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AN ECONOMIC HISTORY OF FERTILITY IN THE U.S.: 1826-1960

Larry E. Jones
Michele Tertilt

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ABSTRACT

In this paper, we use data from the US census to document the history of the relationship between fertility choice and key economic indicators at the individual level for women born between 1826 and 1960. We find that this data suggests several new facts that should be useful for researchers trying to model fertility. (1) The reduction in fertility known as the Demographic Transition (or the Fertility Transition) seems to be much sharper based on cohort fertility measures compared to usual measures like Total Fertility Rate; (2) The baby boom was not quite as large as is suggested by some previous work; (3) We find a strong negative relationship between income and fertility for all cohorts and estimate an overall income elasticity of about -0.38 for the period; (4) We also find systematic deviations from a time invariant, isoelastic, relationship between income and fertility. The most interesting of these is an increase in the income elasticity of demand for children for the 1876-1880 to 1906-1910 birth cohorts. This implies an increased spread in fertility by income which was followed by a dramatic compression.

Larry E. Jones
Department of Economics
University of Minnesota
1035 Heller Hall
Minneapolis, MN 55455
and NBER
lej@econ.umn.edu

Michele Tertilt
Department of Economics
University of Pennsylvania
160 McNeil Building
3718 Locust Walk
Philadelphia, PA 19104-6297
tertilt@stanford.edu

1 Introduction

If children were a normal good, one would expect richer people to have more children than poorer people. This was precisely the concern expressed by Malthus (1798) who argued that economic growth would lead people to reproduce at a faster rate, and hence food supply per capita would eventually decline. However, while plausible theoretically, empirically it is hard to find such a positive link. On a country level, most countries have experienced a decline in fertility while incomes were rapidly growing. Cross-country data also show a clear negative link between GDP and fertility. In this paper, we take a closer look at this relationship in micro data from the United States. Using census data from nine different censuses we analyze the time series and cross-section dimension simultaneously. We explore the exact nature of the relationship between income and fertility for five-year birth cohorts of women between 1826-30 and 1956-60 and find that it is negative for each cohort. We document how 'steep' this relationship is, and find that overall it has been fairly stable. We also conduct several accounting exercises and find that in an accounting sense, increasing incomes can explain up to 90% of the decline in fertility over this time horizon. We also identify systematic deviations from a stable, time-invariant relationship between income and fertility. For example, fertility differentials across income levels first widened and then compressed significantly: fertility was more sensitive to income for women born between 1875 and 1915 – a period covering both the Fertility Transition and the Baby Bust of the 1930s – than either before or after.

Facts such as these are just some of the examples of demographic changes that have been seen in the US and in other developed countries over the last 200 years that pose a challenge to modern researchers to explain and understand. Other examples include changes in the incidence and timing of marriage, the increase in female labor supply, changes in the care of parents in old age, an increasing divorce rate, changes in the timing of births, and large increases in the investment in children through education for example. Traditionally, attempts at understanding the causes of these changes and their interrelationships have been conducted in Sociology, History and Demography. They have increasingly become targets for researchers using the standard techniques of Economics, however. Becker (1960), Becker and Lewis (1973), Schultz (1973) and Willis (1973) are early examples with static models while Barro and Becker (1989), Becker and Barro (1988), Galor and Weil (1996, 2000), Alvarez (1999), Fernandez-Villaverde (2001), Greenwood and Seshadri (2002), Boldrin and Jones (2002), De la Croix and Doepke (2003), Greenwood, Guner, and Knowles (2003), Doekpke (2004), Greenwood, Seshadri, and

Yorukoglu (2004), Boldrin, DeNardi and Jones (2005), Doepke (2005), Falcao and Soares (2005), Greenwood, Seshadri, and Vandenbroucke (2005), Tertilt (2005), and Boldrin, Jones, and Schoonbroodt (2006) and are examples of more recent, explicitly dynamic analyses. This is quite natural in that many of these decisions are intrinsically dynamic and hence, the development over the last 25 years of the techniques of modern capital theory are particularly useful in understanding the trends seen.

With this recent theoretical literature in mind, our approach is based on trying to identify and present facts that will be useful in the challenge of modelling fertility decisions using economic techniques. Thus, we will, whenever possible, use variables that are closely linked to individual decisions of optimizing households given the information that they have. Our ability to do this is restricted, as always, by limitations in the data. For example, only fertility outcomes are available, not planned fertility. Similarly, for most years, only gross fertility is available not surviving fertility (i.e., net of infant and child mortality). Despite these limitations, the data are of considerable interest.

Beginning in 1900 the U.S. Census contains a question asking women how many children they had over their life - Children Ever Born (CEB).[1] This data was collected until 1990 with the exception of 1920 and 1930. Since the 1900 census data has information on the age of a woman, we can use this data to go back to the 1826 birth cohort (by focusing on 74 year old women) to form a long time series of estimated fertility for surviving women. Since the Census data is individual record data, it also contains detailed information on the characteristics of women, their husbands, and other family members that are of use in disentangling fertility patterns over the last 150 years. In particular, the Census contains data on occupation, education, race, and geography. Using Occupation and Education as proxies for income or wealth,[2] we construct a cross-section of the relationship between wealth and fertility for five-year birth cohorts beginning with 1826-30 and ending in 1956-60.[3] This allows us both to identify separately the cross-sectional and

[1]All data presented in this paper is based on a 1% sample of the U.S. Census data, made publicly available at www.ipums.org by Ruggles et. al. (2004). Our analysis is based on data from the IPUMS webpage available as of 10/20/2004. This data set is updated regularly, the revision history, is available at: http://www.ipums.org/usa/revisions.html

[2]Indeed, these may be better measures of the relevant variables determining decisions than, for example, income in a single year.

[3]Our analysis is based on women born between 1826 and 1960, grouped together in cohorts spanning five birth years each. Data for earlier birth cohorts is also available from the 1900 Census, but since it requires information from women that are in their 80's, sample sizes are correspondingly smaller. Hence, we focus on the period since the 1826 to 1830 birth cohort, which we identify with the mid-point of the period and call the 1828 cohort.

time series properties of the relationship between income and fertility and, as a result, document how the time series of fertility has differed for women in different parts of the income distribution.

Some of the facts we describe in this paper are commonly known: the overall decline in fertility and the baby bust and boom of the 1930s through 1960s. To paint a complete picture of the U.S. fertility experience, we include a description of these well-known facts in addition to the many novel insights based on the long time series of cross-sectional fertility data that are provided.

Much of the focus of the paper is on the relationship between measures of wealth and fertility. Our main findings regarding the relationship between fertility and occupational income (OI) – a proxy for life time income – are as follows.[4]

First, we find a strong negative relationship between OI and fertility for each cross-section. Our estimate of the overall income elasticity of fertility is -0.38. Evaluated at the mean income for the entire time period, $15,000, this means that a doubling of income implies a fertility fall from 3.2 to 2.5 children per woman.

Second, we find that the observed fertility pattern is surprisingly consistent with the hypothesis that all of the observed fertility decline is the result of a single stable relationship between income and fertility in conjunction with an outward shift in the income distribution over time. We fit an iso-elastic regression between OI by decile of the population and average CEB within that decile for each birth cohort. Using the estimate obtained in this way, we can decompose the observed changes in fertility into movements along the curve due to the growth of income over time and shifts of the curve itself. Between the 1828 birth cohort and the 1958 one, average income increased by a factor of about 13, and our estimated elasticity of fertility is -0.38. Thus, one would expect fertility to fall by 63%, from 5.6 to 2.1 children, whereas the actual fall was to 1.8. Hence, in this sense, 94% of the observed drop in fertility would have been predicted based on the relationship between income and fertility fitted from the 1828 birth cohort.[5]

Third, we document systematic deviations from such a stable relationship. These include a pattern of fertility that is too low for women born during the 1875 to 1910 period and too high for women born between 1925 and 1940. Not only did the level of the relationship between fertility and income change, but also its slope. We find that the income elasticity of children changed significantly over time, rising from about -0.33 in

[4]We postpone the precise definition of OI until Section 4.

[5]Of course the results of this calculation depend on which cohorts are used. We give more details in Section 4.

the early years up to a peak of about -0.50 for cohorts born in the late 1800's and down to about -0.20 in more recent times. We document that the initial widening of fertility across income groups is related to a difference in timing of the fertility transition: The fertility decline between the 1828 and 1898 birth cohorts started early and was very gradual for the upper part of the income distribution, while it began later and was very fast for the lower part of the income distribution.[6] The compression during the twentieth century, on the other hand, was due to a difference in magnitudes of the baby bust and boom: The baby bust was largest in magnitudes for people at the bottom of the income distribution, while the baby boom was most pronounced for the upper tail of the income distribution, leading to a convergence in fertility across the income distribution.

We conduct several other analyses to put these results into a broader perspective and check for their robustness:

- For the early part of the period that we study, some information on surviving children is available.[7] Using this, we can check to see if our findings are robust to possible income related infant and child mortality differences. We find that the relationship between income and surviving fertility is almost identical to that between income and births;
- We also find a strong negative relationship between years of schooling of the husband and fertility. Moreover, this relationship seems to have a fairly stable 'slope,' at least in the data available from the Census. Even when controlling for wife's education (and also including an interaction term), we find that an additional year of husband's education decreases fertility on average by a tenth of a child;
- We document the cross-sectional and time series pattern of fertility with respect to education, race, immigration status, and geography. For each of these dimensions of heterogeneity, we ask how much of the overall fertility decline can be accounted for by the observed change in the distribution of these characteristics.

We believe that the facts we document are of particular interest for several reasons.

1. We find an extremely robust negative relationship between fertility and income for 27 cohorts of women. This is contrary to what some authors have suggested

[6]This mirrors very closely the differences in the patterns of the time series of fertility between rural and urban areas. See Sections 4 and 5 for more discussion.

[7]In both the 1900 and 1910 censuses data on both children born and children surviving were collected.

that early on in the development process fertility and wealth used to be positively related (e.g. Wrigley (1988)). Rather, we find that even in the mid-1800's wealth and fertility had a negative relationship.

2. Since this negative relationship between fertility and wealth goes back so far in time, we think it should give one pause when considering the hypothesis that the reason for lower fertility at the upper end of the income distribution is the higher value of the mother's time (e.g. Moffitt (1984) and Schultz (1985)). That is, this relationship was present in the data during a period in which most women did not work in the market at all – married female labor force participation before 1920 was less than 5% (Schoonbroodt 2003). Hence, the emphasis on the distinction between male and female earnings seems irrelevant here.

3. Since our measure of lifetime income is based on husband's income only, we argue that higher income of men is an important predictor for lower fertility. Moreover, using education as a measure of income, we find that controlling for wife's education, the husband's education is strongly negatively related to fertility. This is contrary to some authors who find a negative relationship between women's income and fertility, but a weakly positive (or insignificant) relationship between husband's income and fertility (e.g. Fleischer and Rhodes (1979), Hotz and Miller (1988), Borg (1989), Heckman and Walker (1990)).[8]

A natural question of causation arises with respect to this exercise. Is it technological improvements and the resultant income growth that caused fertility to change? Or, is it something else that caused the reduction in fertility and at the same time made technological innovation and human capital formation more profitable? We have no definitive answer to these questions. Thus, although we will be looking at patterns of correlations between CEB and various other variables, it is important to remember that these are only correlations.

The main focus of this paper is how fertility relates to wealth or income. We describe the existing literature on this topic in Section 2. In Section 3, we lay out the basic time series pattern of fertility in the US over the last 150 years and discuss how the data from the census gives new insights to even these data. In Section 4, we describe the relationships between fertility and income, and fertility and education which emerge from the Census

[8] The strong negative correlation between fertility and occupation of the husband could be because husband's time is also an important input into child-rearing, contrary to what is typically assumed in this literature, or, because the hypothesis that children are normal goods is simply not true.

data. In Section 5, we look at four other dimensions that show interesting variation in fertility patterns: race, immigration status, region, and urbanization. Conclusions are offered in Section 6.

2 Previous Work on Fertility and Income

In this section, we briefly review the previous literature on the relationship between fertility and measures of economic well-being. This literature is partly from Demography and Sociology and partly from Economics. It is, by necessity, incomplete.

Most of the papers in Demography and Sociology have dealt with parts of the history of US fertility, and many of them have also used data from the Census. Most of these papers deal with fertility decisions either for specific time periods or specific demographic groups. Examples include the study of the sub-group of white women between 1886 and 1900 (Tolnay, S. E., S. N. Graham, and A. M. Guest, (1982)), the analysis of Norwegian immigrants (Gjerde, J. and A. McCants, (1995)), coal miners (Haines (1978)) and Mormons in Utah (Anderton, D. L. (1986)). They touch on a variety of relevant issues – the role that religion and urbanization played in fertility reduction, etc. As is common in that literature, they deal with fairly specific questions - what roles were played by the spacing of births and delayed marriage play in the Fertility Transition in the US? And, what exactly was the timing of the Fertility Transition in the US and how does it compare to what has been found concerning Europe and earlier studies on the US (e.g., Hacker (2003)). Thus, they are not concerned with the relationship between fertility and income per se.

