10 and class III can afford 10. Assuming constant preferences amongst the social classes, this will result in a positive wealth fertility relationship. The interplay of P_2, S_c and Y^A are key to understanding how fertility declines, and this will be illustrated with similar numerical examples later in this section.

Maximizing Utility

Applying the method of Lagrange by introducing the multiplier λ, the Lagrangian function is

$$L = U(S_{p,} S_c) - \lambda(P_1 S_p + P_2 S_c n - Y)$$

s.t. $n \geq 1$

Further it is assumed that

$$u_{S_p} = MU_{S_p} > 0, \qquad u_{S_c} = MU_{S_p} > 0,$$

The first order derivatives are interpreted as the marginal utilities, and the identities above state that utility increases with higher values of relative socioeconomic status.

$$u_{S_p S_p} < 0, \qquad u_{S_c S_c} < 0,$$

The second derivatives indicated in the identity above show that the law of diminishing marginal returns applies to increments in relative socioeconomic status.

Further, $u_{S_pS_c} < 0,$ if parents and children's relative socioeconomic status are substitutes, $u_{S_pS_c} > 0,$ if they are complements and $u_{S_pS_c} = 0$ if they are unrelated. The optimal choice for S_c^*, S_p^*, n^* and the multiplier, λ^*, will satisfy the three first-order conditions[135].

$$v_\lambda = P_1 S_p + P_2 S_c n - Y = 0$$

$$v_{S_p} = MU_{S_p} = \lambda P_1 = \pi_{S_p}$$

$$v_{S_c} = MU_{S_x} = \lambda P_2 n = \pi_{S_c}$$

Where π denotes the shadow price[136] of either parents/children's relative socioeconomic status. In this model, parents choose S_p, S_c and n, whereas P_1, P_2 and Y are determined by the market. The crucial difference between this model and that of Becker's is the notion that parents choose family size, n^* in order to maximise S_c^* and S_p^*, subject to $n^* > 1$. Parents will choose n^* where S_c^* and S_p^* are maximized. The above system results in the following identity for the number of children:

$$\frac{MU_{S_p}}{MU_{S_x}} = \frac{u_{S_p}}{u_{S_c}} = \frac{\lambda P_1}{\lambda P_2 n} = \frac{\pi_{S_p}}{\pi_{S_c}}$$

$$\frac{P_1}{P_2 n} = \frac{\pi_{S_p}}{\pi_{S_c}}$$

The optimum family size, which maximises both parents and children's relative socioeconomic status, is a function of the ratio of the respective shadow prices and the actual (market) prices. The shadow price can be interpreted as the maximum price that parent's will pay for an extra unit of either S_p or S_c. Assuming that parents are altruistic, we can interpret $\dfrac{\pi_{S_c}}{\pi_{S_p}}$ as the degree of parental altruism ($\pi_{S_c} > \pi_{S_p} \therefore A > 1$) we can rewrite the above identity as:

---

135 $\lambda^* > 0$ is implied by the first derivative conditions.

136 The shadow price can be interpreted as the rate at which the maximised value of the utility function increases with increments to either parents or children's relative socioeconomic status.

$$\frac{P_1}{P_2 n} = \frac{1}{A}$$

$$A = \frac{P_2 n}{P_1}$$

$$n^* = A\frac{P_1}{P_2}$$

The optimal choice for the number of offspring depends on the degree of altruism and the ratio of price of obtaining status for parents and children. There is an inverse relationship with the price of obtaining children's status, P_2. This 'price' can also be interpreted as a measure of the likelihood of relative social position enhancement (relative to parents). This likelihood is judge by parents at time t, and is positively related to the level (and rate of change) of the degree of economic inequality between the parents socioeconomic group, and that which it aspires to join, at time t. P_2 represents parents perception of the cost of raising their offspring's relative social status by one unit.

As introduced above, P_2 represents parents perception of the cost of raising their child's relative socioeconomic status. This is analogous to 'child quality' in the Becker model (see chapter 2), and may reflect the cost of education amongst other things. This 'price' is estimated by parents, and in this model, it is positively related to the degree of economic inequality between the parents, and the socioeconomic group to which they aspire to join. Further, it may also reflect institutional barriers to social mobility, which may or may not be related to actual (measurable) economic inequality.

Proposition: *The price parents perceive for increasing status is directly related to the level of economic inequality in their society.*

The proposition here is that both P_1 and P_2 are directly related to the level of economic inequality and the degree of social mobility within a society. Formally,

$$P_1 f(g)$$

$$P_2 f(g, \Delta g)$$

Where g is a measure of income inequality, and $\Delta g = {dg}/{dt}$, the time trend of inequality. The effects of changes in g on P_1 and P_2 are not the same. I propose that parents actively estimate a value for P_2, which represent the perceived costs of raising children's relative socioeconomic success at time $t+n$ by one unit, which is based on the rate of change of g at time t.

$$S_{ct+n} f(P_2)$$

$$P_2 f(g_t, \Delta g_t)$$

$$\therefore S_{ct+n} f(g_t, \Delta g_t)$$

Parents judge the current change in income inequality as perfectly equal to the future change. They dynamically adjust their forecast of P_2. The price parents pay for one unit of relative socioeconomic status enhancement (P_1) is directly related to the level of income inequality between the parents and the socioeconomic group to which they aspire to belong to. The price parents pays for one unit of relative socioeconomic enhancement for their children (P_2**)** is directly related to the level of Income inequality at time t and the trend in income inequality (Δg_t). P_2 is related to Δg_t because parents actively integrate their perception of trends in income differentials into their perceptions of the cost of raising their children's relative socioeconomic status. This observation is important in understanding how parents increase their investment in their children as economic inequality decreases and is discussed further later in this section.

Section 6.4: How the Model can Explain Fertility Decline

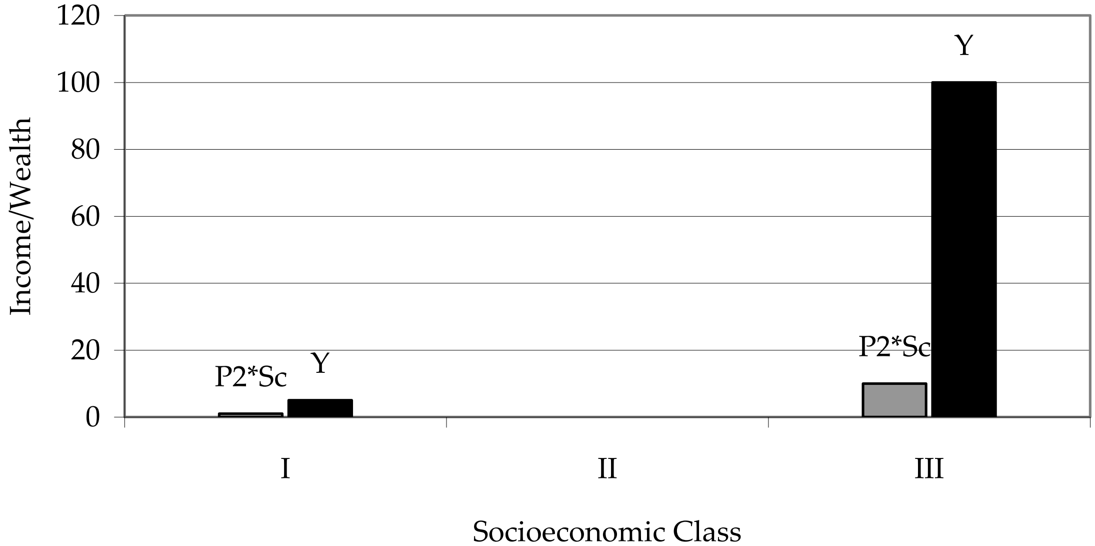
Returning to the interplay of S_c, P_2 and Y^A, this section explains how this simple status model of fertility can explain how fertility declines. Numerical examples are employed to illustrate the effects. These numbers are, of course, arbitrary. It is a matter of empirical observation for the validity of these hypotheses. The demographic evolution of the hypothetical three class community in this simple model is described in three stages: a pre- transitional stage, an early transitional stage and finally a transitional stage.

Stage 1: The Pre-Transitional Society

As discussed in the intuition section of this chapter, historical societies were typically very unequal. Societies were dominated by small groups of elites and a mass of peasants. This type of society is illustrated in figure 6.3.

The distribution of economic status (Y^A) is spectacularly unequal. There is no 'middle class'. The top class has 20 times the level of income as the bottom class. Parents of class I can not afford to invest in upward social mobility for their offspring as $P_2^{III} > Y^{AI}$. Therefore they will only invest in what they can afford ($P_2Sc^I = 1$, the bare minimum required to raise a living child). No further investment is made as there will be no extra gain from this expenditure in terms of social status. The numerical example above indicates that parents in this example will choose 5 children. Parents of class III are able to afford 10 children with satisfactory status investment. This example predicts a strongly positive status-fertility relationship and fertility is high for the society as a whole. The empirical basis for this is the overwhelming positive status-fertility relationship presented by Skirbekk's (2007) metanalysis, which is illustrated in figure 6.1. Further, the evolutionary ecology of human reproduction predicts a positive wealth fertility relationship (Mace 2000 p.391, Mace and Gurmu 2008 p.340). Those who have access to more resources than others should be able to reproduce more. Some are extraordinarily successful. The Y chromosome haplotype of Genghis Khan is found in one out of 200 of the World's men (Mace 2000 p.393).

Figure 6.3: The Pre-Transitional Society



Class	P_2Sc	Y^A
I	1	5
II	-	-
III	10	100

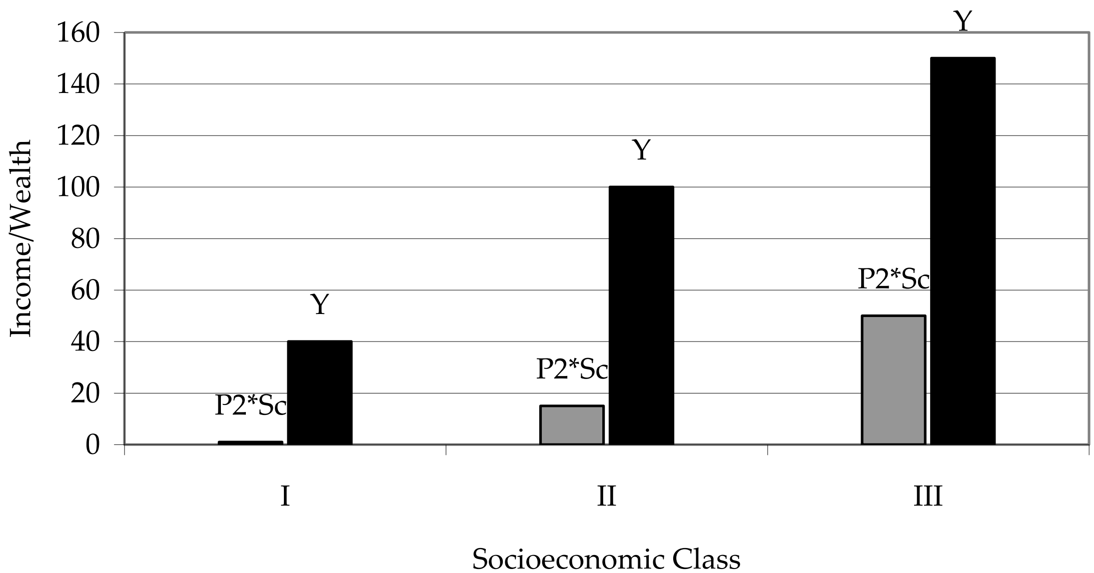
Stage II: The Early Stages of the Fertility Transition

Over time, changes in the distribution of wealth and status, and the price of obtaining it for offspring occur. The environment now is more equal, and a 'middle' class has arisen. Now, all classes in society can invest in upward mobility for their offspring. Parents of class I can afford a range of 4-12[137] children, parents of class II can afford a range of 2-10 children, and parents of class III can afford 3 children. Parents in the top status group have to restrict their fertility in order for the satisfactory investment per child, and the status-fertility relationship is sharply negative. Aggregate fertility does

[137] They can afford 40, but let's take 12 to mean that they can afford to have as many children as they like. 12 is a realistic (average) maximum in a historical society.

not decline as the proportion of the population that are members of class III is too small to move the average rate.

Figure 6.4: The Early Transitional Society

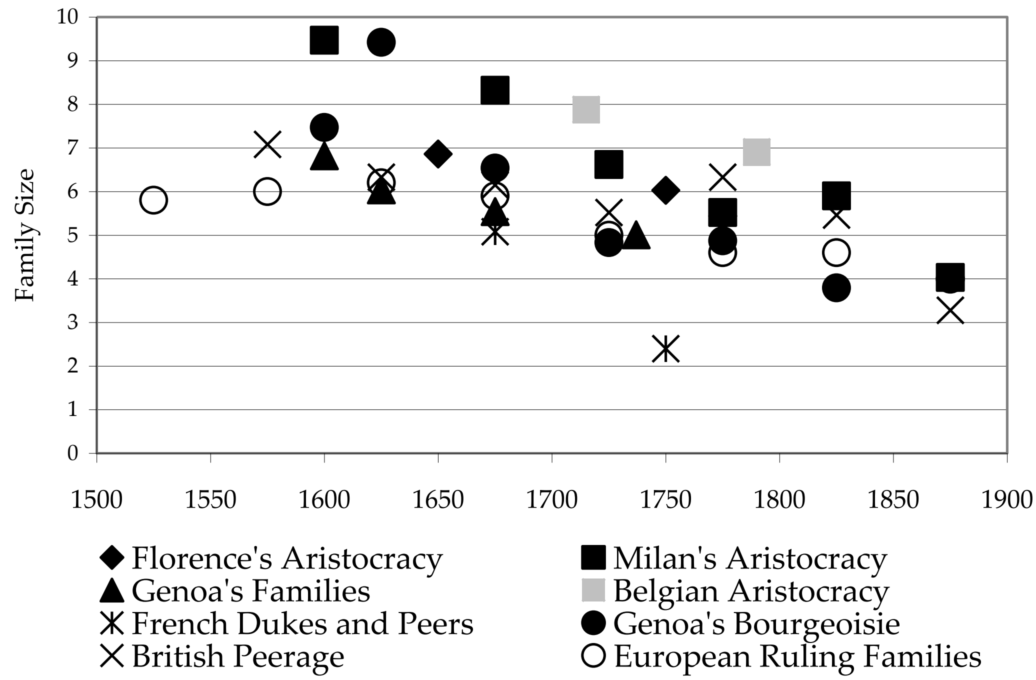


Class	P_2Sc	Y^A
I	1	40
II	10	100
III	50	150

Empirically, it is demonstrated and universally accepted that the pioneers of fertility decline in European society were the aristocratic class, the bourgeoisie – the top income/wealth bracket. Figure 6.5 is derived from Livi-Bacci's chapter in the summary volume of the EFP (1986). The trend in the completed family size of Europe's super rich and elites is clear. From apx. the 17the century, family size is being reduced. As a whole

Europe is entering an 'early transitional stage'. Aggregate fertility is still high, but there are groups (the super rich) who are initiating family limitation[138].

Figure 6.5: The Fertility of Europe's Elites, 1500-1900



Source: Livi-Bacci, 1986 p.185

The results of chapter 4A also support this hypothesis. Around about 1800, the 'super-fertility' of the rich, which had existed for at least four centuries prior, declined to equal that of the poor. In addition, chapter 4 demonstrated how the pioneers of the English fertility decline were the poorest members of the top occupational status classes, strongly suggesting a process of social status preservation similar to process stated in this simple model. For France, the first segments of society to reduce their fertility were the richest members of the decline regime villages.

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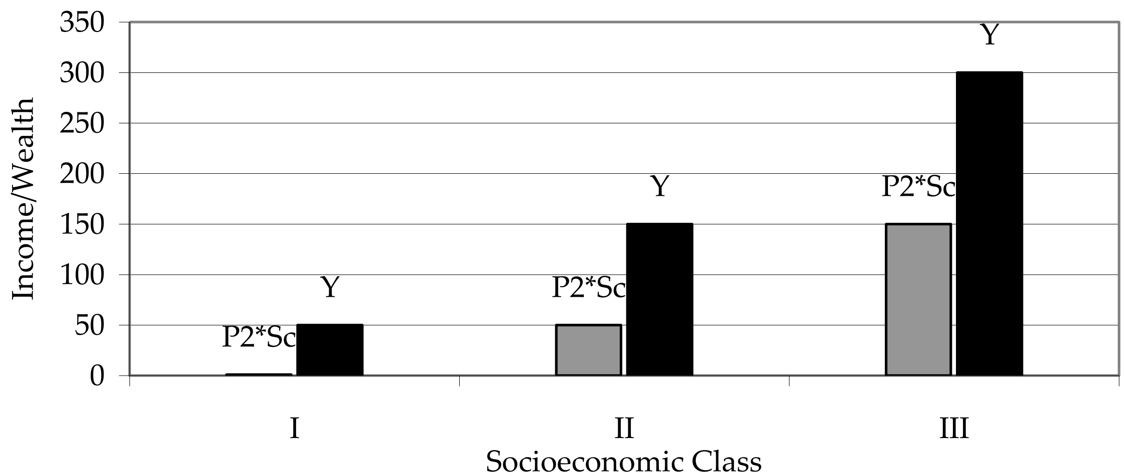
[138] Another intriguing possibility is the relative level of intergenerational transfers from parents to offspring. Perhaps the level of inequality in the past allowed a small elite to pass on large transfers of wealth to a large family. Movements in the underlying level of inequality in a society may result in certain families choosing lower fertility in order to maximise this intergenerational transfer and therefore maximise the relative status of their descendants (hypothesis derived from Mace 2000 p.393).

Stage III: The onset of Sustained Fertility Decline

In the next stage, the relative cost of children has risen for all classes. Parents of class I can now afford a range of 1-5 children, parents of class II can afford a range of 1-3 children and parents of class III can afford 2 children. The status fertility relationship will be approximately flat. All groups in the population, (apart from some members of the bottom status group) will restrict fertility in order to preserve or increase status obtainment for their offspring. Aggregate fertility decline has taken hold. Empirically, this stage corresponds to the late 19th century in Europe.

Figure 6.6: The Transitional Society



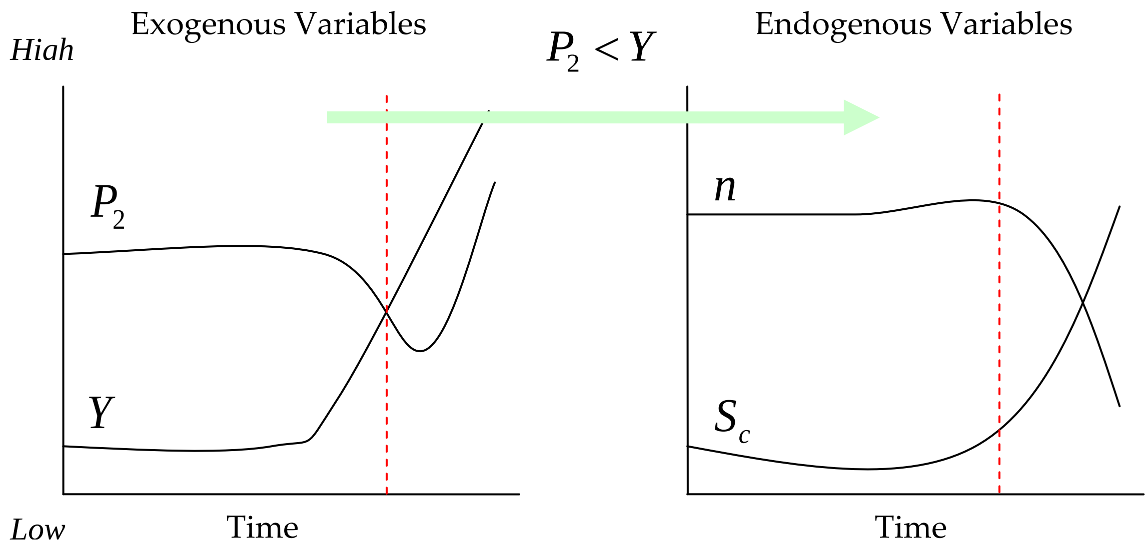
Class	P_2Sc	Y^A
I	1	50
II	50	150
III	150	300

In relation to evolutionary arguments, Richerson and Boyd state "Natural selection has shaped the psychology of social learning so that we are predisposed to imitate people with prestige and material well being" (2005 p.177). My theory proposes that this effect will only happen when parents judge the act of family limitation to be economically justified. In other words, they will only adjust their fertility when they judge this adjustment to have a realistic effect of increasing their or their children's relative socioeconomic status.

In the literature on Europe's fertility decline, many authors express the sentiment that relative status concerns were a central causal force in the limitation of family size. Concluding his analysis of the Belgian fertility transition, Lesthaeghe states "The mechanism of social capillarity was probably at work" (1977 p.224). Schneider and Schneider's account of the fertility transition in Sicily describes the late decline of the *bracciante* (day Labourers); "the majority in this class began to contracept after 1950 in order to have a decent life and because *decency had become a target worth pursuing*". Further, they did so for "social betterment" (1996 pp.258, 262, my italics). On the social mobility environment, Lesthaeghe and Wilson write; "In nineteenth century Western Europe, the system of social status and associated income levels was gradually replaced with a new hierarchy: the traditional status system based on ascribed status yielded reluctantly to a newer one based on achieved status" (Lesthaeghe and Wilson 1886 p.267). Fertility decline in nineteenth century Europe was coincident with the appearance this new "social status system" (Lesthaeghe and Wilson 1886 p.268).

P_2 is extraordinarily expensive in Pre-Transition times – i.e. it is next to impossible for parents in the vast majority of the population to influence children's chances of social 'success' (S_c). Parents cannot afford to buy any 'units' of S_c, which means $S_c \approx 0$ for the pre-Transition case, hence the term $S_c \approx 0$. For the vast majority of human history, available income Y has been stagnating. As society develops, Y surges. At the moment $P_2 < Y$, parents invest in S_c. As $n = \frac{Y^A}{P_2 S_c}$, when S_c increases, fertility n is reduced. The threshold moment for the fertility transition is the time $P_2 < Y$, and this is illustrated in figure 6.7 (broken line).

Figure 6.7: The Evolution of the Variables over Time



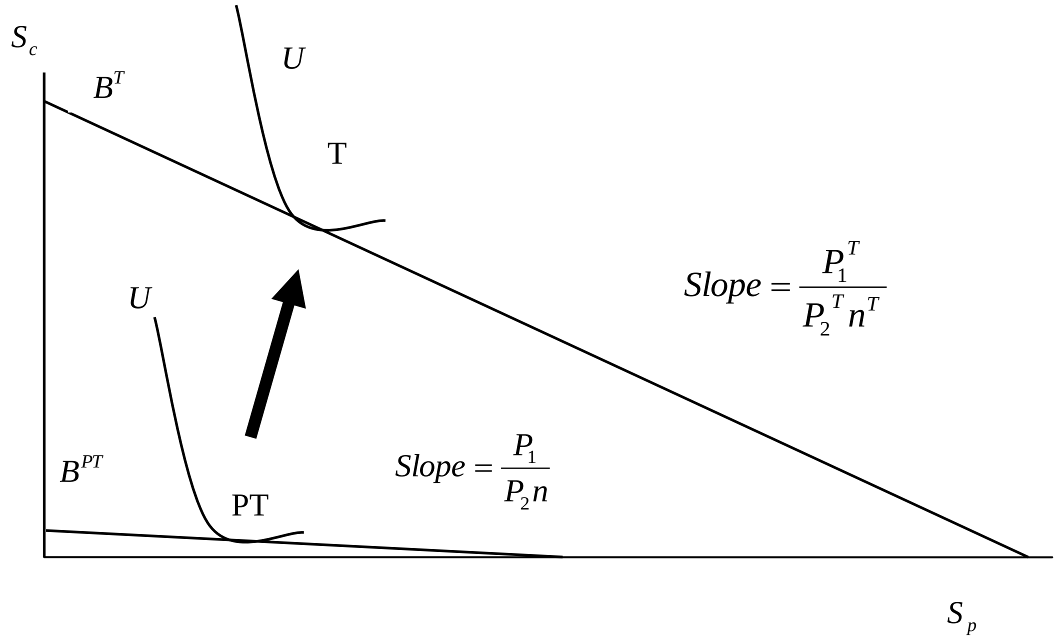
When P_2 is very large (pre-Transition reality), and the term $P_2 S_c$ is close to zero, parents will maximise their fertility. As discussed, in the pre-transition setting $P_2 S_c$ is close to zero, therefore n is maximised. However, as an economy develops, P_2 declines, therefore 'units' of S_c bought by parents increase. Table 6.1 summarises the differences between a Pre-transitional Society (PT) and a Transitional society (T) with respect to the variables in the model.