A general finding in the empirical fertility literature is that income and fertility are negatively correlated. This fact has been established both in time series and in cross section.[9] During development, most countries have experienced growing incomes and declining fertility simultaneously, at least over the last couple of centuries. This 'fertility transition' and the general coincidence of its timing with per capita income growth has been often mentioned in both Demography and Economics. In Demography the early origins are often traced to Notestein (1945), but others give even earlier attributions. (See Chenais (1992) for a discussion of the history of these ideas). The comparative roles of development and other changes, like improved health and in particular, improved public health provisions have long been debated in that literature – McKeown (1979) offers a useful summary as well as a detailed analysis of the causal interpretations of changes in the

[9]See Barro and Sala-i-Martin (1995) for cross-country evidence.

understanding of disease and health. He concludes that changes in health are not enough, leaving development and/or economic growth as a sort of residual. A causal interpretation of this relationship has been controversial in the demography literature (see Livi-Bacci, (1990) and others). An early, explicit description of a possible mechanism behind this empirical link which is well known in Demography is Caldwell's 'wealth flows' theory, (see Caldwell (1982)). In this descriptive theory, he portrays the Demographic Transition as resulting from the breakdown of the typical decision-making structure of the nuclear family (wherein the family head makes most of the decisions for the group including those concerning fertility). Caldwell argues that this breakdown leads to a reversal of wealth flows within the family, originally from child to parent now from parent to child, which makes children more costly and therefore leads to a decline in fertility. Caldwell associates this family breakdown with the process of income growth, urbanization, and industrialization, which have typically come together as a part of economic development, but he does not give explicit reasons for why this breakdown in decision-making is a necessary byproduct of development.

These ideas also have a long history in Economics. For example, in his introduction to an early collected volume on Fertility Choice and Economics, Schultz (1973) asks: "What is the explanation of the demographic transition, that is, how do we explain the economic and social processes and family behavior that accounts for the marked decline from very high birth and death rates to modern very low birth and death rates?" Although most of the papers in that volume are static in nature and it is understood that this is a considerable weakness, Schulz is explicit in his view that using the models developed therein to conduct comparative statics exercises with respect to changes over time in the value of education, the cost of birth control and "the secular rise in family income" mark a useful first step. (See also De Tray, Willis, and Becker and Lewis (and others) in that same 1973 volume.) More recent references include, but are not limited to, Becker (1992), Galor and Weil (1999), Hansen and Prescott (2002), and Lucas (2002). Some of this discussion has focused on the evolution of averages within a cohort over the development process and the corresponding income growth while other parts have focused on cross-sectional phenomena at a given point in time.

The relationship between fertility and income has also been studied at business cycle frequencies. Here the answers are less clear cut, however. Some authors find a positive correlation between income and fertility over the business cycle (e.g. Simon (1969, 1977), and Mikevska and Zak (2002) for Central and Eastern Europe). Butz and Ward (1979), on the other hand, find that fertility has been counter-cyclical in recent U.S. data.

Most cross sectional studies find a negative correlation between income and fertility. For example, Borg (1989) finds a negative relationship using panel data from South Korea in 1976 and Docquier (2004) documents a similar relationship for the U.S. using data from the PSID in 1994. Westoff (1954) finds a negative relationship between fertility and occupational status for the years 1900-1952 using U.S. Census data. It is sometimes argued that early on in the development process, a positive relationship between income and fertility existed. However, studies documenting such a positive relationship empirically are rare.[10] Weir (1995) finds a weakly positive relationship between economic status and fertility in 18th century France, while Wrigley (1961) and Haines (1976) document higher fertility in the coal mining areas of France and Prussia than in surrounding agricultural areas during the end of the 19th century. Simon (1977, ch. 16) documents a positive relationship between farm size in hectors and the average numbers of children born for rural areas in Poland in 1948 and Clark and Hamilton (2006) document a positive relationship between occupational status and the number of *surviving* children in England in the late 16th and early 17th century (see also Clark (2005, 2007)).

The negative relationship between income and fertility has been viewed as a puzzle by many economists: If children are a normal good, then the quantity should go up as income goes up. Indeed, this was one of the important motivations for Becker's development of the 'quantity-quality' model of fertility choice – should a parent have a large number of children but give them little in way of economic advantage, or, have few children each with a large bequest, or large educational expenditure? This has generated a number of new theories (see Macunovich (1996) for a survey) as well as large number of empirical studies testing these refined theories.

One theory emphasizes the importance of wages as the shadow price of time. A higher income typically also means a higher wage. If children are time intensive, then the opportunity cost goes up with income, and consumers might demand fewer children in response to rising income. An extensive empirical literature trying to verify this "price of time theory" exists. There seems to be a broad consensus that the price of time (typically measured as wages, in particular, female wages) is indeed negatively correlated with fertility. This has been confirmed in many different empirical cross-sectional studies (see Rosenzweig (1990) for an analysis of India, Indonesia and the Philippines, Schultz (1986) for an analysis of U.S. data and Schultz (1997) for a recent survey).

[10] A more recent version of such a positive relationship is that U.S. fertility is higher than most other countries in the OECD even though U.S. income is higher. This does not hold for a larger set of countries however. See Ahn and Mira (2002) for the discussion of a related point.

A second theory is the "relative income hypothesis" first proposed by Easterlin, who argues that income *relative* to parents' income is important for fertility decisions.[11] People form habits about an "acceptable standard of living" during childhood, and then their own income relative to this standard determines fertility decisions. Macunovich (1998) provides a survey of the empirical literature on the Easterlin hypothesis. The evidence is mixed, partly because there are at least four different interpretations of the Easterlin hypothesis.

Some studies make a distinction between husband's vs. wife's wage, and typically find a strong negative correlation between women's wages and fertility (supporting the price of time theory) and a weakly positive, if any, relationship between male wages and fertility. Freedman and Thornton (1982) find a small positive relationship between husband's income and fertility using data from Detroit between 1962 and 1977. Heckman and Walker (1990) find a weakly positive effect of male income on fertility in Swedish data. Merrigan and St. Pierre (1998) confirm this result for Canada. Fleischer and Rhodes (1979) also find a positive effect using U.S. data. Cho (1968) identifies no relationship between income and fertility for whites in 1960 U.S. census data. Using aggregate U.S. data, Butz and Ward (1979) also argue that male earnings have a positive effect on the total fertility rate. Finally, Schultz (1986) finds no evidence that non-employment income or physical wealth is positively related to fertility using 1967 U.S. data.

We conclude that despite the extensive empirical work, there is still no conclusive evidence on the exact relationship between income and fertility. Quoting Heckman and Walker (1990), "Most economists would agree with Ward and Butz (1980) that current and future wages and income [...] are likely determinants of fertility. There is little agreement beyond this."

The literature on the relationship between Education and Fertility is similar to that on Income and Fertility. There is general acceptance of the idea that there is a negative correlation between them, based partly on time series observations for the developed countries (i.e., education rose throughout the development process while fertility fell) and partly on a widespread group of studies conducted on cross sections for individual countries. Indeed, this is one of Caldwell's central predictions about fertility, viz., that as countries adopted universal primary schooling, fertility would naturally fall (Caldwell, 1982). An excellent survey of this prevailing view and its many manifestations can be found in Cleland (2004). More recently, much of the work has focused on the relationship between the education of the mother and fertility, and it has been argued that this has

[11]See for example Easterlin (1966).

stronger predictive power than many of the other typically used variables including socio-economic status (e.g., income or occupation of the husband). This view began with the study of the relationship between mother's education and infant mortality in data from Nigeria by Caldwell (1979) and has been extended to cover other demographic variates since then. (See for example Breierova and Duflo (2004) on Indonesia, and Akmam (2002) on Bangladesh.)

Many of the comments above concerning past studies on the relationship between income and fertility also apply to the relationship between education and fertility. For example, since there is a lack of long panel data sets available, it is difficult to decompose the changes seen in time series data on fertility at the aggregate level into two components, one constituting movements of the education distribution along a given education/fertility relationship, the other movements of the relationship itself.

The empirical literature suffers from three main problems. First, many data sources have information only on fertility or on wages (income), not both simultaneously. Many studies use fertility micro data and match this with wage information from the census by region. For example Heckman and Walker (1990) use age and sex specific wages from tax return data. Because of this, most of the identification comes from cohort variation, rather than cross-sectional variation. It seems that the question whether richer families have more children cannot be addressed in a very satisfactory fashion with this data.

Secondly, there is a lack of cross-sectional studies over time.[12] The typical analysis is either based on micro evidence for one year or on aggregate time series data. Hence, one cannot address the question: How much of the observed drop in fertility over time comes from following a time invariant relationship between income and fertility with income simply increasing over time? This is an interesting accounting exercise, but it requires a time series of cross sectional data sets. The closest in spirit to this is probably Strulik and Sikandar (2002) who use a panel of countries to analyze the relationship between fertility and GDP across countries and over time. They find an 'income threshold' below which there is no relationship between income and fertility, and above which fertility declines exponentially with income. Another comprehensive analysis is Haines (1979) who analyzes the relationship between fertility and occupation in a variety of geographic locations in the U.S. and Europe during the fifty year period between 1850 and 1900. Haines' research shows robust occupational fertility differential throughout this time period. However, the emphasis of this work is on coal mining and metallurgy, and his work does not extend

[12]One notable exception is Westoff (1954), who analyzes U.S. fertility for six different occupations from 1900 to 1952.

into the 20th century.

Finally, there is disagreement on what the right measures are, i.e. income vs. earnings, wages of men vs. women etc. Of course, the answer depends on the theory under investigation and hence, this is not a discord that can be resolved empirically. Therefore, while our analysis contributes to the first two points, we have little to say about this last point.

3 Basic Trends in US Fertility

Economic models focus on the decisions made by individual households and hence, one would like a measure of fertility decisions at the individual household level. A measure close to this that is available is Children Ever Born (CEB) from the U.S. Census. For the years 1900 to 1990 one of the questions asked on the census form was, for each woman, how many children they had had during their lives. Like all data in the census, this measure is a voluntary response and hence is probably measured with some error, even at the level of the individual observation. However, even with its limitations, this is probably the best source for actual fertility decisions made by women. Since the age of the respondent is also available, this allows us to obtain estimates of actual realized fertility for women by birth cohort. For the purposes of economic models, where it is total planned fertility that is usually used as the decision variable, this data is most useful for women who have completed their planned fertility. Of course, it is impossible to tell from the data in the census if a woman has truly completed her planned fertility, but, as a proxy, by conditioning on age a reliable estimate of completed fertility can be obtained. For most cases, we focus on women 40-49 years old and we supplement this with other ages to get a longer time series, details are given in Appendix A. Finally, since the first census data available on CEB is from 1900, and because there is a wide variety of ages in that data set, we go back as far as the 1826-30 birth cohort by focusing on up to 70-74 year old women. The last cohort we consider is the 1956-60 cohort, consisting of women 30-34 years old in the 1990 census.[13] This methodology allows us to obtain, from a single source, a fairly complete picture of the history of US fertility since the beginning of the 19th Century.

Throughout this paper, we restrict our attention to 'marital fertility,' i.e., the completed fertility of those women who, when they answer the census, indicate that they are

[13]Not all women in this cohort will have completed their life-time fertility, and hence the last two cohorts in our time series should be interpreted with some caution.

married.[14] Of course some women get divorced, while others bear children out of wedlock. There are two reasons for focusing on CEB of currently married women. First, before 1970 the census recorded CEB only for women who had been married at some point. Second, since the main focus of this paper is on fertility decisions as a function of income and wealth, we do not want to mix single-parent households with two-parent households.

To get a sense of non-marital fertility, we also computed CEB for women who were not married when they answered the census (with the caveat that never married women are included only from 1970 on). We find that, as expected, the level of CEB is lower for unmarried women – on average by half a child – but that the time pattern looks very similar.[15] Certainly out of wedlock childbearing is an important and increasing phenomenon in recent years. The fraction of all children born to women who are unmarried at the time of giving birth has increased from less than 5% in 1920 to 10% in 1970 and more than 30% by 2000 (Greenwood and Guner 2005). However, this does not mean that our methodology necessarily misses a third of all births in the last cohorts because many of these single mothers marry later on. Of course, given the striking increase in births to unmarried women in recent years, it would be of considerable interest to extend our analysis to single mothers as well.

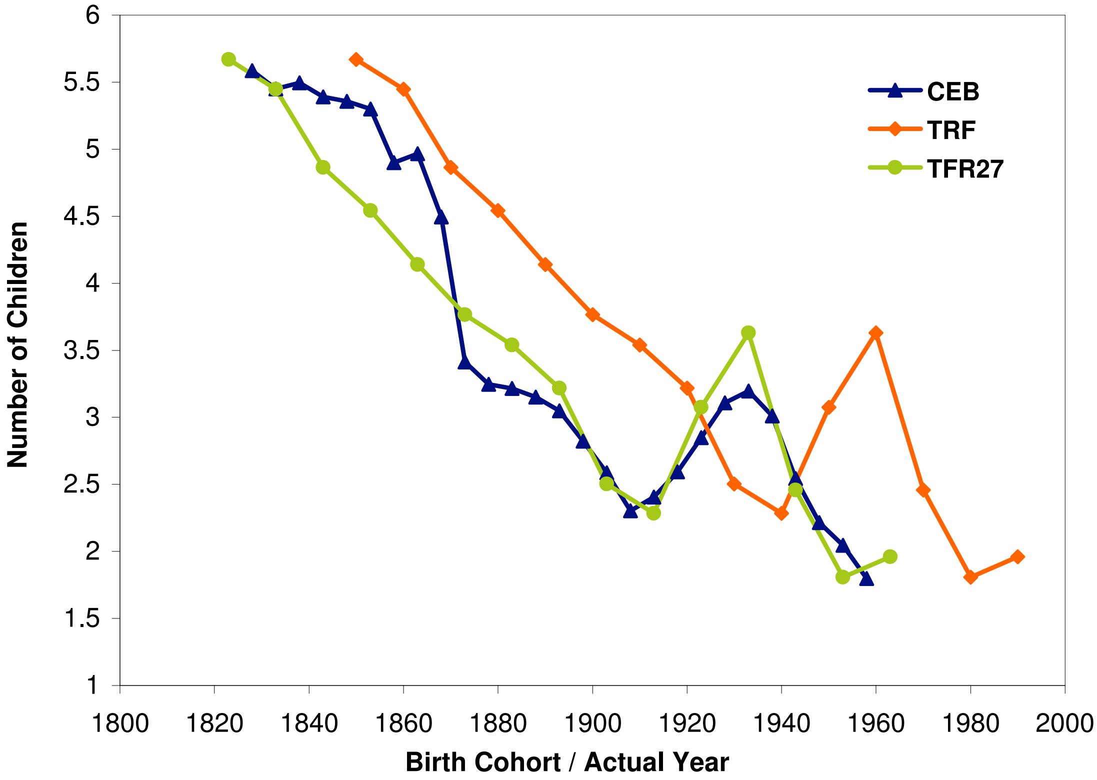
Figure 1 shows CEB over time for women born between 1826 and 1960. As can be seen from the figure there are two noticeable features that really stand out. The first is the long-term reduction in overall fertility that has occurred over the last 200 years. Fertility was roughly constant at 5.5 children for the thirty years between the 1828 and 1853 cohorts. It fell slightly for the next decade, towards five CEB in 1863, while the decline was very steep thereafter: a decline of 1.5 children between the 1863 and 1873 birth cohorts. Over the next 35 years, the decline slowed down again, with an additional decrease of 1.2 children over the entire time period. The overall fertility decline was substantial, starting with about 5.5 children per woman born in 1828 falling to about two children for women born in our last cohort, 1958.