The same points made previously can be underlined with an analysis of the budget constraint and indifference curves. Figure 6.8 illustrates the cases of a Pre transitional society (PT) and a transitional society (T).

Table 6.1: The Values of the Variables in Pre Transition and Transition

	Minimum	Maximum	PT	T
P_2	$< Y$	$> Y$	Max	Min
S_c	1	∞	Min	Max
n	1	12 (apx.)	Max	Min
Y	Subsistence	∞	Min	Max

Figure 6.8: Graphical Budget Constraint Analysis



The slope of the utility function, it is steep and reflects parental altruism. Also, it is the same shape in the pre-Transition era as it is in the Post-Transition era, where preferences between purchase of parental social 'success' and offspring social 'success' is held constant. The next point to make concerns the slope of the pre-Transition budget constraint. As P_2 is huge ($P_2 > Y$), the slope is virtually 0 (but crucially not = 0, as some investment towards S_c is made through the feeding and care of children (analogous to Becker's fixed cost of children)). The slope is not perfectly horizontal because of this, yet the number of 'units' of S_c purchased ≈ 0.

The crucial event which pushes the budget curve up to point T from PT, along with the increase in *Y*, is the changing slope of the budget constraint, which primarily is a function of the declining cost parameter P_2. The process of modern economic growth has an impact on the income distribution of the population. This causes the parameters P_1 and P_2 to change. However, the change in P_2 is greater than the change in P_1, meaning that the (absolute value of)[139] slope coefficient for the pre-Transition (PM) budget constraint is less than that for the Post-Transition (M) case.

$$P^T{}_1 < P_1, P^T{}_2 < P_2$$

$$\Delta P_2 > \Delta P_1$$

$$\left|\frac{P_1}{P_2 n}\right| < \left|\frac{P^T{}_1}{P^T{}_2 n^T}\right|$$

(Please see the previous discussion on the relationship between P_1, P_2 and changing income inequality for the reasons why $\Delta P_2 > \Delta P_1$). Therefore both S_c and S_p increase. However, $\Delta S_c > \Delta S_p$, because $\Delta P_2 > \Delta P_1$.

Holding altruism constant, and considering that the transition from a PT to T stage involves changing P_1 and P_2, the logic indicates the following

$$n^* = \overline{A}\frac{P_1}{P_2}$$

$$PT \Rightarrow T$$

$$\therefore P_1, P_2 \Rightarrow P^T{}_1 P^T{}_2$$

$$\left[P^T{}_1 - P_1\right]\big/P_1 < \left[P^T{}_2 - P_2\right]\big/P_2$$

$$\therefore \frac{P^T{}_1}{P^T{}_2} < \frac{P_1}{P_2}$$

$$\therefore n > n^T$$

The intuitive explanation for this result is that as the economy shifts to a transitional stage, the changing relationship between the prices of parents and children's relative socioeconomic status results in an increase in the quantity demanded of each, but the increase is greater for children's status. In the Pre transitional equilibrium, the quantity demanded of children's status was low as the price was high. As the price decreases (in tandem with shifts in income inequality), the identities

[139] The slope is negative.

calculated via the economic analysis of the social status fertility model indicate that fertility will decrease. This is because once investment in children's status is greater than zero; family size suddenly becomes relevant in determining the success of this investment. In other words, when the price of increasing children's socioeconomic status is too high (and hence the quantity demanded is very small/close to zero), the choice of family size does not have an impact on the future likelihood of increased status for offspring. As the price lowers, and becomes affordable, parents quickly adjust their behaviour with regards to family size. This is because they can now afford to buy units of the "good" future offspring status. Once the demand for these goods is greater than zero, it becomes rational (in the sense of utility maximisation as explored in the model) to reduce fertility.

The difference between this model and the classical micro economic theory of fertility is that it specifies how fertility can decrease with decreases in the price of children's relative socio economic status. This price (referred to as P_2 in the model) is not a normal price, but is a reflection of parents' expectation with regards to the returns to child investment. Further, the maximization of children's status is not a linear function, but operates at discreet values related to the price of obtaining this status. This price is a function of the degree of economic inequality in society. More specifically, I have linked this price to parent's perception of the trend in economic inequality. When economic inequality is changing, both prices for status change. However, because parents are rational and dynamically forecast 'P_2', this change in this price will be greater than the price for parents status. The crucial thread here is my argument that shifts in economic inequality itself can initiate fertility decline.

The simple theory has been stated. In order for this theory to mean anything, testable hypotheses must be constructed. In my view the primary testable hypothesis is the relationship between the fertility rate and the level of economic inequality in a society. Where inequality is high, fertility is high, and vice versa. The empirical test is to examine fertility declines in a comparative context and look for differences in the level of economic inequality between the societies. If the evidence shows that fertility decline occurred irrespective of changes in inequality, or that it declines in highly unequal societies before more equitable societies, then the theory is falsified. The next section will examine the fertility declines in England and France, at both the aggregate and micro level, with respect to simple model and theory outlined here.

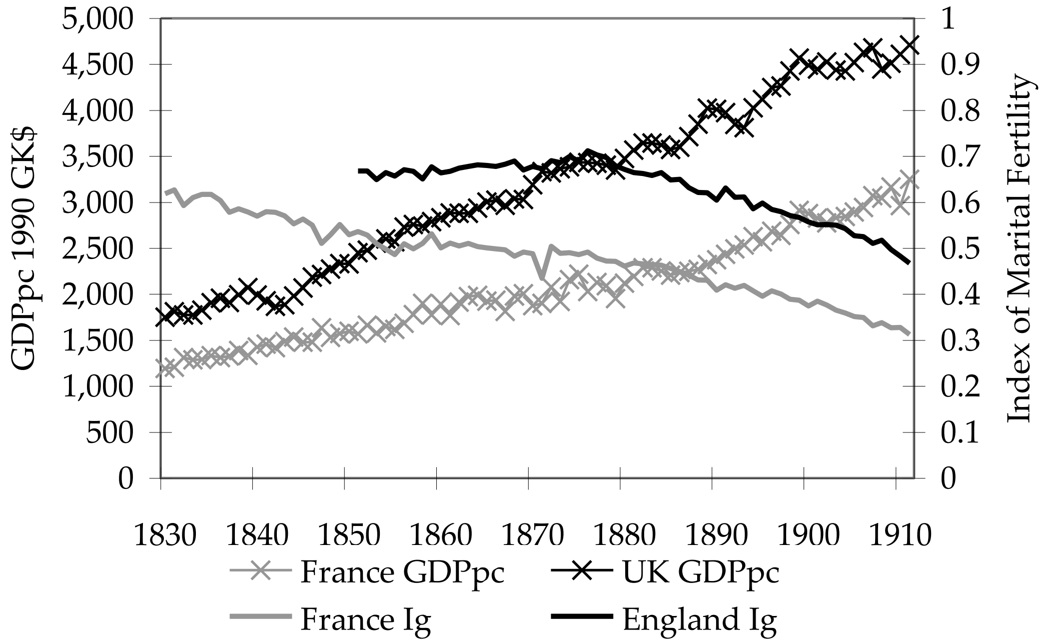
Section 6.5: Empirical Section - England and France compared

This section compares the fertility decline in England and France in the light of the simple status-fertility model. After a brief macro level description, the new micro data is analyzed to test for the patterns expected by the status-fertility model. Figure 6.9 charts the time trend in the index of marital fertility (right axis) and the level of GDP per capita (left axis) in England and France over the 19th century up to the eve of the First World War.

Fertility decline in England lagged behind that in France by over a century. Chapter 3 estimated a sustained fertility decline beginning in 1776 for France and 1877 in England (see chapter 3). As has been previously pointed out, the level of GDP per capita in England was substantially above that of France in this period. A simple modernisation cause of fertility decline does not work in explaining Europe's fertility decline as it cannot explain this pattern. The simple status-fertility model introduced in the last section proposes that inequality, through it's affect on parent's willingness to invest in improving their offspring's status, is highly related to the fertility decline.

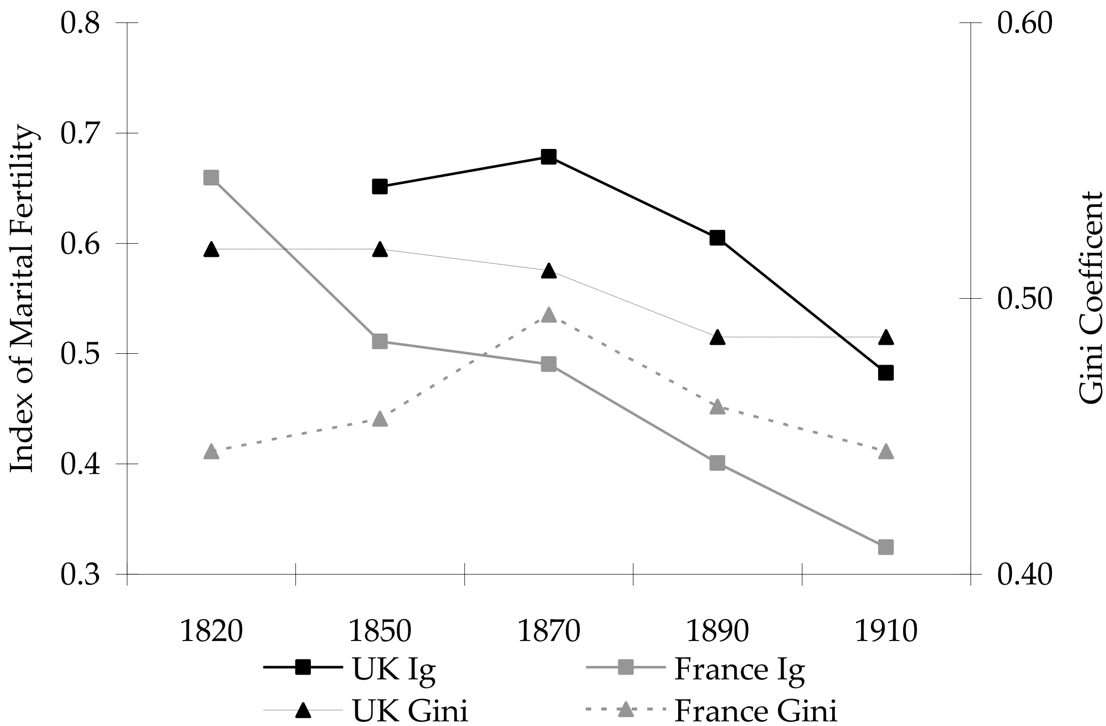
Figure 6.10 plots the gini coefficient (right axis) and the index of marital fertility for England and France for the same period as figure 6.9. This figure presents a very different modernisation – fertility decline picture than figure 6.9. Economic inequality, as measured by the gini coefficient, is lower in France than it is in the UK. This

Figure 6.9: Fertility and Income per capita in England and France, 1830-1913



Source: Ig (Chapter 3), GDPpc (Maddison 2003).

Figure 6.10: Fertility and Inequality in England and France, 1820-1910



Source: Bourguignon and Morrison 2003.

relationship is predicted by the simple status-fertility model introduced earlier. Further, fertility decline in both countries follows the trend in the gini coefficient closely (at least from this superficial visual inspection). Is it possible that France entered into an earlier fertility transition because economic inequality fell from a very high pre transitional level, to a level where parents' believed that child investment could pay off, and therefore they restricted their fertility?

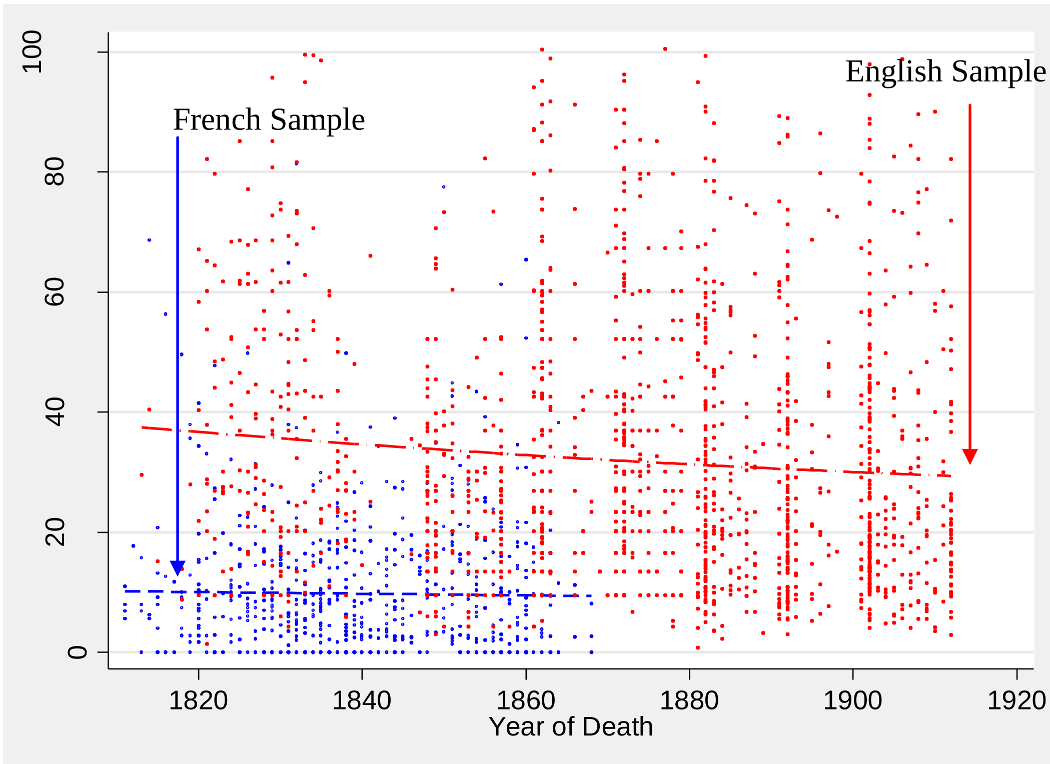
In addition to the levels and trends for both countries in fertility and inequality being in agreement with the theory, the 20 year plateaux in French fertility, from 1850-1870, is associated with a large increase in the level of inequality. This decline is discussed further in the appendix to this chapter, but there is a likelihood it is related to the sharp increase in inequality over the same period.

What can the Micro Data tell us about the early decline of fertility in France and the late decline in England?

Chapters 4 and 5 described in detail the source and characteristics of the individual level data collected for this thesis. In this section, both datasets are analysed side by side in a consistent fashion. Both datasets record estimates of wealth and net fertility. The French data has a far richer demographic description than that available from the English wills. That extra information is discarded here so that calculated estimates may be directly comparable between the samples.

For complete wealth comparability, francs were converted to 1850 British pounds using an exchange rate of 25.31 francs to the pound. This value is reported as the mean exchange rate of the pound in Francs over the 1847-1873 period (Boyer-Xambeu et al 1997 p.118). Even before the era of the classical Gold Standard, the pound-franc exchange rate was remarkably stable. From 1820-1870, the exchange rate varied between 25 and 26 francs (with “two limited exceptions”) (Marcuzzo et al 1997 p.108). Figure 6.11 reports the evolution of the average level of total wealth in the samples.

Figure 6.11: The Trend in Real Wealth by Year of Death, for both Samples

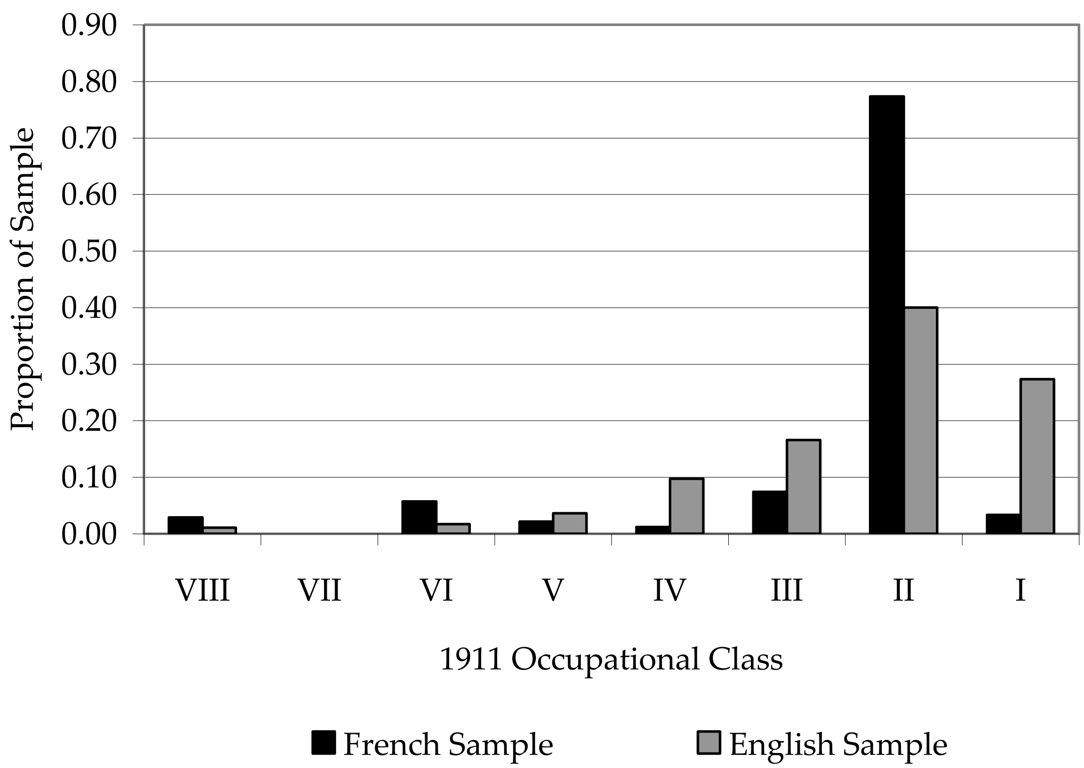


So that the graph may be easily assessed in terms of trends the square root of real total wealth is used (1850 British pounds). Wealth at death is far higher in the English sample[140]. This is partly a result of the fact that the English economy was richer than the French at this time, but it is also the result of a selection bias in the English data. Only those who made a last will and testament were recorded in the English sample, whereas the French sample recorded everybody. This means that the English sample over represents the wealthier members of society. There are limitations to the comparison undertaken here, but care is taken to ensure comparability.

[140] The declining average value in real wealth of death in England may be related to an increase in the proportion of males leaving wills – see chapter 4.

Before any adjustments are made, the first step is to compare the occupational distributions of the samples. The 1911 occupational class schema described in detail in chapter 4 is used for this purpose. This scale descends in occupational class from I (professionals and elites), through II (farmers and shopkeepers), III (the skilled working class, carpenters etc.) and classes IV and V (the semi-skilled and unskilled working classes). The TSA augmented Henry demographic database for France was analyzed with respect to Stevenson's 1911 occupational classifications and a comparison of the results of this exercise is reported in figure 6.12.

Figure 6.12: The Occupational Distribution of the Samples



The English sample over represents the top three occupational classes. The French sample is difficult to estimate because only 2/3rds of the Henry sample males have a recorded occupation. This may explain why occupational class II is so highly represented. There may have been a reluctance to report occupation if the occupation was of a low class. Therefore, the French estimates are likely to over estimate certain 'prestigious' classes. Of the sample analysed here, no occupation is recorded for 37%. If we take the extreme assumption that *none* of these men were members of occupational class II (the middle classes), this puts a lower bound of 47.93% of the labour force categorized as middle class, compared to 40% of the English sample (which over represents this class too). The contrast is interesting as we should expect to find a higher representation of the middle classes in the *English* sample. However, the French sample is considerably more middle class than the English!

The next step in this comparison is to run identical regressions on family size for each of the 2 samples. Due to the selection bias in the English sample towards richer men, wealth quartiles are constructed on a *relative* basis. In other words, males in the sample were sorted into wealth categories based on the wealth distribution within their own sample. The top wealth quartile in France are the richest Frenchmen *relative* to the other Frenchmen. The bottom quartile in England are the poorest English men relative to the other Englishmen[141].

The methodology is identical to that followed in chapters 4 and 5 previously. Negative binomial regressions are run, with interaction coefficients built in to the model. The interaction in England is for urban and rural dwelling whilst the interaction for France is between non-decline and decline regimes. These regimes are characterized as such based on the aggregate time trend of village level fertility over the sample period. In addition to the wealth categories and interactions, an additional regression is run with occupational class as independent variables.

The models to be estimated are:

$$NetF = \alpha + \sum \beta_n WealthQuartile + \varepsilon$$

[141] Similar regression using absolute levels of wealth were run, but this pooling did not result in any coherent patterns (regression unreported here).

$$NetF = \alpha + \sum \beta_n WealthQuartile + \sum \beta_n OccuaptionalClass + \varepsilon$$

As the English sample exhibited evidence for a selection bias towards childless men, the regressions are performed upon all married men who have at least one child. The results of these regressions are reported in table 6.2.

The results of the regressions roughly replicate the results of the separate analyses in chapters 4 and 5[142]. The comparative viewpoint is illuminating. In relation to model 1 (Wealth effects only), there are significant and large wealth effects on net fertility in both England and France. In England, the countryside is still under a cross sectional Malthusian rule. Net fertility increases with wealth. The same is true for France, for those villages where aggregate fertility is high and non-declining. Examining the interaction coefficients, the wealth fertility relationship breaks down. In the English towns, the standard errors for these interaction coefficients are large, resulting in coefficients that fail to be significantly different from zero at the standard levels. For the 'decline' villages in France, the top wealth group show clear and strong evidence of fertility limitation.

Model 2 adds categorical variables representing occupational status, in descending order from class I-V. The wealth effects in both samples are robust to the addition of these status variables, and the coefficients are consistent. The most striking result of this model is the large and highly significant association of status and lower net fertility for the high status groups in England. In France, status is not significantly related to net fertility.

Interpreting these two models together, we can say the following: To understand the English fertility decline, occupational status and wealth is central. It is

[142] The results are slightly different as both regressions here omit certain variables used in the separate analysis. The goal here is to produce comparable coefficients between the samples. This exercise also serves as a robustness check for the results of chapters 4 and 5. If they coefficients here are wildly different from those reported earlier, this would be a source of concern. Thankfully they are not.

Table 6.2: Identical Regression Results for Both Samples

	England	France	England	France
	1		2	
	Coefficient			
Relative Wealth Group	(standard error)			
1	0	0	0	0
	(ref.)	*(ref.)*	*(ref.)*	*(ref.)*
2	0.059	0.190	0.086	0.149
	(0.097)	(0.117)	(0.097)	(0.148)
3	0.172*	0.125	0.201*	0.027
	(0.086)	(0.127)	(0.086)	(0.145)
4	0.202*	0.285*	0.259**	0.273**
	(0.089)	(0.126)	(0.091)	(0.162)
Urban/'Decline' Effect	0.081	0.163	0.072	0.145
	(0.088)	(0.112)	(0.089)	(0.134)
Urban/'Decline' Interactions				
2	-0.122	-0.188	-0.128	-0.281
	(0.128)	(0.152)	(0.128)	(0.187)
3	-0.216	-0.257	-0.228	-0.239
	(0.120)	(0.157)	(0.120)	(0.177)
4	-0.154	-0.474**	-0.154	-0.567**
	(0.120)	(0.158)	(0.120)	(0.194)
Occupational Class				
I			-0.391***	0.422
			(0.111)	(0.257)
II			-0.376***	0.163
			(0.107)	(0.210)
III			-0.290***	0.253
			(0.112)	(0.229)
IV			-0.278	0.011
			(0.121)	(0.441)
V			0	0
			(ref.)	*(ref.)*
Constant	1.142***	1.294***	1.453***	1.229***
	(0.065)	(0.092)	(0.118)	(0.221)
Observations	856	413	856	263
Pseudo R^2	0.003	0.007	0.007	0.021

*** P <0.05

** P <0.01

* P <0.001

the poorest members of the highest status groups who are exhibiting the lowest net fertility. In France, the group who initiate low fertility are the richest residents of the 'decline' villages. For France, status is irrelevant, and does not predict fertility decline. It is clear that the process of fertility transition is different in England and France.

The simple status-fertility model introduced earlier in this chapter directly linked the level of economic inequality and the cost of child investment to the determination of family size. Together with the cost of obtaining status, it is relative wealth in a society which matters for fertility differentials, not absolute wealth. How can this inform the different fertility transitions in England and France?