The second feature that stands out is the baby bust and baby boom that occurred

[14] By focusing on currently married women, we are on average including about 70% of all women. However, this percentage differs considerably by cohorts, with a low of only 30% 1828 cohort, which is based on 70-74 year old women, and thus many widows, and a high 82% in the 1918 cohort who we include as 40-44 year olds.

[15] The gap in CEB varies from cohort to cohort, ranging from a high of 1.3 in the 1858 birth cohort to a low of -0.1 in the 1873 cohort. However, these numbers are difficult to interpret given that never married women were not asked about their children until 1970 and the proportion of singles vs. widows and divorced women varies considerably by age.

Figure 1: CEB by Birth Cohort



during the period from 1920 to 1960. Since the graph is by birth year, this is shown as a dramatic reduction in CEB among women born around 1908 for whom CEB falls to 2.3 and the subsequent increase among women born between 1908 and 1933 where it increases up to 3.3 for the 1933 cohort. The birth cohorts between 1898 to 1913 had exceptionally low fertility given the time – it constitutes a group of women that had fewer children than both their mothers, and their daughters. It is difficult to know, and it has been an issue of some discussion in Demography if this drop is simply a continuation of the Fertility Transition, or if, as some have hypothesized, fertility among those groups of women (the 1898, 1903, 1908 and 1913 birth cohorts) was lower than trend because so much of their fertile lifetimes occurred during the Great Depression. Indeed, Richard Easterlin's theory of the Baby Boom is in part based on the idea that fertility was so high in the 1950's exactly because it was so low in the 1930's. To ease exposition we will call this period of low fertility 'the baby bust of the 1930's.'[16]

[16] Note that the term "baby bust" is also often used to describe the period directly *after* the baby boom, while we use it for the period right *before* the baby boom.

One thing that is immediately obvious from data on CEB is that contrary to what one might have expected, the baby boom and baby bust cycle is not merely a product of delayed fertility. That is, one hypothesis is that fertility was temporarily delayed in the 1930s and 1940s due first to the Depression and then World War II. Subsequently, those same women increased their fertility after these unique events had passed. This version of the data shows that this is clearly not true, however. Those women born between 1906 and 1910 had lower lifetime fertility than those born later, despite the overall downward trend. A second hypothesis one might have is that the baby bust was mostly 'caused' by a larger fraction of women not marrying, while marital fertility has not changed. Since our data are observations on marital fertility, and this shows a substantial decline, it is clear that this is not the whole story. This clear distinction between changes in the number of births per women and changes in the timing of births over the life-cycle is not possible using most other measures of fertility.

The most common other measure of fertility is the Total Fertility Rate (TFR). (See Appendix D for definitions of CEB, TFR, etc., and a detailed discussion of their properties.) The TFR is defined as the sum of the age-specific birth rates over all women alive in a given year. Since it is computed using data from a given year, it is a mixture of the fertility decisions of all birth cohorts alive at the time. If all of these cohorts have the same fertility decisions, the two measures of fertility are identical. If fertility rates are changing from cohort to cohort, then CEB gives the more accurate picture of fertility decisions since it does not mix the fertility decisions of different cohorts. Moreover, in periods of declining fertility (as occurred during the Demographic Transition for example), TFR for any year overestimates fertility for young cohorts and underestimates it for older ones.

CEB does have weaknesses, however. For example, if calculated using a group of women at a given age, it is an unbiased measure of expected fertility to that age, *conditional* on surviving to that age. It will be an overestimate of *unconditional* expected fertility to that age when maternal mortality risk is positive and fertility choice and mortality risk are independent. This effect is present in the data to some degree since mortality rates for women during child bearing years are significant during the earlier parts of the period we consider.[17] Another issue that arises is the choice of age, A, at which the women are sampled. If A is chosen to be too low, CEB is a poor estimate of completed fertility – it is too low. On the other hand, when fertility plans are systematically related to mortality risk (for example through income), this can lead to sensitivity of CEB to A. Thus, when A is chosen to be too large, CEB can again be a poor estimate of

[17] TFR suffers from similar, related difficulties, see the Appendix for more discussion.

completed fertility. By looking at successive censuses, we can compare fertility estimates for women of a given birth year cohort but of different ages when answering the survey. We have plotted all possible combinations in Figure A1 in Appendix E. The figure shows that the estimates differ most for the earlier cohorts. It can also be seen that longevity is negatively correlated with fertility – estimates of fertility for a given cohort in successive censuses (and hence for older women) fall.[18]

The differences between TFR and CEB can be seen in Figure 1 which shows both TFR and CEB over the history of the US.[19] To make the two time series comparable, we shift TFR by 27 years as this aligns the peak of the baby boom in the two series.[20] Note that the decline in CEB during the Demographic Transition happened much faster than is apparent from the TFR numbers. CEB fell by about one and a half children for women born only 10 years apart: CEB for the 1861-1865 cohort was 5.0 and dropped to 3.4 for the 1871-1875 cohort. In contrast, the same fall in TFR takes 4 decades: TFR in 1843 was 4.9 and fell to 3.5 in 1883. This difference is due to the way TFR mixes cohorts in a given year. Also note that TFR increases the size of the baby boom over that displayed in CEB. From trough to peak CEB displays a difference of 0.9 children, compared to 1.4 for TFR. This is because, although delayed fertility for a given woman was not the whole story in the baby boom, it was part of it.[21]

The average value of CEB (or TFR) is only one of many possible ways of summarizing the history of fertility. It is a summary of the fertility experiences of many different women and completely abstracts from the diversity in experiences. A drop in CEB (or TFR) from four to two, for example, could be due to all women decreasing births from four to two or half of all females decreasing fertility to zero, while the other half remains at four, or any other convex combination. By looking at the average only, one completely abstracts from changes in the distribution of children across women within a birth cohort. The distribution, however, has also changed. Figure A2 in Appendix E shows the fractions

[18] One reason for this finding is that longevity is positively related to income. As we show later, it is also true that richer people have fewer children. It then follows naturally that average CEB for a given cohort is negatively related to age. Another possible bias is selective memory: especially children that die as infants might be remembered less as the mother ages.

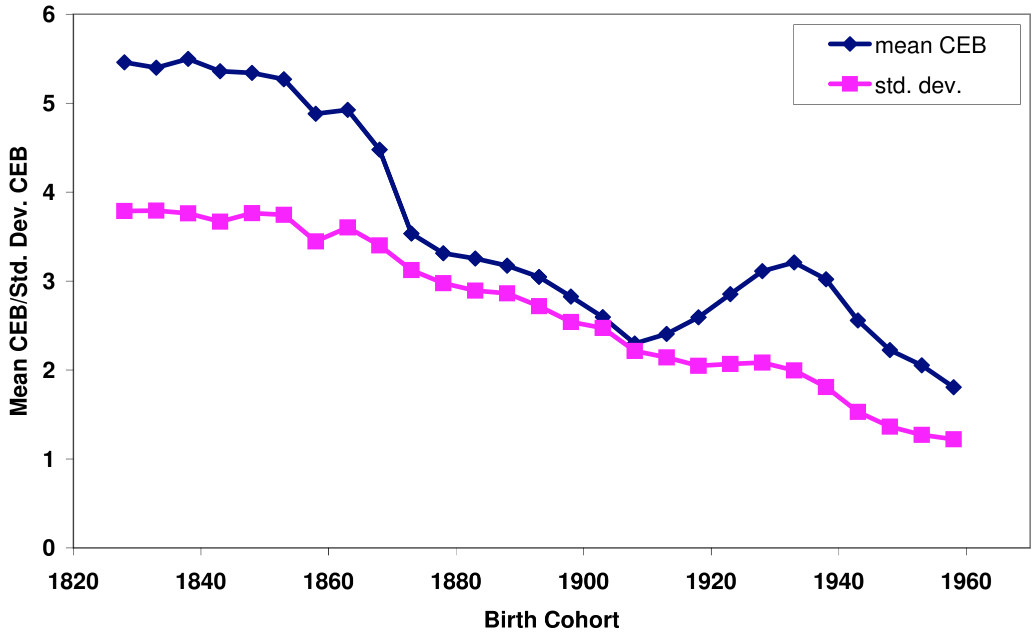
[19] We constructed TFR numbers by using Haines' (1994) estimates for TFR for black and white women assuming that the fraction of black women has remained constant at 10% over the time period, and ignoring other ethnicities.

[20] Note that the average age of first marriages ranges between 20 and 25 years for women over this time period (US Census 2006). Hence, the implication that the "average birth" occurs at age 27 seems reasonable.

[21] The point that part of the baby boom was due to an overlap in timing is also made in Russell (1982).

of women having a given number of children. Overall, the fraction of women with 0 and 1 children does not show much trend, being on average 10% over the entire time period considered. The percentage with 2 and 3 children has gone up significantly, from about 10% each over the cohorts born from 1818 to 1868 to 40% and 20%, respectively, for the 1958 cohort.[22] The percentage of women with 4 or more children, on the other hand, has dropped sharply from more than 60% for women born before 1860 down to about 10% for the most recent cohorts. The baby bust and boom can also be clearly identified. During the baby bust, 40% of married women had one child or no children, which is the highest it has ever been. One might have thought that the distribution of CEB across women is shifting to the left in a first order stochastic dominance sense, however, as Figure A3 in Appendix E shows, this is clearly not true.

Figure 2: CEB by Birth Cohort, by Sub-Groups



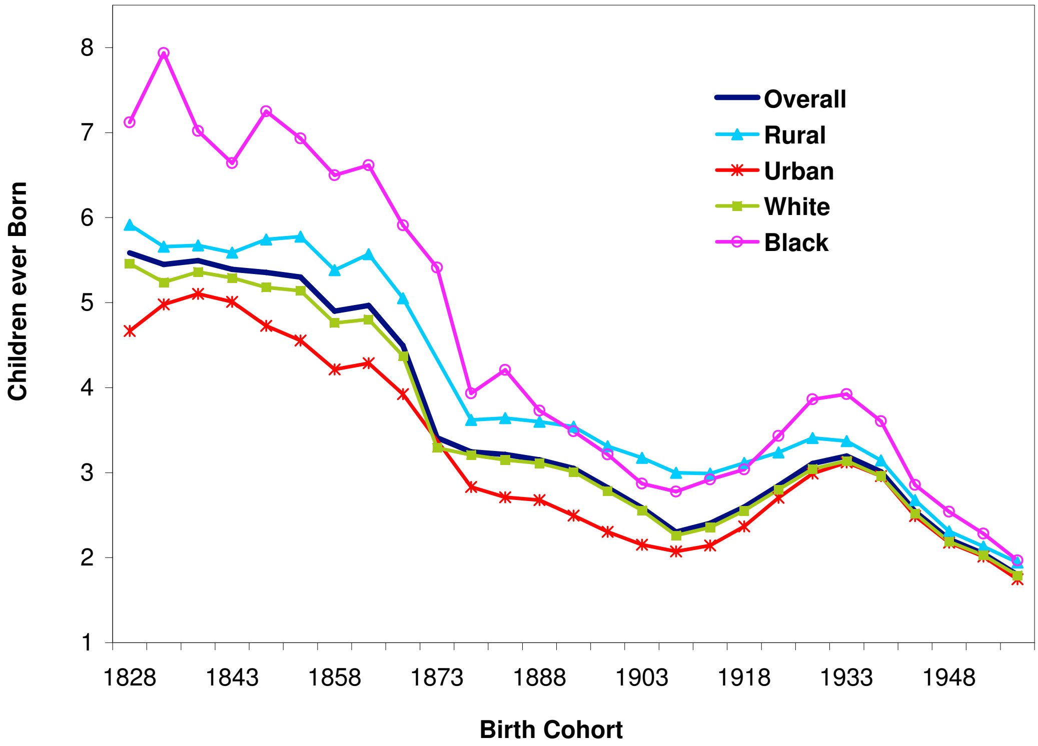
As another way of analyzing changes in the distribution of CEB over time, we computed the standard deviation of the CEB distribution for all cohorts. Figure 2 shows that the standard deviation has been monotonically falling over time. An interesting finding is that there is no increase in the standard deviation during the baby boom even though the mean increased a lot. In other words, the whole distribution just shifted out by about

[22]See also David and Sanderson (1987) on the emergence of the "2-child norm."

one child without a corresponding increase in the spread during that period.