The results of the identical regressions indicate that fertility decline was differentiated along wealth and status lines. The group which demonstrate the largest and most significant reduction in net fertility is the wealthiest quartile of the decline villages in France. The wealthiest quartile in England have a higher net fertility than the reference group (the poorest quartile, both urban and rural). If fertility decline is related to the level of wealth, then we should expect that the richest groups should reduce their fertility first. This is not the case as the richest English quartile is far richer than the richest French quartile. The results of this *relative* wealth analysis strongly suggest that in order to understand fertility decline, we must look at the *relative* wealth of individuals rather than the absolute.

The simple status-fertility model predicts that we should see differences in the level of economic inequality between the subgroups which differ in the level of fertility. The first test of this model at the individual level is to construct a summary measure of the degree of inequality in real wealth both between and within the samples. Table 6.3 reports the gini coefficient for both samples, with and urban/rural division for England and a decline/non decline division for France. As the English sample was based upon testators (who always left assets greater than zero), two ginis are constructed: one for the entire wealth distribution (only possible for France) and another for those who died with greater than zero wealth at death.

Table 6.3: The Degree of Economic Inequality in the Samples

	All	>0
England		
Urban	-	0.77
Rural	-	0.75
France		
Non Decline	0.79	0.78
Decline	0.71	0.67

The distribution of the calculated gini coefficients in table 6.3 correspond to the theoretical relationship proposed by the model. For England, where fertility decline is not detected between rural or urban divisions, the gini is high and similar. For France, the gini is significantly lower where fertility is declining. Taking both countries together, we see that the division with the lowest level of inequality is also the division which demonstrates the largest decline in fertility in the sample period.

Another way to examine the level of inequality in a society is to look at the relationship between occupational status and wealth. The regression results indicated that net fertility was lower for the poorest members of the top status groups in England, while for France the status-fertility relationship was non-existent. The next test of the simple status-fertility model is to examine the relationship between wealth and occupational status. If occupational status is highly related to wealth, this suggests that the level of economic inequality is higher than would be the case where the relationship is relatively lower. In the former case, the accumulation of wealth is highly related to occupational status. Where this relationship breaks down, a fertility decline can occur because it implies a lower level of economic inequality and a more even wealth distribution. Table 6.4 reports the results of a simple regression of the categorical variables representing occupational status on the dependent variable, the square root of real wealth.

Again, interaction coefficients are included, but in this instance only for decline regime France. Table 6.4 indicates a strong and ascending relationship between occupational status and the level of real wealth[143]. For all occupational classes above the unskilled working class, the level of expected real wealth increases, and is highly significant for occupational classes I and II ($P<0.001$). Despite this high average association, it is the poorest members of this group who are reducing their fertility as revealed in table 6.3.

For France, the relationship between status and wealth is far nosier. Apart from the top occupational class, who have a very large and significant positive association with wealth, none of the occupational class variables have a statistically significant association with the level of real wealth. Interestingly, there is suggestive evidence that the strong wealth association for the top occupational class is different between the non decline and decline villages. The interaction coefficient for this group is large and negative and reduces the effective coefficient by apx. 83% (an effective coefficient for the non decline villages of 63.3, versus an effective coefficient for the non decline villages of 63.3+ (-53.1) =10.2. However, the number of observations belonging to the top occupational status class in the French 'decline' villages is very small. Hence, the standard error is large, and the estimated interaction coefficient is statistically insignificant from zero ($P>0.05$).

Excluding the top occupational status class, the results of the regression of occupational class on real wealth support the hypothesis of fertility decline presented earlier in this chapter. Where status and wealth are linked, fertility is high – as is the

[143] Included as a square root in the model so as to avoid the distortion of extremely high values on the average relationship.

Table 6.4: Regression on the Square Root of Real Wealth

	England	France
Occupational Status	Coefficient (standard error)	
I	24.008***	63.325***
	(5.185)	(16.797)
II	17.501***	7.841
	(4.977)	(11.964)
III	8.655	1.424
	(5.287)	(14.001)
IV	4.776	-1.728
	(5.628)	(22.57)
V	0	0
	(Ref.)	(Ref.)
Decline Regime		5.648
	-	(29.796)
Decline Regime Interactions		
I		-53.174
	-	(35.08)
II		-2.347
	-	(30.149)
III		-0.404
	-	(32.244)
IV	-	-
Age at Death	1.05	0.167
	(0.755)	(0.949)
Age at Death ^{2}	-0.008	-0.004
	(0.005)	(0.007)
Constant	-22.134	27.658
	(25.12)	(32.48)
Observations	743	239
Pseudo R^2	0.059	0.062
*** P <0.05		
** P <0.01		
* P <0.001		

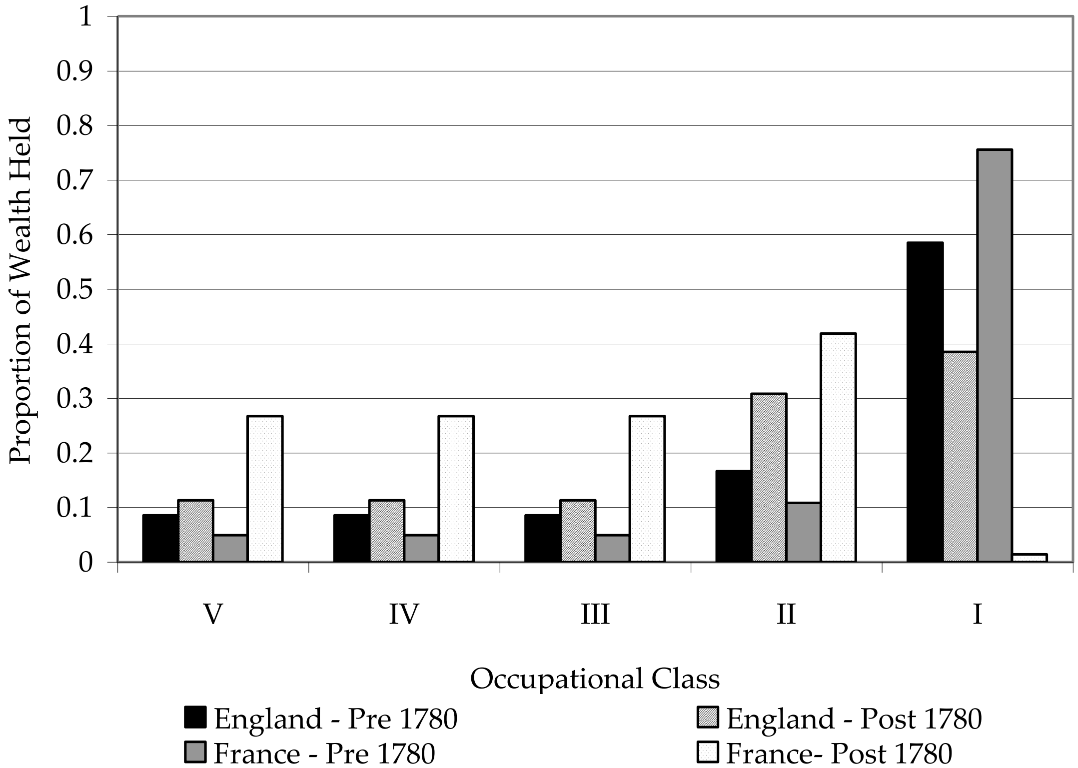
case in England. Where the relationship has broken down, fertility is lower – as in France. The next test of the model is to look at the changing relationship of occupational status and wealth over time. The hypothesis predicts that where the occupational class - wealth relationship is declining, fertility will be restricted as the status-fertility relationship is highly related to the degree of economic inequality. Figure 6.13 illustrates the proportion of total wealth held by occupational class for both samples, before and after 1780[144].

The evidence presented in figure 6.13 must be taken sceptically as the number of observations for the top occupational class in France is very small. However, the patterns are clear. Intriguingly, figure 6.13 reveals strikingly similar patterns between both the English and French samples. The first feature to note is the large drop from before 1780 to after 1780 in the proportion of real wealth for the top occupational classes in both samples (I). Secondly, this is accompanied by increases in the proportion of wealth held for all occupational classes below class I. Finally, the increase in the proportion of wealth held of occupational classes II-IV is greater in France than it is in England. The pattern is consistent with the hypothesis that it is changes in the relative distribution of wealth within in a society which are central in understanding the decline of fertility.

This time pattern and the spatial pattern revealed by the regression results presented in table 6.4 suggest strongly that the decline in fertility is associated with an evening of the wealth distribution. Not only is the relationship between occupational class and wealth far weaker in France than it is in England, it is significantly weaker within France between those villages where fertility is high and non-declining and those where a fertility transition is well underway.

[144] Year of birth based. 1780 was used as an arbitrary divider as it split both samples into sample sizes with appropriate observations for this analysis.

Figure 6.13: The Proportion of Wealth held by Occupational Class, before and after 1780



The final test of the model is to examine the relationship between father and son's wealth at death. Where economic inequality is high, and social mobility is low, father's wealth should be a strong and significant predictor of son's wealth. Where this relationship breaks down, the model suggests that fertility is restricted as economic inequality has declined. To test for this the following regression was estimated:

$$In(W^{S}) = \alpha + \beta(W^{f}) + \varepsilon$$

Where W^{S} is son's wealth, W^{f} is father's wealth, α is a constant, ε is an error term and In is the natural logarithm. The relationship between father and son's wealth is captured by the estimated coefficient β. Table 6.5 reports the results of estimating this coefficient for both samples, with a separate estimate for the non decline and decline villages in France.

Table 6.5: The Relationship between Father and Son's Wealth in the Samples

	England (Pre 1858)	France	
		Non-Decline	Decline
β	0.55	0.75	0.13
(standard error)	(0.041)	(0.269)	(-[145])

The pattern of the results agrees with the stated hypotheses. Where fertility is declining, the intergenerational relationship of wealth has broken down. The value of this estimate for the 'decline' villages in France is a small proportion of the estimates for the rest of the sample.

The comparative micro analysis presented here provides empirical foundations for the simple status-fertility model presented earlier in this chapter. In answer to the question 'Why did fertility decline in France first?', I can propose the following:

Fertility declined in France before anywhere else in the world through a particular interaction of available income (Y^A) and the price of obtaining social status advancement (P_2). The moment available income exceeded the price of obtaining social status advancement ($Y^A > P_2$), fertility decline started. The reason that it occurred in France, and not England first (a country with a higher level of available income), is because the level of economic inequality (g), and therefore the price of obtaining social status advancement was lower in France ($P_2 f(g, \Delta g)$).

Section 6.6: Conclusion

This chapter has introduced a very simple status-fertility model in order to explain how fertility declined in Europe. The model is deliberately parsimonious and is intended to abstract from a deeply complex behavioural process in order to generalize a particular feature of Europe's fertility decline which has yet to be fully understood. Utility

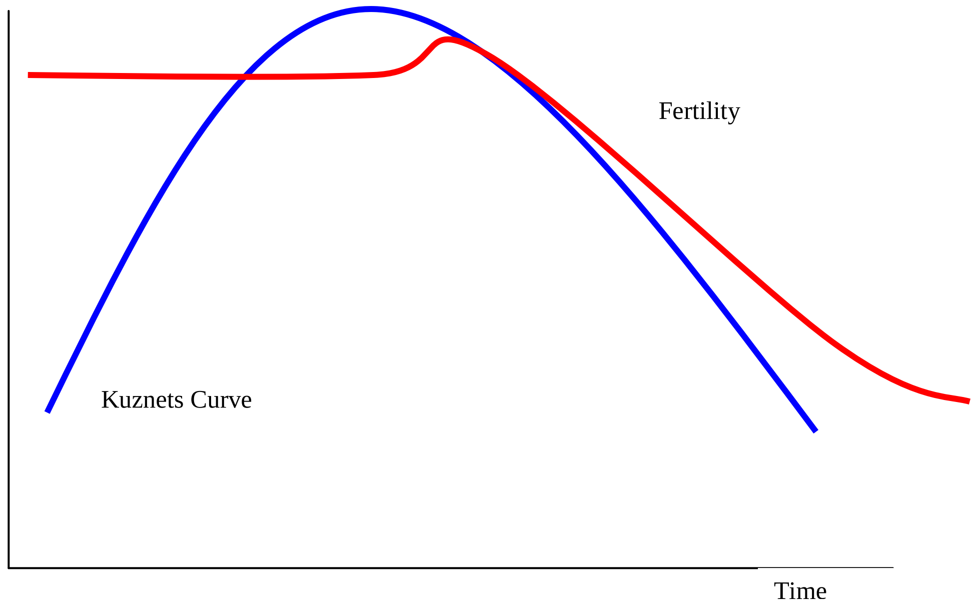
[145] Interaction – all coefficients significant at P<.10.

maximizing parents choose a family size based on social status concerns. They do not simply maximize their family size, but do so only when they can provide each child with an appropriate level of social status investment. As the price of this investment is so high in pre transitional societies, parents choose not to invest in it and instead maximize their fertility subject to available income. Over time, available income increases, and economic inequalities decrease. These changes make child stratus investment possible and altruistic parents quickly choose to decrease their family size and increase their investment per child. The novel feature of this model is the direct link between the level of economic inequality and the fertility rate.