Demographers have put forth many alternative hypotheses to explain why the Fertility Transition seen in these data occurred how and when it did (see Alter (1992) for a summary). Some of these hypotheses are based on simple compositional arguments – suppose group A has lower fertility than group B and the relative sizes of group A and B are changing. In the remainder of this section, we use the Census data on CEB to address the most common of these hypotheses – differences by location (urban vs. rural, farm vs. non-farm, and region), race, and immigrant status. We find that the main features of the US fertility history are common across all of these groups and that, indeed, differences between the groups have largely disappeared.

Figure 3: CEB by Birth Cohort, by Sub-Groups



We begin with the difference between rural and urban populations. Over this time horizon there were both large movements from rural to urban areas and large differences between urban and rural fertility. Of the 1928 birth cohort, only 25% lived in urban areas, whereas about 75% of the last birth cohort (1958) live in urban areas. Figure 3 includes a time series of CEB for women living in urban vs. rural areas. The figure shows that women in rural areas had a substantially higher number of children than in urban settings.[23] The difference is fairly stable at about 1 Children per Woman (CPW) until the 1923 birth cohort, after which the gap narrows to less than half a child, and by 1938, fertility in urban and rural areas is nearly indistinguishable. Thus, although there has always been some difference in the fertility behavior of these areas, and although this was significant in the early years, it is clear that the Fertility Decline is not simply the product of a movement from high and constant fertility rural areas to low and constant, fertility urban areas.[24] There are some other interesting differences in the fertility histories of these two types of areas as well – for example the baby boom was much more pronounced in urban areas, where CEB increased from 2 in 1908 to 3 CPW in 1928, compared to an increase of only 0.4 children for rural women, etc. The distinction between farm and non-farm families paints essentially the same picture as urban and rural (see Table A6).

Another often discussed pattern in the history of fertility is differences by race. From Figure 3 we see that although black fertility has always been, and still is, higher than that of whites, the basic patterns of fertility history are similar. Not only are the overall patterns of fertility similar – a long decline, a baby bust, a baby boom and the subsequent decline – we also see that the difference in fertility by race has fallen dramatically. The difference has at times been substantial, for example 5.5 vs. 7.1 in 1828, but, in the most recent cohort we study, 1958, it is down to a difference of only 0.2 children.

The overall pattern of gradual fertility decline, followed by a sharp baby bust and a baby boom can also be found for women of different immigrant status. The level of fertility, however, differs substantially by immigration status as Figure A4(a) in Appendix E shows.[25] Starting with the 1838 cohort, second generation Americans (i.e. women born in the U.S. with at least one immigrant parent) had consistently lower fertility rates than women born in the U.S. (see also King and Ruggles (1990) on this). Women born in foreign countries, on the other hand, had about a half child more than the average throughout the entire 19th century. This pattern reversed during the baby bust period – starting from the 1898 cohort – when women born abroad had fewer children than native born Americans. That is, the decline in CEB during the baby bust period (1893-1908 cohorts) is steepest for immigrants. This reversal may reflect the time period rather than a changing relationship

[23]One hypothesis is that the costs of raising children are higher in urban areas than in rural settings.

[24]Indeed, using actual CEB numbers for the 1828 cohort (5.9 for rural and 4.7 for urban) together with the fact that by 1958 three quarters of the population lived in urban areas while only one quarter remained in rural areas would imply that CEB should have decreased from 5.6 in 1828 to 5 in 1958, only a small fraction of the actual observed decline.

[25]The graph ends with the 1928 cohort, because information on immigration was collected only up until the 1970 Census.

caused by the baby bust itself. In this period total immigration is falling: the fraction of immigrants in our sample of married women declines from about 20% in the 1898 cohort to roughly 10% in the 1908 cohort. One possibility is that immigrants moving to the U.S. in the 1920's and 1930's may be atypical – i.e., a sample selection issue may arise in immigrants during the Great Depression. In addition to this effect, this is a period in which the fraction of European immigrants is steeply declining from 90% in 1893 to 70% by 1908, while Asian and South American immigration is starting to increase. If European immigrants were, on average, richer than those from Asia and South America this could cause a steep decline like this because of the fact that the Baby Bust was more pronounced for the lower part of the income distribution

Figure A4(b) in Appendix E shows the time series of CEB in four different regions of the country.[26] As can be seen although there are stark differences across the regions early on the overall patterns are similar and the differences are small in the most recent cohorts. The South Western regions have the highest fertility, with almost 7 children per woman early on, compared to New England that had CEB rates as low as 4, even for women born in the middle of the 19th century.[27] These cross-regional differences are larger than urban-rural differences (compare Figure A4(b) to Figure 3), and hence, these differences are not due solely to differences in the urban-rural composition of the areas. Note also that the proportion of women living in the low fertility regions (North England and East North Central) is shrinking over time, while the proportion living in the high fertility regions (South Atlantic and West South Central) is growing. Hence, an appeal to westward migration as an explanation of the Fertility Transition actually goes the wrong way.

[26]These regions do not exhaust the U.S. but they are representative in that they show the entire spectrum of regional differences. The regions that we use are: New England Division (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont), East North Central Division (Illinois, Indiana, Michigan, Ohio, Wisconsin), South Atlantic Division (Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia), and West South Central Division (Arkansas, Louisiana, Oklahoma/Indian Territory, Texas).

[27]Vandenbroucke (2004) argues that people move from East to West precisely because they know they want large families and land is cheaper there. Alternatively, note that the Western states had the highest ratios of males to females, and thus it is plausible that only those men with the highest desire to reproduce married, driving up the average fertility for women (but not men).

4 Economic Determinants of Fertility in the U.S. Census Data

In this section we look at several refinements of the time series of fertility examined above. In particular, we study how fertility is related to various measures of income and education and how the relationship has changed over time.

One of the hypotheses that demographers and economists both put forth is that the reduction in fertility that occurred during the Demographic Transition was primarily due to the increase in per capita income that occurred over the same period (see Alter (1992) for a summary of theories of the Demographic Transition). The simplest implementation of this idea is that for any given cohort, there is a negative relationship between fertility and income, and that growth in GDP per capita simply pushes more and more people into the low fertility range. Thus, this hypothesis can be succinctly summarized as: The fertility decline is due to a move along a time independent relationship between fertility and income. One of our goals is to document to what extent this holds for the U.S. fertility history, and to what extent this transition was a shift of this relationship instead. To do this, we will examine the link between CEB and those measures of economic well being that exist in the Census.

With perfect capital and income insurance markets, economic models say that fertility decisions of a household (and all other decisions as well) are functions of the present discounted value of the entire lifetime stream of income flows only– i.e., 'wealth' in the economic sense.[28] When capital and insurance markets are imperfect, other variables also enter this picture – the degree of individual restrictions on borrowing, the history of 'luck' that the individual has had with respect to income and other shocks. Even if the perfect capital and insurance market hypothesis were correct, no simple measure for the present discounted value of the entire lifetime stream of income flows is available. Because of this, it is necessary, both here and in other studies, to use proxies.

Data on occupation are available over the entire period that we study, 1900 to 1990; income measures were collected by the Census beginning with the 1950 Census; an estimated house value was collected in the 1940 census and from 1960 to date; education data has been collected since the 1940 Census. Each of these measures has pluses and minuses as indicators of true economic wealth. Current income is a tight measure of one term in the present discounted value calculation mentioned above, and would be a very

[28]Throughout this paper, we use the terms "economic wealth" and "present discounted value of life-time income" interchangeably.

good estimate if income did not change over time. However, it is well known that it does change systematically over the life cycle, and also has a large 'error term.' This is due in part to business cycle frequency movements, and in part due to individual specific fluctuations. Also, it is only available for a subset of the time period we are interested in. House value likely suffers greatly from reporting error and is also available only for a small subset of the years, but it has the advantage that it is more stable over time than income flows.[29] Educational attainment is also more stable over time, at the individual level, than income since it is not subject to business cycle frequency fluctuations nor idiosyncratic shocks. However, it is also an imperfect measure of wealth (i.e., the conditional variability of wealth given years of education is high), and it is only available for the most recent censuses. Occupation is the economic variable that has the most coverage since data has been collected on it over the entire period of study. Like education, it is typically not subject to movements over time. It suffers from two difficulties however. First, not all individuals of a given occupation have the same wealth. Second, occupation itself does not easily translate into a dollar wealth equivalent. There is very little that can be done about the first problem. For the second, a measure, Occupational Income, has been created (see Ruggles et al (2004)) that we will use as the basis for a proxy.

Table 1: Correlation between OI and current income of husbands

Cohort	Census Year	Age	Correlation
1913	1960	47	0.49
1918	1960	42	0.48
1923	1970	47	0.47
1928	1970	42	0.46
1933	1980	47	0.45
1938	1980	42	0.44
1943	1990	47	0.45
1948	1990	42	0.45
1953	1990	37	0.44
1958	1990	32	0.40

In sum, various possible measures exist, but they are all imperfect. Our approach will be to use Occupation as our baseline measure of economic wealth since it is available for

[29]Moreover, house value is only reported for house owners, not renters.

a longer time period. The correlation coefficient between current income and occupation are between 0.4 and 0.5 for the years in which both measures are available, see Table 1. We also look at education, as education is a measure that allows us to look at husbands and wives separately.

4.1 Occupational Income and Fertility

The Occupational Income Score (OIS) is a constructed variable that assigns each occupation in all years a value representing the median total income (in hundreds of 1950 dollars) of all persons with that particular occupation in 1950.[30] For example, the OIS of a carpenter in 1850 is equal to that of a carpenter in 1980 and both are equal to the median carpenter income in 1950. That is, if relative incomes of different occupations were constant over time, and all individuals in a given occupation had the same income, the OIS would perfectly rank people by current income. Of course, some occupations have risen or fallen in the income ladder and not all individuals within a given occupation have the same present discounted value of income. But, overall, it seems to be a good approximation. Nevertheless, since it gives the same score to carpenters in 1850 and 1950 without adjusting for trend growth, it misses the fact that carpenters, and all other occupations, in 1950 are richer than carpenters in 1850. This can be partially corrected for by adjusting for trend growth in income, which we will do below.

Prior to 1960, occupations were only recorded for persons in the labor force. Hence, the variable OIS is not available for persons not in the labor force in the early years. Specifically this means that information on OIS is not available for many women, and that the proportion of women with valid OIS is continuously increasing over the time period considered. Because of these limitations, we examine the relationship between CEB and OIS for women in households where the husband is present. The variability of CEB at a given level of income is high and makes identifying systematic relationships difficult. For this reason, and to counteract errors in variables induced by using OIS as a proxy of wealth, we first divide the observations into deciles by OIS. Further, since occupational income score assigns the dollar income of the relevant occupation in 1950 dollars, it will miss the effects of trend growth for all occupations. To account for this effect, we adjusted income scores such that average income grows 2% annually.[31] In

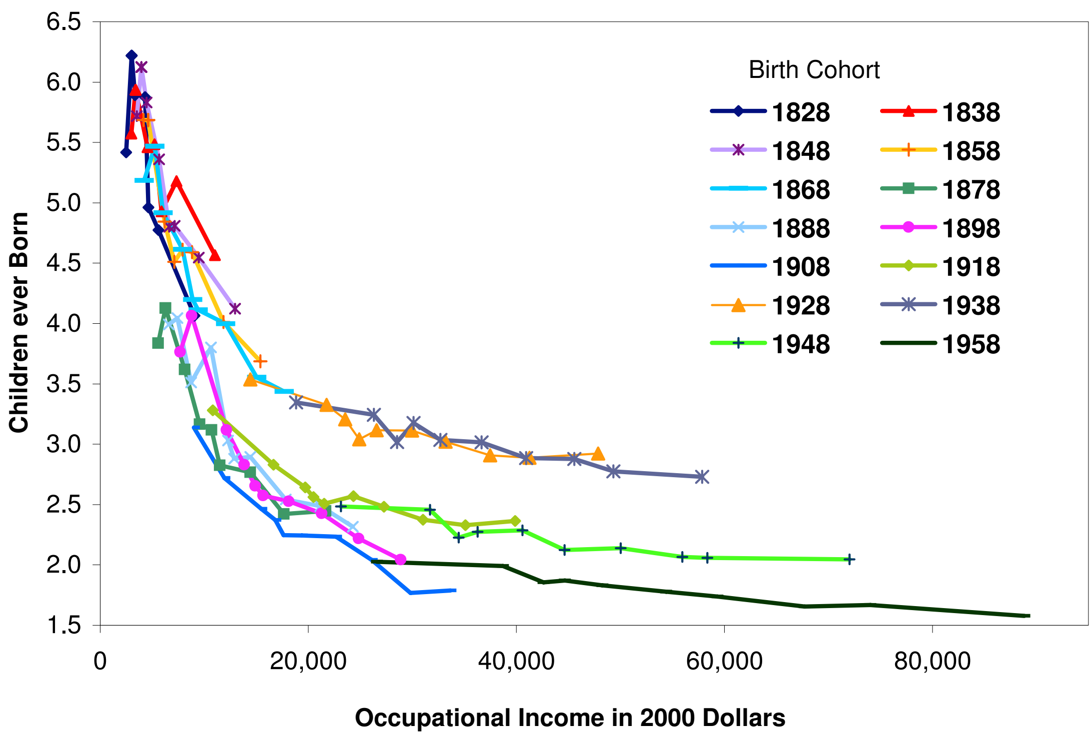
[30]See http://www.ipums.org/usa/chapter4/chapter4.html for details.

[31]We use a 2% trend because this is the average growth rate of output per working age person during the 20th century in the United States (Prescott 2002). We prefer to use a general trend rather than actual GDP growth over this period because we interpret OIS as a measure of life-time earnings rather

addition, we convert 1950 dollars into 2000 dollars using the CPI. We call this adjusted occupational income score simply *occupational income* (OI).

In Figure 4 we plot these decile by decile averages of CEB against OI for each birth cohort. Thus, each point in Figure 4 represents the average CEB of wives of men in one OI decile, for a particular birth cohort of women.[32] (Table A4 in Appendix B includes the actual numbers.) For each cohort, we find a strong negative relationship between OI and CEB. For all cohorts, we find that CEB decreases monotonically across OI deciles, with the occasional exception at the very bottom of the distributions. In the early cohorts (until 1898) CEB actually increases from decile 1 to decile 2. We also find that the relationship is very flat at the upper end of the income distribution, i.e. there is little difference in CEB between the top two deciles, starting with the 1908 cohort.

Figure 4: CEB by Occupational Income in 2000 Dollars



One hypothesis is that the fertility decline was driven solely through the increase in income. While our analysis has nothing to contribute on causality, we can investigate

than actual income in the year in which data was recorded.

[32]As before, for each cohort, we compute average fertility for women in a five year age bracket, as described in Appendix A.

to what extent the data is consistent with such a theory. Let F_{it} denote the number of children ever born for person i in cohort t. The most extreme version of the hypothesis that differences in fertility are completely driven by differences in income would be that F_{it} is a time invariant function of present discounted lifetime income (LI). That is:

$$F_{it} = G(LI_{it})$$

where LI_{it} is the lifetime income of person i in cohort t and G is a time invariant function. This version would have the implication that, although overall fertility could change over time due to the movements in average LI_{it}, conditional on lifetime income, fertility should be unchanged over time.

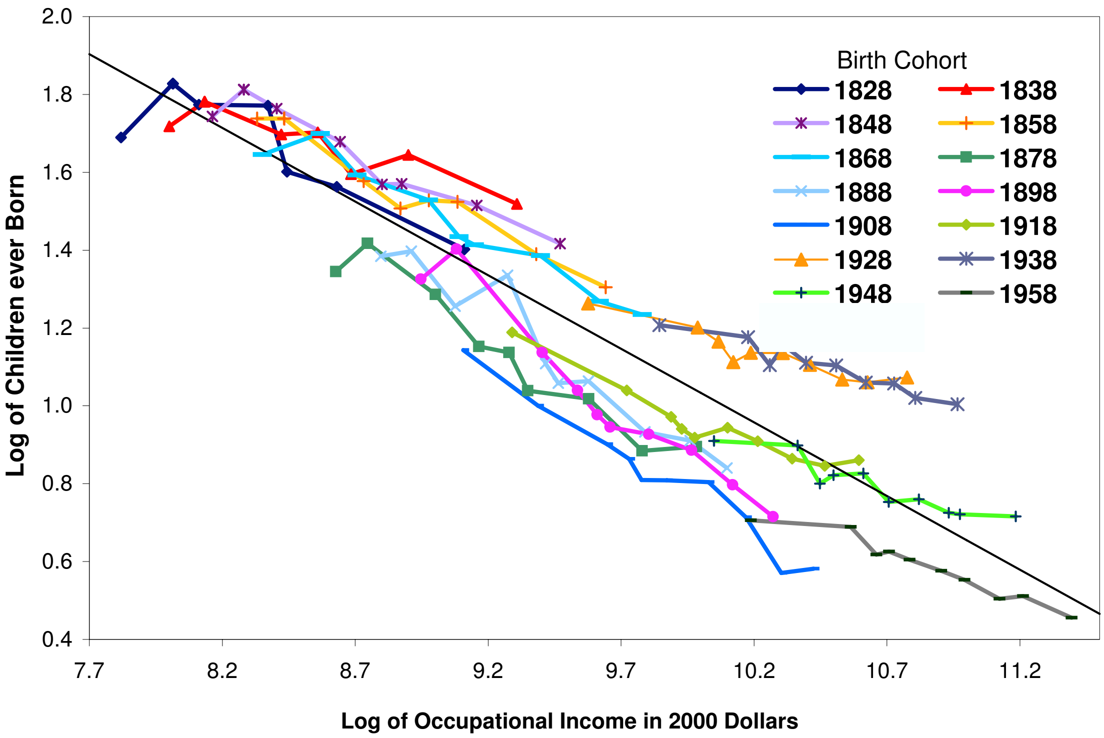
If this were true – and assuming that OI is a good measure for lifetime income – all of the data in Figure 4 would then lie on the curve, $F = G(LI)$. Since there has been such a large increase in average income, the extent to which this is true is difficult to discern in Figure 4, which plots CEB against OI. To more clearly illuminate this relationship, we show the relationship between the natural logarithms of CEB and OI in Figure 5. In addition to the data, this picture includes a fitted relationship (OLS regression) based on data from all cohorts. The relationship between CEB and OI looks surprisingly time invariant. The estimated relationship is $\log(CEB) = 4.82 - 0.38\log(OI)$ with an extremely high R^2 of 0.82. Therefore, much of the observed overall fertility change seen between the 1828 and 1958 birth cohorts seems consistent with this view.

However, the picture also shows systematic deviations from such a stable relationship. As can be seen, while the 1828 and 1948 birth cohorts are approximately right on the fitted curve, the baby bust cohorts are clearly below, and the baby boom cohorts are clearly above. Thus, it seems that there are other, large effects that are missing from this view, and we will come back to this later.

Using the data underlying Figure 5, we can do a formal accounting decomposition of the observed patterns from start to finish into movements along a curve relating income to fertility and shifts of that curve over time.[33] To do this, we now fit a log-log regression between average OI by decile of the population and average CEB within that decile for *each* birth cohort. The slope coefficient from this regression can be interpreted as the income elasticity of the demand for children. The cohort-by-cohort elasticities are given in Table A5 in Appendix B. Between the 1828 birth cohort and the 1958 one, OI increased from \$4,154 to \$54,517, approximately a 13-fold increase. Based on the elasticity

[33]Such an accounting decomposition had not been possible previously as past empirical work focused either exclusively on a time series or on a cross-section.

Figure 5: Log (CEB) by Log(Occupational Income)

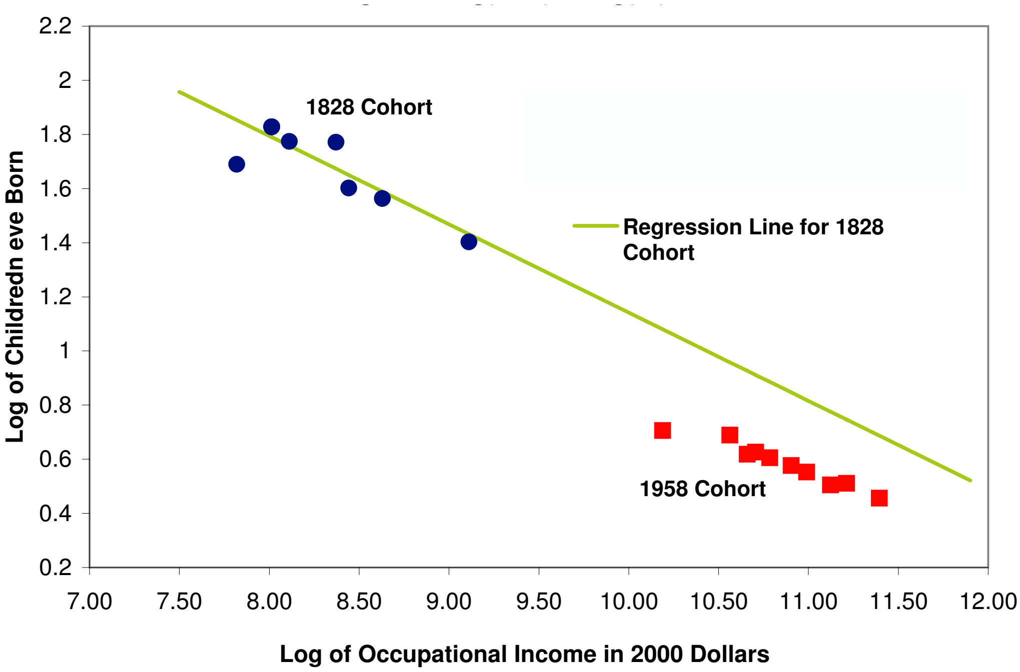


estimate from the regression using 1828 data of -0.33, the predicted CEB in 1958 would be $CEB_{1958} = \left(\frac{OI_{1958}}{OI_{1828}}\right)^{-0.33} CEB_{1828} = 2.4$, while the actual value for women born in 1958 was 1.8. In this sense, 84% of the overall reduction of 3.8 CPW between 1828 and 1958 would have been predicted given the relationship between income and fertility fitted from the 1828 birth cohort. Figure 6 illustrates this accounting exercise graphically.[34]

Of course, the results of calculations such as this depend on the details of how they are done. For example, when using the elasticity that is estimated based on all data, -0.38, we find that 92% of the overall fertility decline can be accounted for. Alternatively, if we use the fitted relationship between OI and fertility based on the 1948 birth cohort, we find that only 60% of the decline can be accounted for. To see this, not that average income in 1898 was only 30% of the average income in 1948 and in 1828 it was only 9% of 1948 income. Based on this, the average fertility of 2.22 in 1948 and the estimated elasticity of -0.20, we would predict that fertility should have been 3.54 in 1828 (it was actually 5.59) and 2.70 for the 1898 birth cohort (it was actually 2.82). Thus, this version of the

[34]¿From the figure, it appears that only 7 deciles are present in the 1828 birth cohort. This is because several deciles have the same occupational income. These are deciles 2-5. See Table A.4 for the actual values for all 10 deciles.

Figure 6: 1958 Predicted vs. Actual CEB (based on 1828 data)

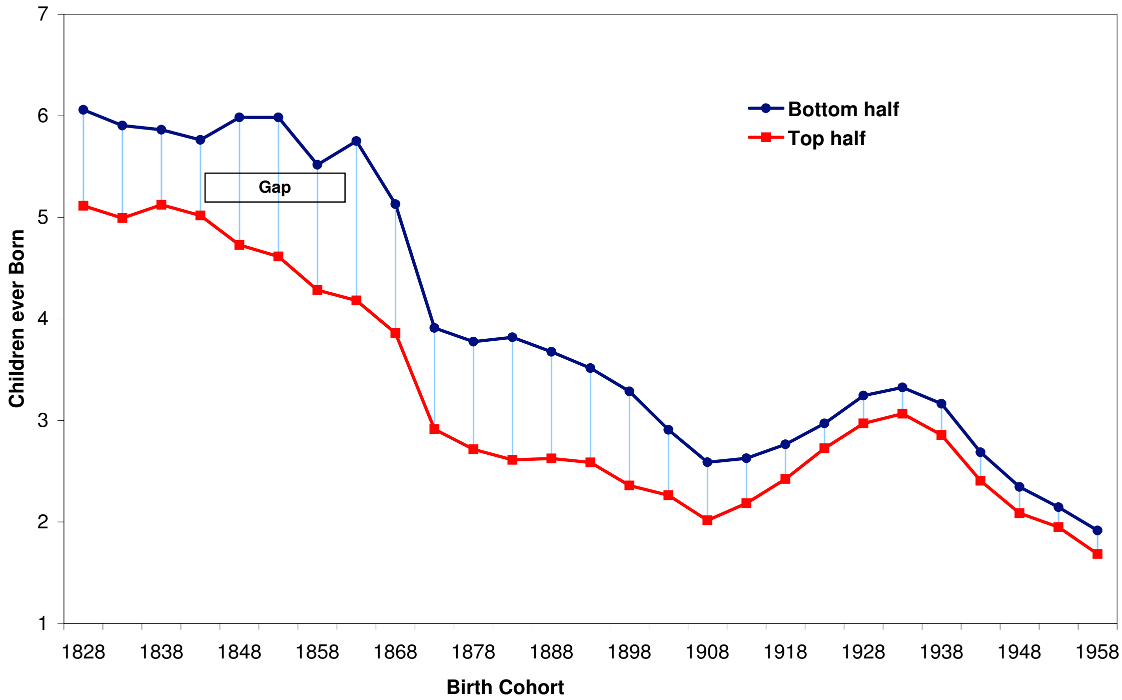


calculations would say that the log linear relationship would account for about 60% of the observed differences in fertility levels between the 1828 and 1948 cohorts.