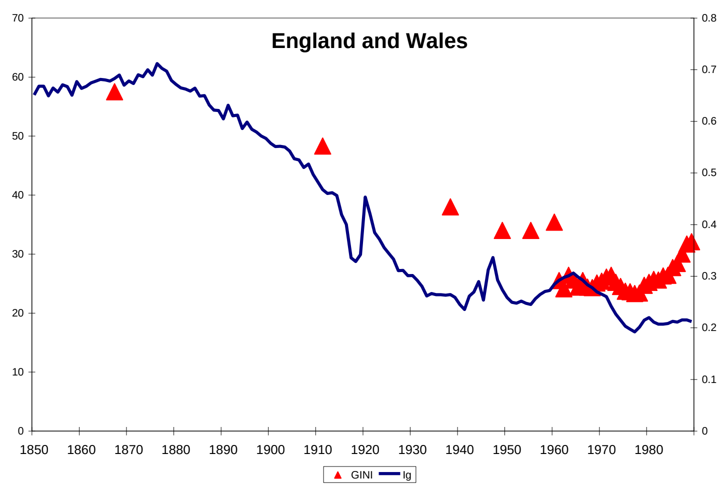
The empirical basis for this model was examined with respect to England and France. The newly collected individual level data was examined for the relationship between economic inequality and fertility decline. Three tests were performed, a gini coefficient analysis, a regression on occupational status and wealth and finally a regression on the strength of the intergenerational transmission of wealth. In all tests, the group which exhibited the strongest fertility decline in the sample, the richest quartile of the 'decline' villages in France had measures of inequality significantly below those of the rest of the sample. These tests provide strong support for the validity of the theorized relationships in the model being relevant for understanding Europe's fertility transition.

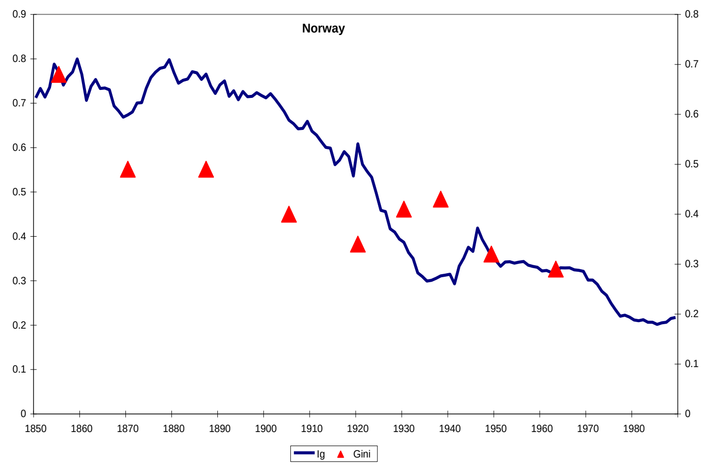
Appendix to Chapter 6

'Stylised impression' of the historical trend in income inequality and fertility



Empirical graphs

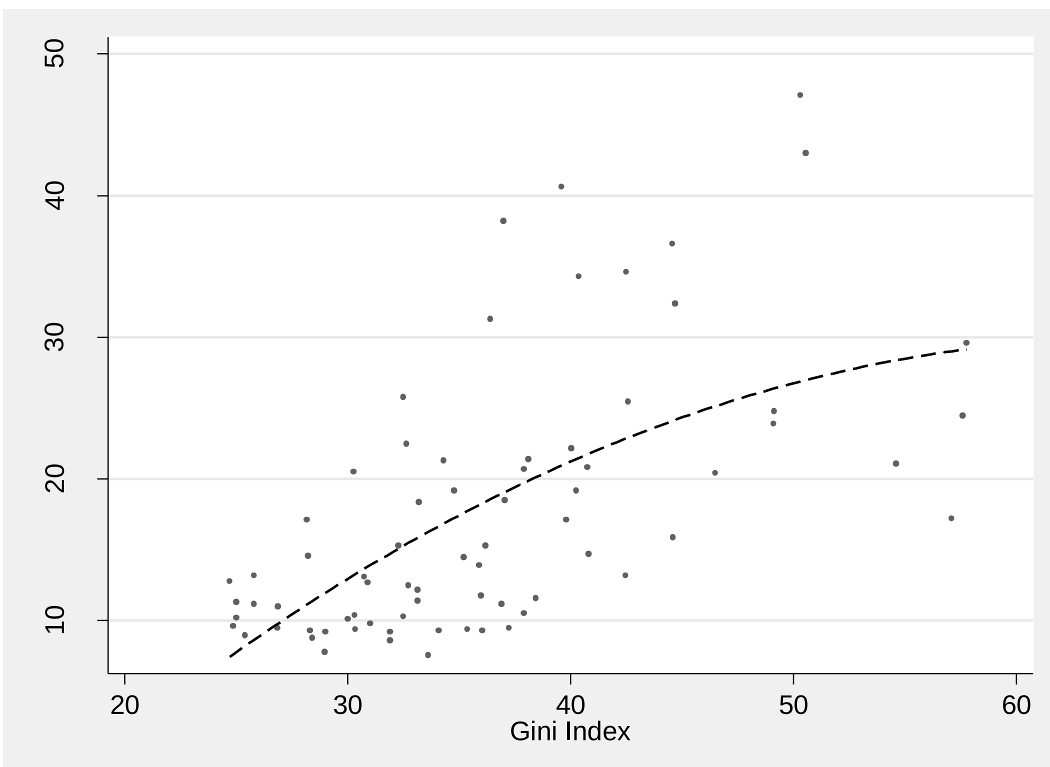




Source: World Income Inequality Database (WIID) United Nations University http://www.wider.unu.edu/wiid/wiid.htm

Pooled (TSCS) 1960-2000

(World Development Indicators) Source: World Bank 2008.

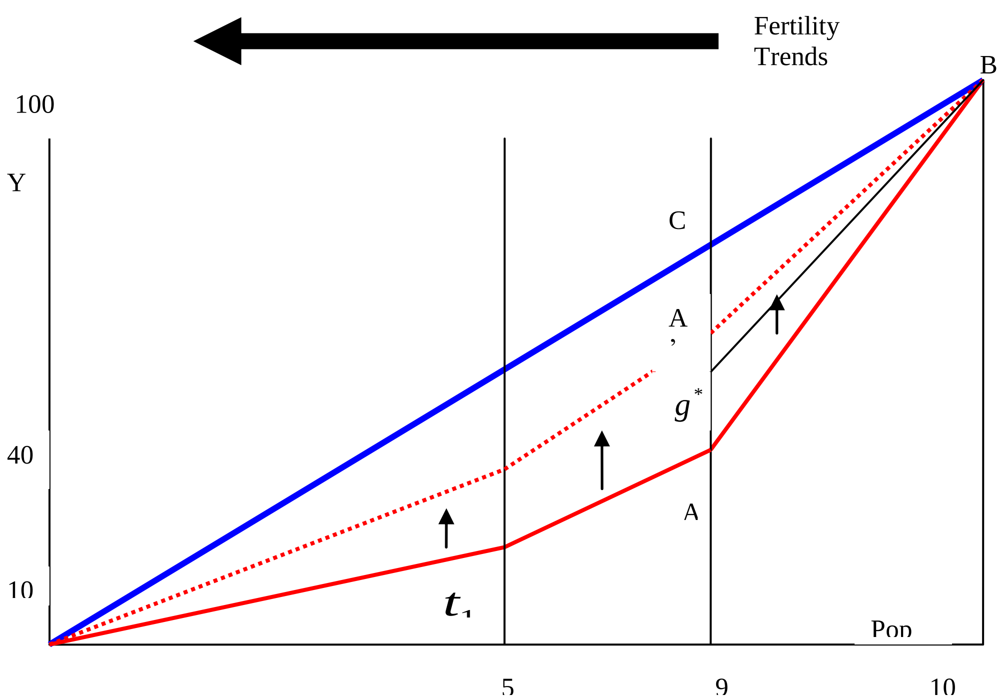


Urbanisation/Population density

	Urbanisation Rates 10,000+		Urbanisation Rates 5,000+	
	England and Wales	France	England and Wales	France
1700	13.2	8.7	14.6	12.3
1750	16.4	8.7	22.3	12.5
1800	22.3	8.9	29.9	12.5
1870	43.0	18.1	49.6	21.6

Source: Malanima and Volckart 2009.)

More Inequality and fertility discussion



The X axis represents the cumulative proportion of the population (the above representation is in deciles), while the Y axis represents the share of total income. The above graph conveys a distribution where the 50% of the population hold 10% of the total wealth, 90% hold 40% of all wealth and 10% hold 60% of all wealth.

Now, suppose group 1 represent the 10th decile of the population, that is they are the top 10% of the population with respect to share of income. Group 2 are the second (corresponding to 40% of the population, and group 3 represent the bottom half of the population with respect to share of income.

The proposition:

Group 2 (indicated by deciles 5-9) will only imitate /control/adopt the fertility trend of group 1 when economic inequality between the 2 groups reaches a certain threshold. At this point it is economically rational to control fertility behaviour. This threshold is indicated by the point g^*. The area g^*BC represents the threshold degree of economic inequality, below which members of group 2 will begin to adjust their fertility. The area g^*BC represents the degree of economic inequality between the socioeconomic groups labelled 1 and 2 (denoted g_{12}). g_{12} acts as a proxy for P_2, and P_2 is inversely related to family size, as was discussed in the last section.

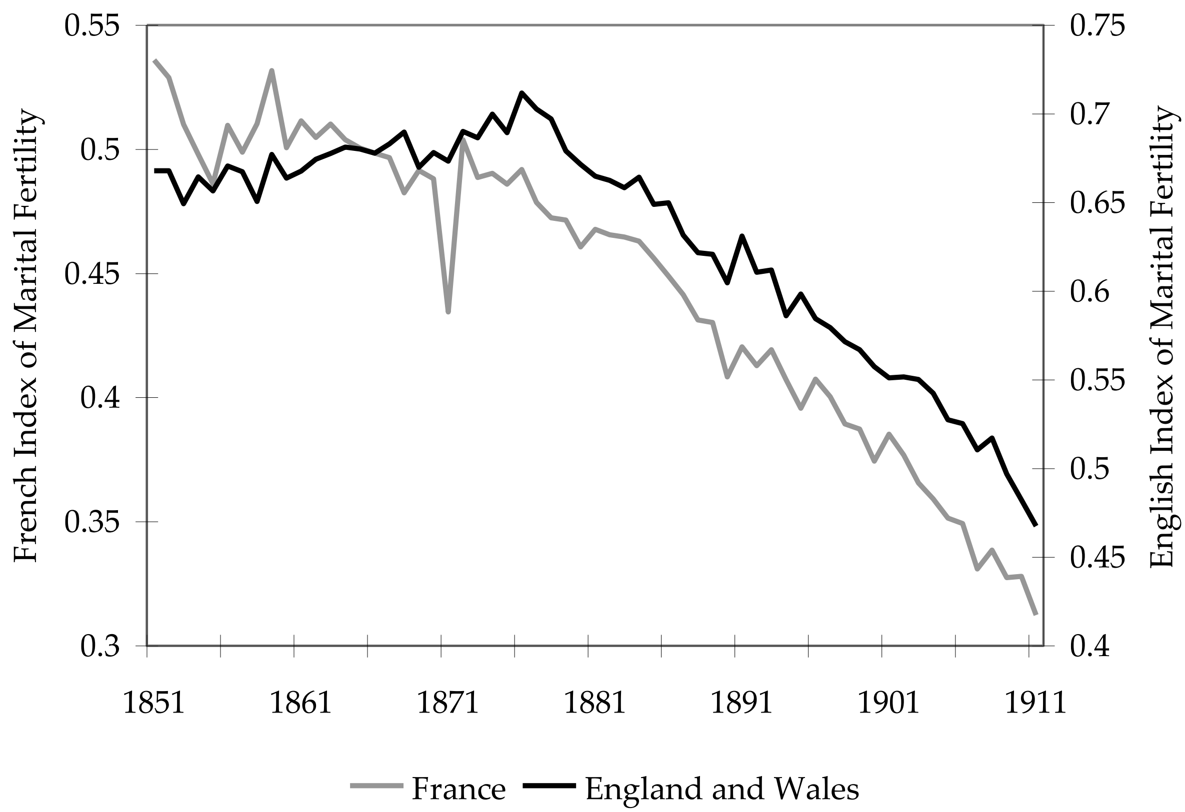
An upward shift in the Lorenz curve, indicating a decline in economic inequality, occurs between times t_1 and t_2 [146]. The area ABC is less than the area A'BC, therefore economic inequality between the socioeconomic groups 1 and 2 falls ($g_{12} \downarrow$). The area A'BC is less than the threshold value of economic inequality (g^*BC), therefore $g_{12} < g_{12}^*$. Once economic inequality fall below a certain threshold value, the members of group 2 reduce in parallel their dynamic forecast of the value for the cost parameter of children's relative socioeconomic status, P_2. As they seek to maximise their offspring's relative socioeconomic status, they adjust their family size to meet this goal. As discussed previously, family size is not maximised for its own sake but is an endogenous variable with respect to maximisation of relative socioeconomic status. As