4.1.1 Decreasing Fertility Inequality

Some interesting deviations from a time invariant relationship exist. The most striking pattern is the "compression of fertility" over time, i.e. that fertility became less income sensitive over time. There are several ways to measure this. We look at two measures: the change, over time, in the absolute difference in CEB from the bottom to the top halves of the income distribution, and the change, over time, in the estimated income elasticity of demand for children. The difference from the top to the bottom of the income distribution of fertility has been falling, reaching an all-time low of a fifth of a child in 1953. This can be clearly seen in Figure 7 which shows average CEB of women with husbands above and below median occupational income over time. Note, however, that this decline did not occur monotonically. Roughly, there was a difference of about 1 child in the early cohorts, increasing to a high of 1.6 with the 1863 cohort, then rapidly falling to only half a child by 1908 and further falling to a quarter of a child by the 1923 birth cohort, where it stabilized. Overall then, there has been a significant decrease not only in fertility but

Figure 7: CEB by Top and Bottom Half of the Income Distribution



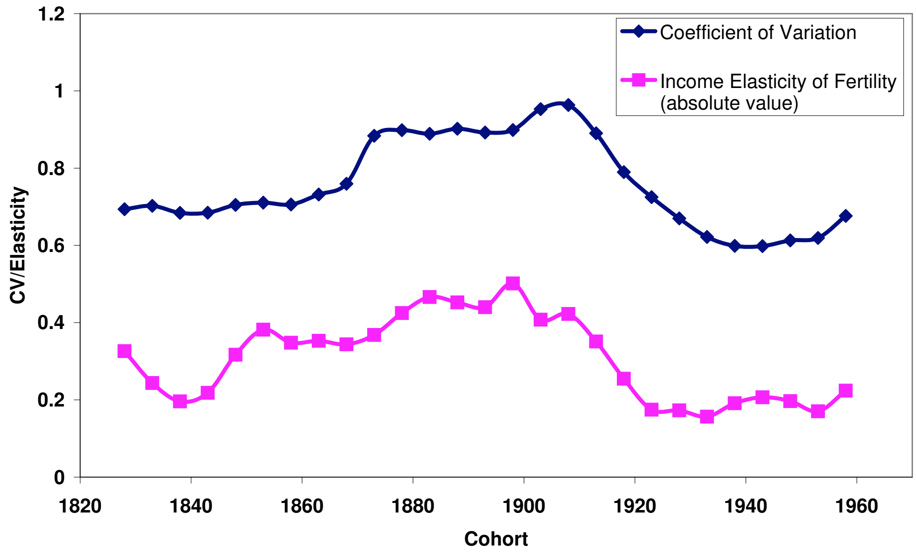
also its top to bottom variation with respect to income – fertility has become 'compressed' with respect to income.

Part of this compression is what would be expected with movements along an iso-elastic demand curve for children with a negative slope, but there are other forces at work as well. To see this, note that our estimated income elasticities of demand for children have also decreased (see Table A5). Interestingly, it changed in a non-monotone way over time, rising from about -0.33 in the early years up to a peak of about -0.45 or -0.50 for cohorts born in the late 1800's and down to about -0.20 in more recent times.[35] The change in the income elasticities is closely mirrored in overall changes in the fertility distribution. Figure 8 plots the coefficient of variation (CV) of the OI distribution over time. In the same picture we have included the absolute value of the income elasticity. The fall in the CV shows that over the entire time period, the variance of fertility fell by more than it would have if fertility had just fallen proportionally throughout the entire distribution. This is particularly true during the baby boom where the variance of fertility increased by less than as if fertility had increased proportionally for everybody. Thus, the widening

[35]See Westoff (1954) for an early account of the widening and compression of fertility.

and then compression in the relationship between income and fertility is closely reflected in changes of the overall fertility distribution.

Figure 8: Measures of Fertility Inequality



Note that the decline in elasticities immediately implies that the fertility compression was not solely the result of a compression in income, at least in its simplest form – viz., that the income elasticity was constant but income compressed. This conclusion depends on both the assumption that OI is a good proxy for income and the assumption that the income elasticity is constant over time. As Goldin and Katz (1999) document, there has been a compression of income due to a fall in the skill premium during the 20th century. Thus, some of fertility compression may be due to the income compression.[36] However, it is also well-documented that income inequality and the skill premium rose again during the later parts of the 20th century, while fertility compresses over the entire time period.

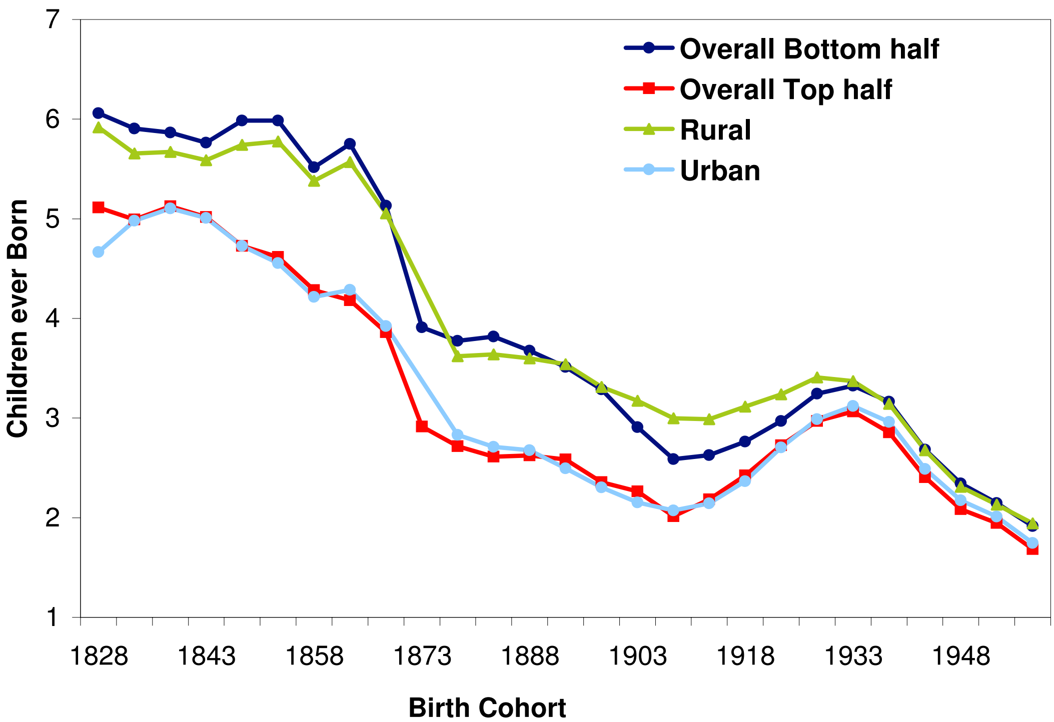
The reason for the overall widening of fertility during the 19th century is that the timing of the Fertility Transition (1828-1898) did not occur evenly across the income distribution. This can be most easily seen in Figure 7.[37] Fertility for the bottom half was roughly constant at about 6 between the 1828 and 1853 cohorts. After this, it fell steeply to the 1898 cohort where it reached 3.3 children per woman (CPW), a reduction of 2.7 children overall. In contrast, for the upper half of the income distribution, the decline

[36] Similarly, if the relationship between LI and CEB is non-linear, but with a different functional form, the observed fertility compression could be due solely to income compression.

[37] See also Figure A5 in Appendix E which shows a finer breakdown by income deciles.

was more or less steady between the 1828 and 1898 birth cohorts from about 5.0 to 2.4 children per woman. Thus, the overall drop between the 1828 and 1898 birth cohorts was similar in magnitude for women in both halves of the income distribution: falling by about two and a half children. It follows that over the 70 year period there was little change in the absolute difference in the number of children. Because of the difference in timing, however, the overall changes mask the observation that in the interceding period the CEB difference rose, reaching a maximum of about 1.6 CPW with the 1863 birth cohort. In sum then, the Fertility Transition began early and was gradual for the upper part of the income distribution while it began later, and was much steeper for the lower part. Overall, the decline was similar in magnitude, but, because of the difference in timing, the spread grew in the interim. This pattern mirrors closely the pattern seen when the data is divided between urban and rural components as can be seen in Figure 9. The Fertility Transition began early and was gradual for women living in urban areas while it began later, and was much steeper for those living in rural areas. (See also the discussion in Section 5.)

Figure 9: CEB for Top/Bottom Half of Income Distribution and Urban/Rural Areas



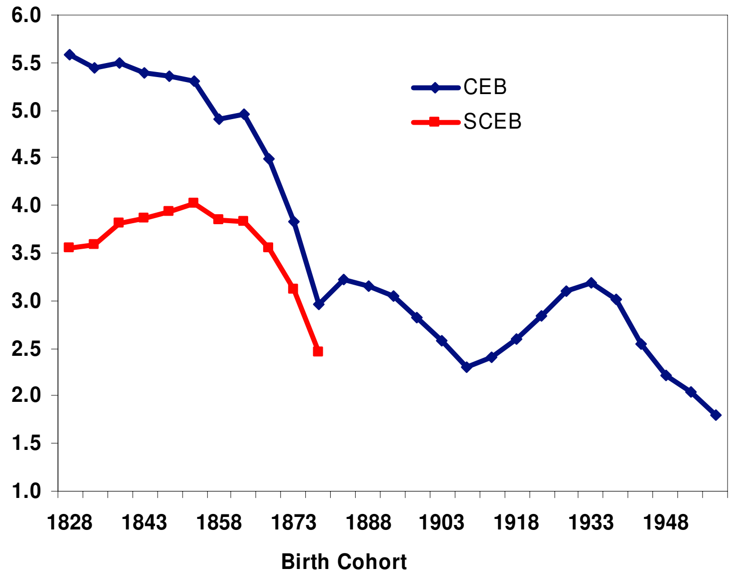
The fertility compression during the 20th century is related to a difference in magnitudes of the baby bust and baby boom at different parts of the income distribution. From Figure 7 it can be seen that the baby bust was more pronounced for poorer families. Between 1898 and 1908, fertility declined from 3.3 to 2.6 CPW for the bottom half, and from 2.36 to 2.02 for the top half. That is, there was a reduction of 0.70 CPW for the bottom half, compared to a fall of only 0.35 CPW for the top half of the income distribution. A similar asymmetry also occurred during the baby boom period (1908-1933), which was most pronounced for richer women. Women in the upper half of the income distribution increased their fertility from 2.0 CPW in 1908 to 3.1 CPW in 1933. Women in the lower half, in contrast, increased their fertility from 2.6 in 1908 to 3.3 in 1933. Thus, fertility increased by 1.1 CPW for the top half and only 0.7 CPW for the lower half. Together, the relatively steeper fall in CPW for poorer families and the subsequent milder increase has led to a compression in fertility across the income distribution. Indeed, most of that compression had been completed by the 1923 birth cohort, when the difference in average fertility between the bottom and top halves fell from 0.93 to 0.24, where it still is today.

One might be concerned that the pattern of widening and then compression of fertility with respect to income is an artifact of the data, driven by OI becoming an increasingly worse estimate of lifetime income the further away one goes from the 1950 census. Recall that OI was constructed as the median income of that occupation in 1950, and thus one would expect OI to be a relatively good proxy for actual income in 1950. The further the distance from the 1950 census, the larger one would expect the error to be, since some occupations will have changed in relative status, etc. In principle, an increasing error could be responsible for the fertility gap being largest in years where data is good and decreasing in both directions from there. However, we strongly believe that this is not the case. First, the peak is at the wrong time. The cohorts that are based on the 1950 census are the 1903 and 1908 cohorts, while we find the peak of the fertility gap between bottom and top of the income distribution occurs in 1863, and we find the highest income elasticity for the cohorts between 1883 and 1898. Secondly, actual income data is available in four censuses (1960-1990). Using this data, we also find a substantial decline in the fertility gap over this time period. Finally, the correlation between OIS and income falls only by a small amount over this time period, as shown in Table 1, suggesting that the error may have not increased by a large amount. Further details on this are included in Appendix C.

4.1.2 Surviving Children Ever Born

The difference between gross and net fertility was quite substantial in the earlier years of the time period that we study. As many as one third of children born did not reach working age. It is clear that both gross and net fertility are important from an economic point of view. Data limitations force us to abstract from mortality considerations for the most part.[38] To our knowledge, no estimates of the relationship between wealth and infant and/or child mortality are available for the period we study.

Figure 10: Time Series of SCEB vs. CEB



The census data does, however, contain some limited information on the surviving number of children. In both the 1900 and the 1910 Censuses, all women who had ever been married were asked about how many living children they currently had. In the following, we will label this variable *surviving children ever born* (SCEB). We can replicate our previous analysis using SCEB for the cohorts between 1828 and 1868, i.e. 9 cohorts. All other cohorts were based on data from a census other than 1900 and 1910, so that no information on SCEB is available.[39]

Not surprisingly, we find that a substantial number of children die before their mother. The time series of SCEB together with CEB is plotted in Figure 10. The percentage of

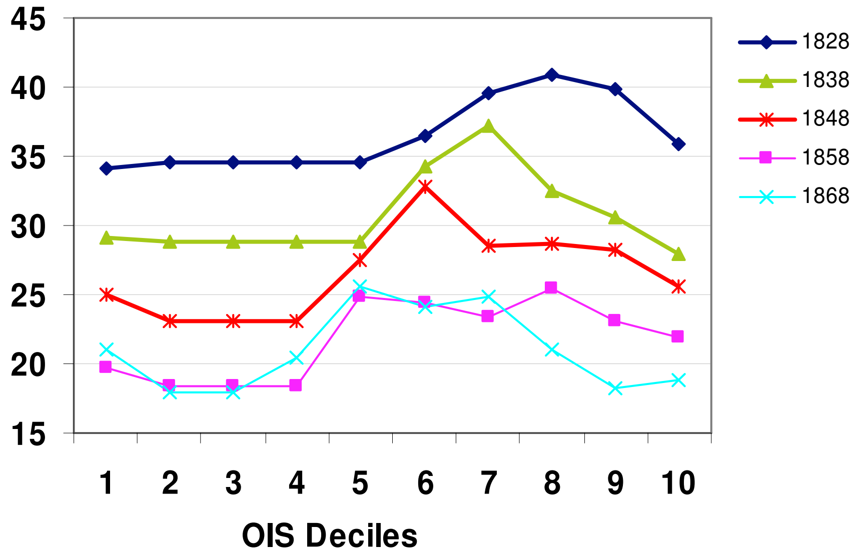
[38]See also Haines and Preston (1996) and Ferrie (2003) on constructing mortality estimates from Census data.

[39]The figures contain data for the 1873 and 1878 cohorts, which are based on 32 and 37 year old women in the 1910 census, i.e., these are age/cohort combinations that we do not use elsewhere in this paper.

children that had died declines monotonically from 37% for the 1828 birth cohort to 21% for the 1868 birth cohort. Note that this decline is not only due to declining mortality rates because the age at which mortality is established changes in these measurements. That is, for the 1828 birth cohort we measure the fraction of children that die before their mother's 72nd birthday, while for the 1868 cohort survival is measured at their mother's 42nd birthday.[40]

The relationship between SCEB and occupational income is essentially the same as between CEB and OI. That is, all our findings from the previous section, that fertility and income are negatively related, and that this relationship has changed non-monotonically over time, are robust to controlling for mortality. We find that the relationship between income and SCEB is negative for every single cohort for which data is available. Figure 12 plots our two measures of the relationship between fertility and income (elasticity and top to bottom gap) for all cohorts between 1828 and 1878. The graphs show how the estimates based on the two measures of fertility track each other very closely.

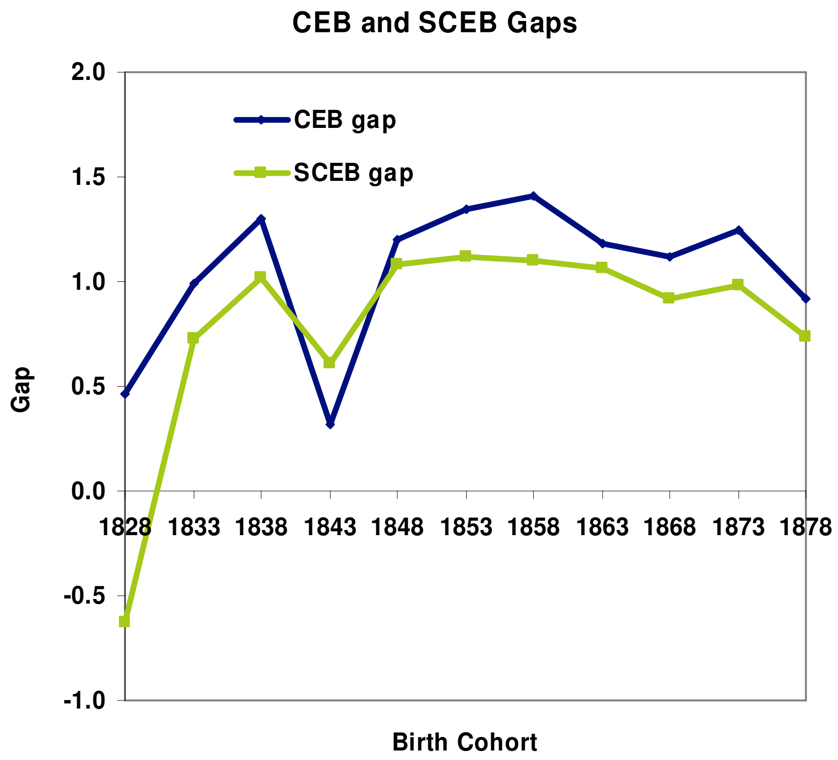
Figure 11: Percent not Surviving

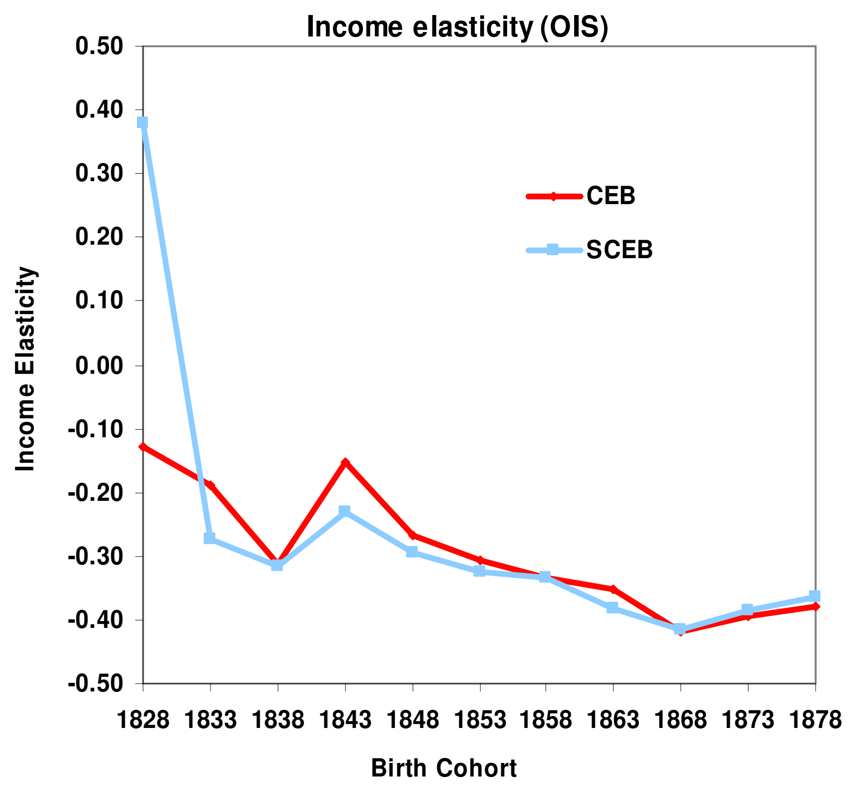


It is sometimes argued that mortality was higher among poor people because of the different hygienic circumstances. We cannot confirm this hypothesis in the Census data. In fact, mortality (measured as a fraction of children that does not survive) is somewhat higher among richer people. This might reflect the fact that both incomes as well as mortality were higher in urban areas.

[40]More precisely, for the 1828 cohort, we measure survival of children of women aged 70-74 at census enumeration day, while for the 1868 it is measured for women aged 40-44 etc.

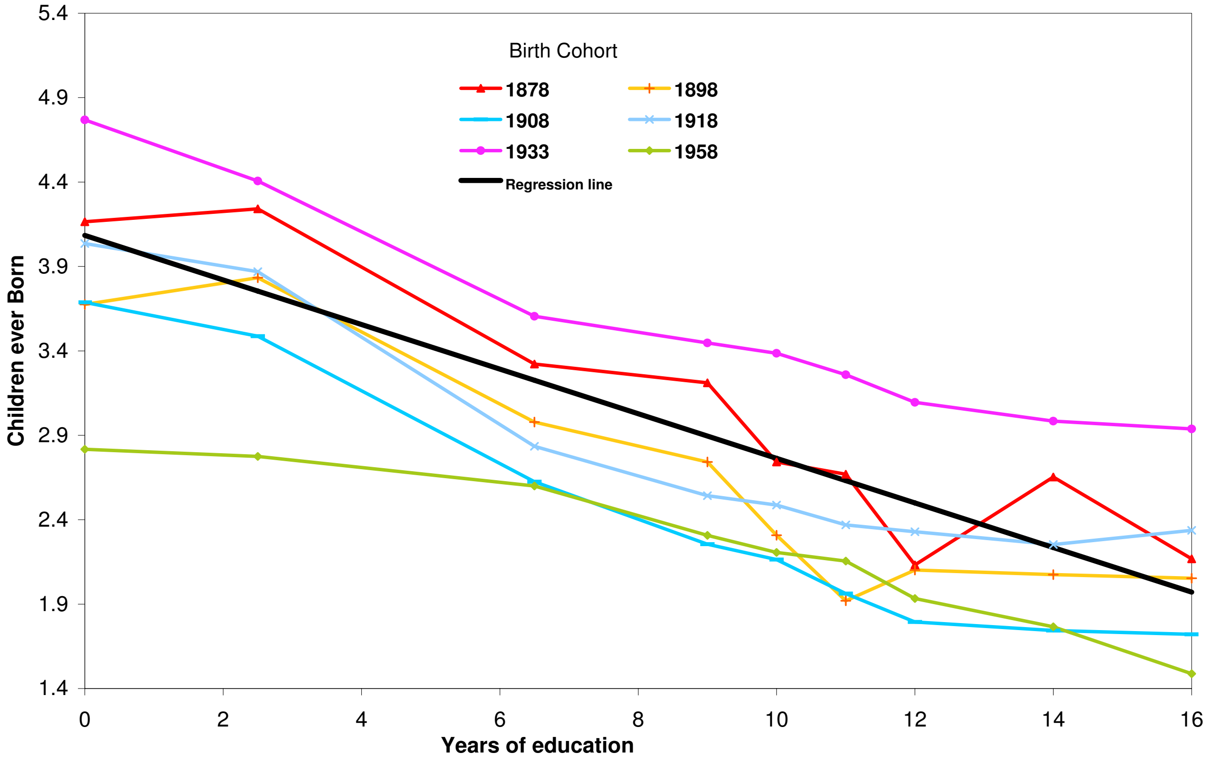
Figure 12: Surviving Children Ever Born





4.2 Education and Fertility

Figure 13: CEB by Education of Husband



Next, we turn to the relationship between fertility and education for those years in which education data is available – the censuses from 1940 to date. Education provides another measure of economic well-being. The advantage of using information on education is that this data is available both for men and women for 100 years of birth cohorts (1868-1958). This allows us to investigate husband's and wife's contribution to the fertility decline separately.

To facilitate comparisons to the previous subsection we first focus on the education of the husband. Figure 13 shows mean CEB by cohort and husband's years of schooling. The figure also includes a fitted line based on data from all cohorts.[41] As with OI, we find a substantial negative relationship between CEB and husband's education throughout the entire time period. As with OI, there has been a considerable increase in the overall level of education over the 100 years (see Table 2). Because of this, we can do the same

[41] As before, this regression is based on the cohort- and education-specific mean CEB as shown in the picture, not on the underlying individual level data.

decomposition we did in the previous section, and ask whether the decline in CEB over time is consistent with a movement along a stable time-invariant relationship between education and fertility, or whether the relationship itself is changing. From the Figure, it is clear that some of each is going on. Clearly, the later cohorts are characterized by both higher education as well as lower CEB. However, for any given number of years of schooling, CEB varies by about 1 child across cohorts. For example, wives of men with 12 years of education born in 1868 had 2.8 children, and this fell to about 1.9 children per woman in the 1958 birth cohort. More generally, we can see a substantial downward shift of the curve during the fertility transition (comparing the 1878 cohort with the the 1908 cohort), followed by an upward shift until the 1933 cohort (baby boom), followed by a sharp collapse for the 1958 cohort.

To better quantify the relationship between education and fertility, and how this has changed over time, we ran the following OLS regression for each cohort, t:

$$CEB_{it} = \beta_{0t} + \beta_{1t} * EdH_{it} + \varepsilon_{it}$$

where each CEB_{it} is the average CEB for women in cohort t with husbands who have i years of schooling. As a measure of how sensitive fertility is to education, we report the slope coefficient in Table 2.

As in the relationship between CEB and OI, we find a substantial compression of fertility across years of education between the 1868 and 1958 cohorts. Note that the coefficient in 1958 is about half the one in 1868. In contrast to the relationship between CEB and OI, however, there is no widening at first. To some extent this is because we have a shorter time series for the education variables.

The one exception to the general rule that higher education is associated with lower fertility within a cohort can be found in the baby boom generations. That is, in both the 1918 and 1928 birth cohorts, wives of college educated men had slightly higher fertility than those of high school educated men. Indeed, even in the birth cohorts from 1878 to 1908, there is very little difference in the fertility behavior of the wives of high school and college educated men. This is consistent with our earlier finding that the relationship between OI and CEB flattens out for high levels of OI.

The baby bust and boom is a phenomenon that affected all schooling levels, as can be seen in Figure A6 in Appendix E. Similarly to our income analysis, we find that the baby bust was most pronounced for wives of little educated husbands while the baby boom was most pronounced for wives of the highly educated husbands. Between the 1868 and the 1908 cohorts, wives of husbands with little education decreased their fertility from 4.8 to

Table 2: Relationship between CEB and Husband's Education

Cohort	Age	β_{1t}	average years of education
1868	72	-0.17	6.51
1873	67	-0.19	6.62
1878	62	-0.14	6.86
1883	57	-0.16	7.05
1888	52	-0.14	7.12
1893	47	-0.15	7.49
1898	42	-0.13	7.78
1903	57	-0.14	8.27
1908	52	-0.14	8.83
1913	47	-0.13	9.35
1918	42	-0.12	9.94
1923	47	-0.12	10.73
1928	42	-0.12	11.05
1933	47	-0.12	11.63
1938	42	-0.15	12.03
1943	47	-0.11	12.87
1948	42	-0.11	13.31
1953	37	-0.09	13.46
1958	32	-0.08	13.31

Note: Cohorts comprise five years each (labelled by the mid-point). The variable Age refers to the age of the woman at the moment the census took place. Source: Authors' calculations based on US Census, several years.

3.5 CPW (a fall of 1.3 CPW) while wives of college-educated husbands decreased fertility from 2.6 to 1.7 CPW (a reducation of 0.9 CPW). Between the 1908 and the 1933 cohort, women married to a husband with little schooling increased CEB from 3.5 to 4.4, while if married to a man with some college, CEB increased from 1.7 to 3.0. It is also interesting that the baby boom was not completely synchronized across education levels. While for most education levels the peak occurred in the 1933 cohort, this is not true for very low levels of education: the highest CEB for wives of men with no schooling was the 1938 cohort and for the 1-4 years of schooling group, this peak was in the 1928 cohort.

In terms of accounting for the overall fertility decline, the fitted linear relationship between CEB and husband's education in years based on the 1868 birth cohort is $CEB = 5.08 - 0.17 * EdH$. Between the 1868 and 1958 birth cohorts, mean education of husbands increased from 6.7 years to 13.2. Based on this, using the regression, we would expect mean CEB to fall by 1.1 CPW. In fact, it fell by 1.9, so that about 60% of the observed change can be accounted for by the increase in mean education of husbands.