[146] This also corresponds with a decline in the absolute value of the Gini coefficient, which measures the area between the Lorenz curve and the line of perfect inequality. The Gini coefficient =1 in a situation of perfect inequality, and 0 in a situation of perfect economic equality.

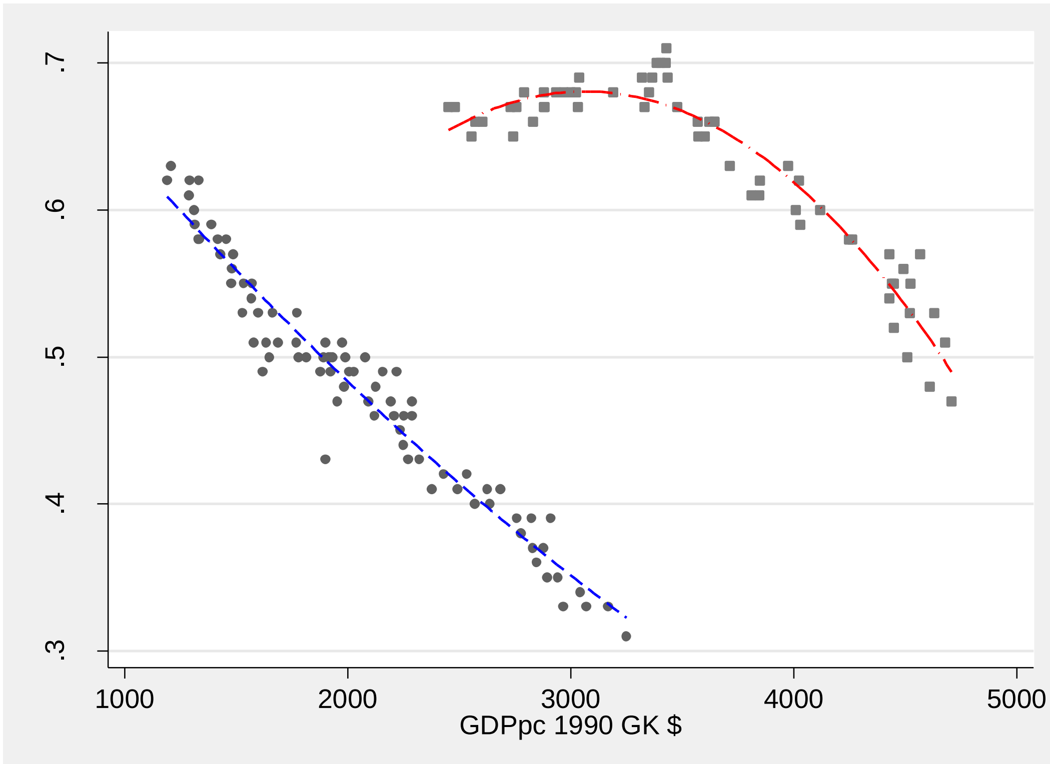
group 1 have initiated fertility control, group 2 imitate this pattern as it now makes rational economic sense to do so (the level of economic inequality has reached its threshold level, and hence P_2 has become affordable). The trend for family size 'diffuses' along socioeconomic strata; in this simple model from group 1 to group 2, when the economic inequality between groups 1 and 2 falls to a certain threshold level. Similarly, the trend diffuses between groups 2 and 3 when the economic inequality between groups 2 and 3, falls to a certain threshold level.

Graph showing the similar trend in England and France of 19th century fertility

Graph showing the very different income fertility relationship in England (right) and France (left)



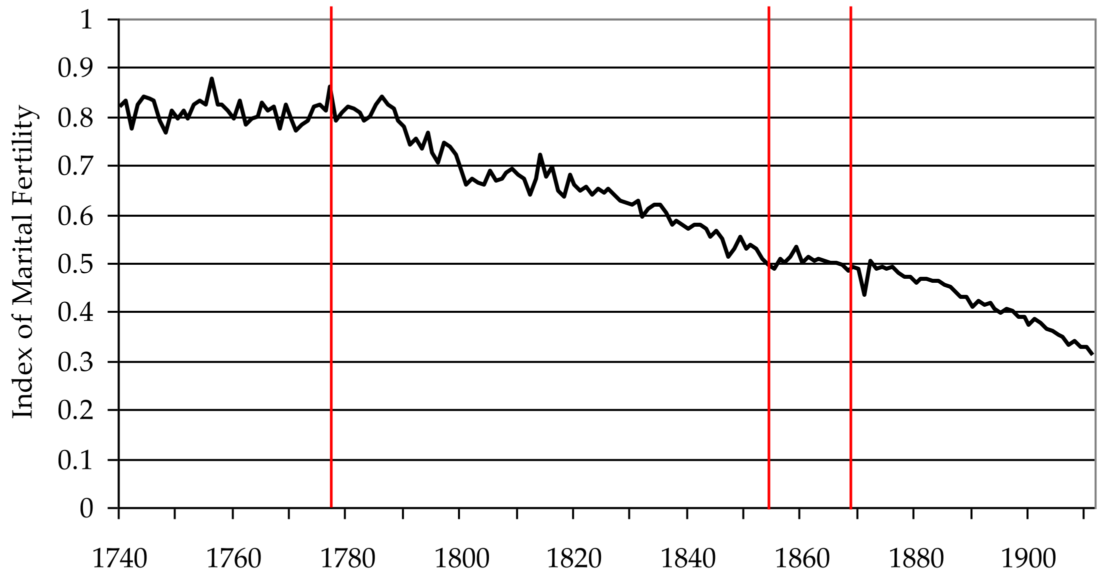
Scatter Plot of Income per capita and the Index of Marital Fertility in France (left) and England (right)



Two Declines

Examining Weir's estimates of Coale's marital fertility index (*Ig*) for France, over the period 1740-1911, it is possible to distinguish an initial decline around 1790 which continues until about 1850. Rather curiously, a 25 year plateau is observed before fertility begins a sharper decline after apx. 1875. The Franco-Prussian war (1870-1) provokes a sharp dip in the trend, with a recovery phase over the following years (Bonneuil 1997 p.90).

The Rate of Fertility Decline in 19th Century France



Rates of decline[147]

Period	Number of years	% Decline per annum
1776 -1850	74	0.52
1850-70	20	-0.39
1870-1912	42	0.86

The plateau in the decline of fertility (which lasted nearly a generation) raises some fundamental questions about the innovation hypothesis for fertility decline. It is argued, by Knodel and van de Walle for example, that pre-modern populations always desired low fertility, and it was the absences and ignorance of effective techniques to limit family size which prevented its achievement. The diffusion of new knowledge about fertility control was the main reason for the decline in fertility levels in Europe, according to this argument. What then, could have cause this diffusion effect to effectively pause for a generation? I argue that this 'pause' in the fertility transition was

[147] My own calculations, based on Weirs estimates for Ig, (1994 p.330-1).

closely related to the sharp rise in economic inequality which occurred at exactly the same time.

OLS regression on the Square Root of Real Wealth

	England	France
Year of Birth	-0.356**	-0.523
	(.138)	(0.565)
Age at Death	0.128	0.991
	(1.456)	(6.756)
Age at Death ^{2}	0.001	0.003
	(0.011)	(0.05)
Constant	684**	898
	(264)	(1033)
Observations	392	14

In England, the real Wealth of the top status group is decreasing significantly:

Real Wealth of Top Occupational Status Group in England, 1750-1860

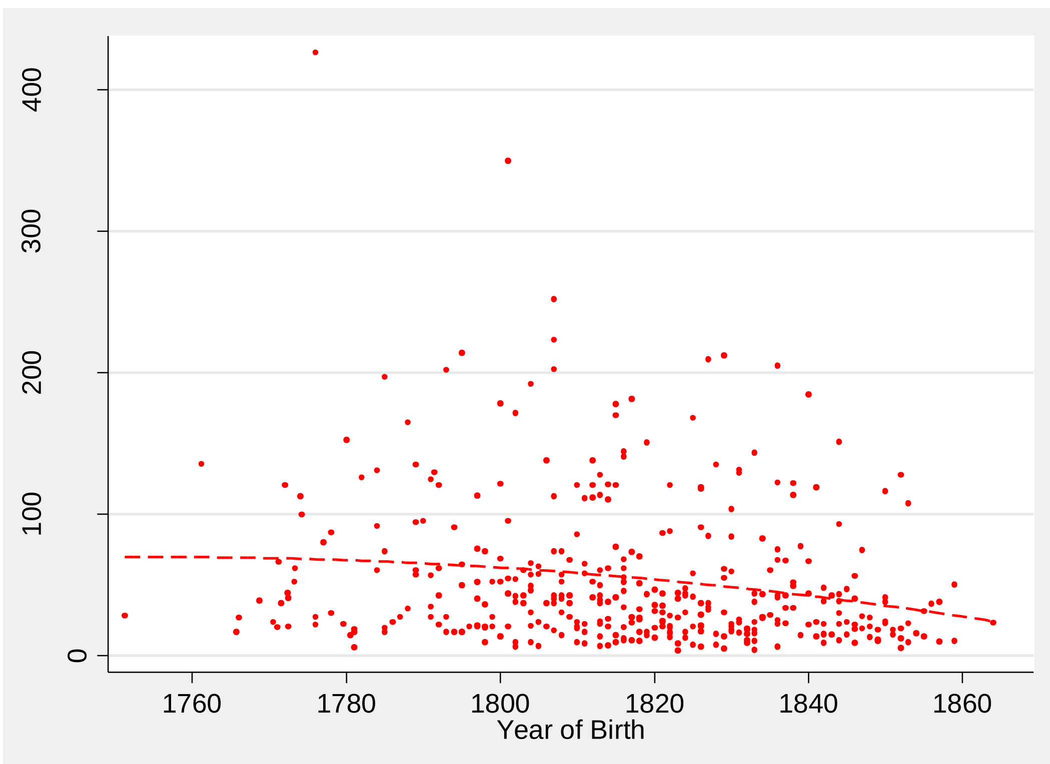


Table reporting the numbers used in figure 6.14: Mean wealth by Occupational Class

	England				France			
	Rural		Urban		Non Decline		Decline	
	Mean	%	Mean	%	Mean	%	Mean	%
I	6737.19	0.48	5076.09	0.36	2713.14	0.80	259.00	0.19
II	3497.73	0.25	4656.81	0.33	288.61	0.08	379.58	0.28
III	1420.36	0.10	1658.58	0.12	133.94	0.04	293.03	0.22
IV	1888.73	0.13	2235.47	0.16	63.47	0.02	154.30	0.11
V	600.32	0.04	636.89	0.04	203.07	0.06	258.30	0.19

Figure 6.14 reports the mean levels of real wealth held for all the occupational classes for both samples. Here, I split each sample into its spatial division: For England, and urban/rural divide and for France, a decline/non decline divide.

Figure 6.14: The Spatial Differences in Average Wealth, by Occupational Class

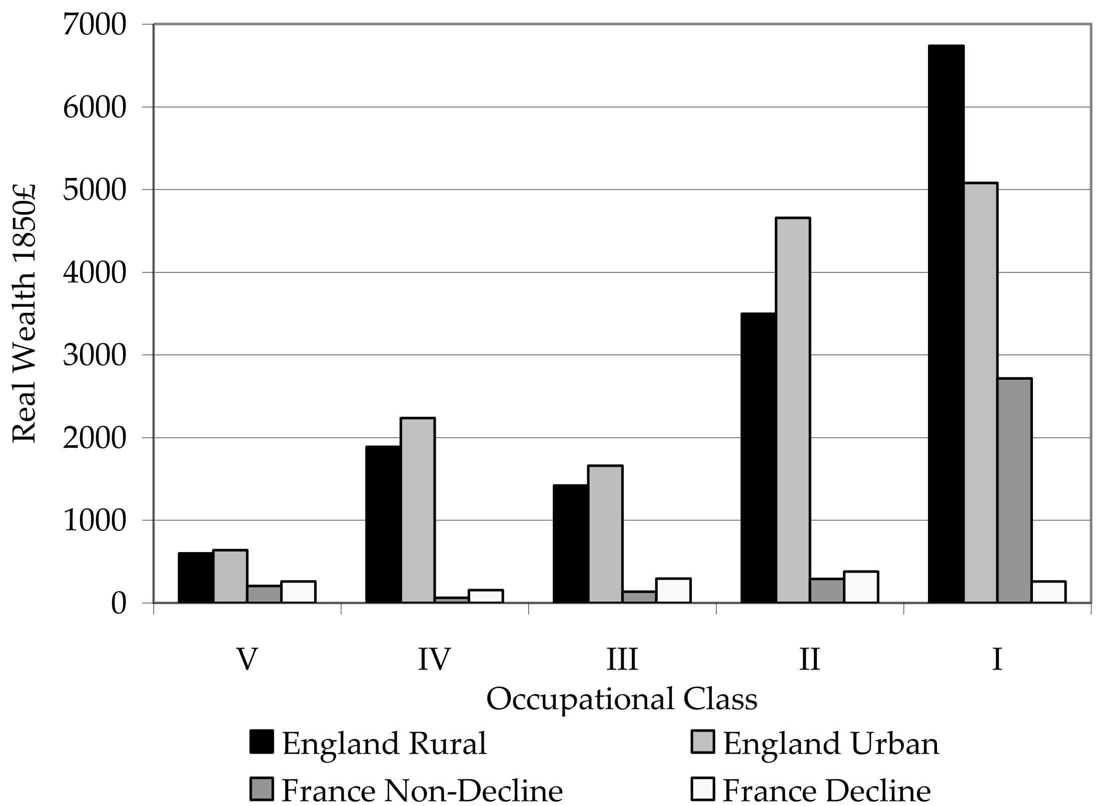


Figure 6.14 reports the mean level of wealth per occupational class, not the proportion of wealth held, and thus serves as a visualization of the regression results presented in table 6.4 This is why the average level of wealth is so much lower for every occupational class in France. Disregarding the level differences between the samples, we can see clear differences in the pattern of the occupational class and wealth relationship between the spatial divisions. In England, there are strong associations for both spatial locations between wealth and occupational status. In France, the relationship is non existent below the top occupational class. For the decline villages in France, the mean wealth by occupational class is almost the same for every class.

Chapter 7 – Conclusion to the Thesis

Our understandings of historical fertility transitions are empirically and theoretically incomplete. Therefore, this thesis has asked: Why did fertility decline in Europe? Through synthesising the microeconomic theory of fertility and insights from evolutionary biology, together with the analysis of existing macro and newly collected micro level data, this thesis argues that fertility declined in 19th century Europe because the environment for social mobility changed.

The world of the early 21st century is the result of the onset of modern economic growth and the simultaneous great divergence of the level of economic development in different regions of the globe. Today, lesser developed countries have higher fertility rates than the most developed countries. The least developed countries have the highest fertility rates of all. Demographers forecast that these trends will converge via the onset of fertility transition in those regions where fertility is still high. Despite these strong economic-demographic correlations, there is no consensus for why fertility declined in the first place. The field is splintered by those who propose non-economic innovative-diffusion hypotheses and those who insist on an underlying economic and rational adaptation. The results of the European fertility project condemned the simple causal mechanisms proposed by demographic transition theory.

Europe's fertility decline occurred against the backdrop of a rapidly changing economic system. The long night of the pre-industrial era was characterised by stagnation in material living standards, which were oscillating, but never rising consistently, from the Neolithic revolution to the end of the 18th century. Human societies moderated their fertility (and therefore the growth rate of their population) through access to marriage. Within marriage, individuals appear to have maximised their fertility. A mere two centuries ago humans began to practice family limitation on a wide scale. The technology employed was not new, but ancient. The timing of this change does not match well the timings of economic change in the countries of Europe. For France, it predated modern economic growth. For England, the fertility transition followed the industrial revolution by over a century. In addition to the economic transformation, the fertility 'revolution' is still poorly understood.

Economic models of fertility place decreases in infant and child mortality as central and causal forces in the decline of fertility. If parents do not respond to changes in the early life mortality of offspring, then all economic or rational models of fertility behaviour are lost. The highly aggregated nature of the European Fertility Project meant that the true relationship between infant mortality and fertility was blurred. At the individual level, my research indicates that child mortality decline was highly related to the decline of fertility in France. Precise child mortality measures were not calculated for England. However, both analyses focused upon net reproduction. The calculated differentials displayed significant reductions in *realised* family size for the forerunners and early pioneers of the fertility transition. Therefore, I chose to look for reasons why net reproduction was declining, taking reductions in infant mortality as related, but not central, to these new family size preferences.

In this thesis, I have assessed the individual economic correlates of the French and English fertility transitions. This required the collection and analysis of new individual level data on economic status and fertility life history. For England, thousands of wills were read and coded. For France, existing demographic data were linked to newly collected wealth at death estimates from official records. The period of fertility transition was captured by the thesis data. The principal finding was the strong association of wealth and fertility both before and during the demographic transition. The pre transitional phase was characterised by a strong positive wealth-fertility relationship in both England and France. At the onset of the fertility decline, it is the richest groups of the four French sample villages which displayed the lowest fertility in cross section. They were the pioneers of family limitation in France. In England, the interaction of status and wealth is crucial in understanding the fertility decline. It is the poorest members of the highest status groups who have the lowest fertility at the onset of the fertility transition there. The identification of these large and significant economic-demographic differentials is the primary empirical contribution of this thesis. However, if the fertility transition was non-economic in origin, how come we have such strong individual level economic correlates of low fertility at the genesis of the demographic transition?

To answer this question, I have re-examined the economic model of fertility and adjusted it to reflect insights from evolutionary disciplines concerned with human nature. No man is an island. Every decision we make is a result of our own internal desires. However, our internal desires can be shaped by our culture. In this thesis, culture is no black box explanation. We can interpret culture as the aggregate influence of the wants and needs of an individual's social group. We are strongly conditioned to strive for high social status. By definition, increased social status is a relative measure, not absolute. In pre-modern societies, wealth was typically very unevenly distributed. A small group of elites dominated the majority of the population, who lived close to subsistence. In this environment, family size had no impact upon relative social status as the economic distance between the elites and everyone else was so large. A peasant could choose to restrict fertility and have three children instead of six. In both situations, all of these children would remain peasants, as would their parents.

I propose that changes in the environment for social mobility will suddenly make family size relevant in the determination of relative social status. This will act through a threshold level of economic inequality, which signifies the economic distance between societal sub groups. Parent's will adapt and rationally adjust their fertility preferences to reflect this environmental change. The new demographic regime will originate amongst the elites and then spread down the wealth distribution. The wealth fertility relationship will switch from strongly positive, to negative and finally flat over the complete transitional phase. This economic change may be coincident with the growth of per capita income in a country, or it may precede it. The crucial socioeconomic triggers for the fertility transition are the level of economic inequality and the social mobility environment it implies.

The simple status fertility model I propose in this thesis is elementary and unsophisticated. This I believe is its greatest strength. There are more things in heaven and earth that influence human fertility than could ever be captured by any economic model. However, the beauty of economics is to abstract from the chaos of the world around us and to generalise the relationships of the principal components in the determination of human decision making and behaviour. Through testing theories against the historical record, we can reformulate original hypotheses and improve our understanding of specific historical events, and also how people fundamentally work. The ideas presented in this thesis are close in many respects to existing theories, for instance Becker's quantity-quality trade-off, Oded Galor's increased investment in human capital explanation[148] for the fertility decline and Arsene Dumont's 'social capillarity' hypothesis. However, I am unaware of any previous work which explicitly relates the environment for social mobility and the level of economic inequality to the determination of human fertility as I have done in this thesis.

The population 'time bomb' paranoia of the 1970s has receded from policy makers' priorities, and concern in the developed world is now focused upon the implications of low fertility. However, in sub-Saharan Africa, the fertility transition has yet to occur and demographers have concentrated on the impact of the AIDS epidemic. The interaction between the economy and the demographic characteristics of the population are of crucial importance for economic development. The immediate and long run effects of the fertility level on the population and on the economy are profound. Understanding how people determine their family size is not only important

[148] As part of Unified Growth Theory.

in an academic sense, but is important for present and future policy makers. This thesis has re-examined the world's first fertility transition with respect to its economic correlates. The idea that social mobility is a motivating factor in people's fertility decisions has received strong support from the empirical data collected. Further research with detailed individual level data and the appropriate theoretical approach can illuminate the many unresolved paradoxes of fertility transitions.

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Primary Sources
Chapter 4

Post 1858 Wills (1969 collected)
Principal Registry of the Family Division, First Avenue House, High Holborn, WC1 6NP, London

Individual enumerator's returns from the 1841-1901 Census of the United Kingdom, downloaded from www.ancestry.co.uk

Pre 1858 Wills (947 collected)
http://yourarchives.nationalarchives.gov.uk/index.php?title=Category:Probate_transcripts (259) Will transcripts uploaded by amateur genealogists and family researchers

Essex Record Office, Wharf Rd, Chelmsford, CM2 6YT, Consistory Court Wills, 1550-1857 (345)

http://www.nationalarchives.gov.uk/documentsonline/wills.asp (343), accessed at the National Archives, Kew, Richmond, Surrey, TW9 4DU. For these wills the gross probate valuation was sourced separately. The 'Probate Act Books' from 1820-39, also at Kew were used for this purpose. The references are PROB 8/213-33.

Each testator used in the database has individually assigned source information and/or a weblink to a sit where the will can be accessed. This information is freely available to anyone who is interested: Please contact the author.

Linked Sources
UK Census returns at www.ancestry.co.uk

Chapter 4A

Primary Sources of Wills
Essex Record Office, Chelmsford - Consistory Court Wills, 1550-1857
London Metropolitan Archive - Consistory Court Wills, 1600-1857
Public Record Office, Kew – Canterbury Court Wills, 1600-1857
Suffolk Record Office - Consistory Court Wills, 1550-1857
Probate Department of The Principal Registry Family Division: Probate Search Room, First Avenue House, 42-49 High Holborn, London – all wills 1858-1914.

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Webb Abstracts of Wills

Earls Colne, Essex. Will transcripts and links to parish records, 1490-1857.
http://linux02.lib.cam.ac.uk/earlscolne/probate/index.htm

Kent Will Transcipts. Will abstracts from Kent pre 1858.
http://freepages.genealogy.rootsweb.ancestry.com/~mrawson/wills.html

Sterry One-Name Study**.** Will transcipts and links to parish records. http://www.sterryworldwide.com/

Surrey Plus Wills Index. Will abstracts from Surrey, Middlesex, and Kent. http://www.rootsweb.ancestry.com/~engsurry/

Chapter 5

Archives Départementales de la Alpes-Maritime, serie Q3, *Tables Des Successions et Absences*.

Archives Départementales de la Dordogne, serie Q3, *Tables Des Successions et Absences*.

Archives Départementales de la Lozere, serie Q3, *Tables Des Successions et Absences*.

Archives Départementales de la Seine - St. Denis, serie Q3, *Tables Des Successions et Absences*.