In sum then, the CEB/Education data paints a similar picture to that seen with CEB vs. OIS. The relationship is typically downward sloping and significantly so. A large fraction of the time series variation in fertility is consistent with the view that there is a constant (linear), time invariant relationship between fertility and years of schooling and that the observed time patterns of fertility correspond to a movement outward (i.e., an increase in the level of schooling for everyone) along this fixed relationship. There are also significant deviations from this however. It is clear from Figure 13 that there is much more of a downward shift in the curve in CEB vs. Education than there was with income. For example, CEB for women of husbands with eight years of education fell by approximately one CPW over the 100 years we analyze. This quantity is similar at other levels of education as well.[42]

4.2.1 Husbands vs. Wives

We now analyze the joint relationship between fertility and the level of schooling both of the husband and the wife in a married couple. We divided the individual records into a grid of combinations of years of education for wives and husbands. For each combination and each birth cohort, we calculated mean CEB. For these basic observations, we estimated

[42] This masks the possibility that there have been changes in the quality of a year of schooling over the time range studied, a very likely possibility.

relationships of the form:[43]

$$CEB_{it} = \beta_{0t} + \beta_{EdWt} * EdW_{it} + \beta_{EdHt} * EdH_{it} + \beta_{EdW*EdWt} * EdW_{it} * EdH_{it} + \varepsilon_{it}.$$

We included a cross term since, in the data, it is apparent that the higher is a woman's education the less sensitive is her fertility level to her husband's education (and vice versa).

Table 3 summarizes the results of regressions of the mean values of CEB, averaged in a cell, on education of both the husband and wife. In each cohort regression, we see that CEB is declining in both the education level of the wife and the husband, and significantly so.[44] Note that the coefficients of husband's and wife's education are similar in size (the wife's being slightly larger) and that there is no systematic time trend.

To give a sense of the size of these coefficient estimates, take say 1948, in which the coefficient on wife's education is -0.15. This means that, other things equal, the difference in fertility of a couple in which the wife has completed college and one that has only completed high school is about 0.6 children. Because of positive assortative mating, the effect is even larger actually.

Notice that for most birth cohorts the cross term has a positive coefficient. This means that, other things equal, a higher education of the husband implies that the fertility decision is less sensitive to the number of years of education of the wife (and vice versa). Also note that the coefficient sizes are smaller, but that the units are different for this variable since it is years^2. Interestingly, we find a negative cross-term for some of the early cohorts (1868, 1873, 1878, 1888). That is, during this time period, a higher education of the husband implied that fertility was more sensitive to the wife's education.

Temporally, we see that in the period between the baby bust and baby boom, fertility became more sensitive to years of education of both wives and husbands with the individual coefficients increasing from about 0.10 to 0.20. After that, they returned to their earlier levels.

These regression results can be used to carry out an accounting exercise much like those conducted above. Note that mean education of women increases from 6.7 to 13.2 years, while that of their husbands increased from 6.5 to 13.3 from the 1868 to the 1958 birth cohort. Using the regression results from the 1883 birth cohort[45], we would expect

[43]Following the same approach as before, we ran this regression on $9 \times 9 = 81$ "observations", where each observation is average CEB of a combination of husband's and wife's level of schooling.

[44]The two exceptions to this are the 1868 and 1888 birth cohorts, where CEB is declining in the education of the wife, but increasing in the education of the husband.

[45]We use 1883 because this is the first year, where all regression coefficients have the same sign as in all the later periods.

Table 3: Regression Coefficients: CEB on Education

Cohort	Age	β_{EdW}	β_{EdH}	$\beta_{EdH*EdW}$
1868	72	-0.07	0.14	-0.017
1873	67	-0.10	-0.03	-0.007
1878	62	-0.12	-0.05	-0.001
1883	57	-0.14	-0.18	0.008
1888	52	-0.08	0.09	-0.014
1893	47	-0.16	-0.14	0.007
1898	42	-0.12	-0.06	0.0004
1903	57	-0.15	-0.10	0.005
1908	52	-0.17	-0.16	0.010
1913	47	-0.19	-0.21	0.015
1918	42	-0.23	-0.19	0.015
1923	47	-0.20	-0.16	0.012
1928	42	-0.16	-0.14	0.008
1933	47	-0.14	-0.13	0.005
1938	42	-0.14	-0.19	0.008
1943	47	-0.12	-0.09	0.003
1948	42	-0.15	-0.11	0.006
1958	32	-0.11	-0.07	0.003

Note: Cohorts comprise five years each (labelled by the mid-point). The variable Age refers to the age of the woman at the moment the census took place. Source: Authors' calculations based on US Census, several years.

CEB to fall by $6.5 * 0.14 + 6.8 * 0.18 - 132 * 0.08 = 1.08$ CPW over this time period. In fact fertility during this time period fell by 1.9 CPW. In this sense, 57% of the observed decline in fertility can be accounted for by increases in education.

Summarizing, we find that contrary to other studies (e.g. Hotz and Miller (1988), Heckman and Walker (1990) using Swedish data, Fleisher and Rhodes (1979) and Merrigan and St. Pierre (1998) for Canada), the negative relationship between fertility and husband's education is still present when wife's education is also controlled for in the analysis. Each of these has a separate and significant impact on fertility. Moreover, we find a significant and regular 'cross effect' – that increases in education have a lesser effect when the partner is more educated.

5 Other 'Cuts' on the Data on Fertility

In the previous sections we have examined the overall history of fertility in the US over the last 150 years, traced the major events of this history – the Fertility Decline, the Baby Bust of the 1930's, the Baby Boom of the 1950's and the more recent, steady decline in fertility. We have seen that these basic phenomena have occurred, and with similar timing, among all the main subgroups of the US population – Urban, Rural, Farm, Non-Farm, Black, White, Immigrant, Second Generation, Native Born, New Englanders, etc.

We have also documented how these basic events were related to economic variables – occupation and education. What the analysis by income shows is that the uniformity of the overall pattern of decline masks an interesting phenomenon. This is that this decline was not 'even' across the income distribution. Indeed, rather than a slow steady and uniform decline for all income types at the same rate, this decline first occurred among the upper incomes and then, later, and more rapidly for the lower incomes. This difference in timing caused an initial spreading, in levels, of fertility from the top to the bottom, and similarly, a non-monotonicity of estimated income elasticities of demand for children.

In this section, we look into these patterns further and address the following questions. Are elasticities in groups over the entire time period the same as elasticities for everyone over the entire time period? We find that they are not the same, but surprisingly similar. We ask to what extent the observed differences in fertility levels across groups (e.g. by race) are consistent with one overall relationship between fertility and income, but differences across the groups in income. Finally, we investigate whether the overall patterns by income described above – first a widening then a reduction in differences – are present *within* each subgroup.

5.1 Overall CEB vs. Occupational Income for SubGroups

The strong, negative relationship between OI and CEB holds for all cuts on the data described above – urban/rural, farm/non-farm, black/white, immigrant/non-immigrant and by region of the country. We examine this relationship in this section both graphically and through the estimation of income elasticities of demand for children by groups.

We find that the income elasticities for the various groups are surprisingly similar to the overall elasticity of -0.38, ranging from -0.24 to -0.48, see Table 4. Each row in this table describes the result of estimating an income elasticity (i.e., a regression of log(CEB) on log(OI)) for a particular subgroup of the population, using data from the entire sample period covered. Note that this period of coverage (generally the birth cohorts between 1828 and 1958) is different for immigrant status because of data availability. The first two columns of the table give the intercept and slope, respectively from these regressions. The fourth column gives the average CEB for each group and the last column is a measure of how much of the difference in CEB can be accounted for exclusively through income differences.

One of the most surprising results in this table is the uniformity between the urban/rural estimates of slope and intercept. Moreover, these are remarkably close to the overall estimates. The same statement is true for the farm/non-farm cut of the data. These two facts are despite the leading role played in the verbal stories for the Fertility Transition in Demography by both Urbanization and movements off the farm. What it suggests is that the observed differences in *levels* of fertility are largely due to differences in income, with both rural and farm areas having lower levels of income.

To get a better idea about how much of the differences between groups can be explained, in an accounting sense, by income differences across groups, we added a fourth column to the table. Using the actual average CEB of a benchmark group (B) for each cut, the estimated overall elasticity of -0.38, and the actual income gap between a group and this benchmark group, we calculated a predicted CEB for the remaining cuts.[46] The number reported in the table is the fraction of the actual CEB ratio that is explained by the predicted CEB ratio. According to this method, we find that about half of the difference in fertility between urban and rural locations is accounted for by rural areas being poorer. This result is even more striking when comparing farm and non-farm areas, where more than 70 percent of the higher fertility on farms is accounted for by the lower average OI.

[46] Predicted CEB of group G based on benchmark B is calculated as $CEB_G = \left(\frac{OI_G}{OI_B}\right)^{-0.38} CEB_B$.

Table 4: Income Elasticity of CEB by Groups

Group	Intercept	Income Elasticity	OI	CEB	CEB gap explained by income gap**
All	4.82	-0.38	15,050	3.57	
By Location					
Urban	4.42	-0.35	13,263	3.21	B
Rural	4.36	-0.33	17,307	3.94	46%
Farm	4.65	-0.36	10,258	4.28	71%
Non-Farm	4.46	-0.33	16,863	3.30	B
By Race					
Black	5.29	-0.42	11,343	4.52	42%
White	4.71	-0.37	15,339	3.49	B
By Immigration Status*					
Foreign Born*	5.78	-0.48	11,978	4.06	none***
US born, Foreign Parents*	5.05	-0.41	12,640	3.66	80%
US born, US parents*	4.88	-0.39	11,411	3.84	B
By Region					
New England	3.42	-0.24	16,242	3.05	B
East North Central	4.26	-0.32	15,280	3.42	19%
South Atlantic	5.60	-0.45	13,870	3.41	52%
West South Central	5.39	-0.43	13,685	4.25	17%

* Immigration status is available only for the cohorts between 1828 and 1928.

** relative to benchmark (B) category.

*** Foreign born Americans have higher incomes *and* higher fertility than US born, US parents.

The relationship between OI and CEB for whites is very similar to the overall population. This is not surprising, given that whites make up 85-95 percent of the population during this time period. One result that is clear from our estimated relationship between OI and fertility is that the fertility gap between whites and blacks is not just due to income (Table A8 in Appendix B gives the estimated cohort elasticities by race). This is also evident from column 4 in the table, which finds that based on the estimated elasticity, 42% of the one-child difference in CPW between black and whites (i.e. about half a child) is due to income differences.

This finding is also reflected in the table by the differences in the constant terms – 5.29 for blacks vs. 4.71 for whites. To get some idea of the magnitude of this difference, note that it implies that *if* the estimated elasticities for the two races were the same, *then* at every level of income, blacks would have, on average, exp(5.29)/exp(4.71)=1.77 times as many CPW over the sample period. Since the elasticity estimate for blacks is higher in absolute value than that for whites and the average incomes are different in the two groups, this overstates the actual difference however. In fact, since the intercept is larger for blacks and the elasticity is also larger, it follows that, on average, low income blacks have more children than low income whites, but that the reverse is true for high incomes. It is because blacks had lower incomes on average over the period that this is consistent with overall fertility being higher for blacks. (Note that this also depends on the location of mean incomes of the groups relative to the intersection point of the two fitted lines.)

As is the case with race, the differences in intercepts by place of birth, foreign vs. native, reflects the overall higher level of fertility for foreign born compared with native women. Second generation mothers, on the other hand, have on average fewer children than Americans with native parents.[47] Again, this difference in intercepts shows that the difference is not solely due to differences in income. Somewhat surprising is the fact that the demand for children by foreigners is more income sensitive than the other two groups.

The relationship between income and fertility is downward sloping in all of the regions of the country that we study. Conditioning on income, the regional differences are not that large (roughly half a child). Relative to New England, we find that between 17% and 52% of the CEB gap can be accounted for by income differences. On the flip side, this also leaves a lot of room for "regional fixed effects." Note that of all the cuts in the data, the one done by region shows the biggest differences across groups. This is true of both the intercepts, ranging from a high of 5.60 for the South Atlantic region to a low of 3.42 for New England, and for the income elasticities – roughly in line with modern

[47]Starting with the 1928 birth cohorts, this trend has reversed.

levels for the country as a whole (in the -0.2 to -0.3 range) for New England and the East North Central regions and much higher (around -0.4) for both the South Atlantic and West South Central regions. Thus, although both the SA and WSC regions were poorer overall throughout most of the sample period, this income difference alone does not seem to be the source of the fertility differences between North and South, or East and West.

5.2 Compression

As documented in the previous section, there was at first a widening of CEB across income (1828-1898 birth cohorts), then a compression until the 1923 cohort, after which the gap in CEB between the top and bottom half of the income distribution stabilized at about 0.25 CPW. One hypothesis about this compression in fertility is that it is due to compositional effects with respect to some other variate with no conditional compression. For example, it might be that within both the urban and rural populations no compression has occurred, but that a larger and larger fraction of the population is located in lower fertility, urban areas. In principle, changes over time like this could be responsible for both the overall decline in fertility and the observed compression. Other alternatives include the racial make-up of the population, the geographic distribution of the population and the immigrant and non-immigrant fractions. We explore these possibilities in this section. As a rule, we find that this pattern over time across the income distribution also holds within the smaller groups although there is considerably more noise and one or two notable exceptions. Most striking is the fact that in addition to the overall compression in fertility between mean CEBs across groups (as discussed in Section 3), there has also been a compression of CEB across income deciles within most groups. That is, not only has mean fertility of blacks become more similar to that of whites, it is also true that the difference in fertility between the top and bottom income levels for blacks and whites has converged (i.e., the average slope in levels). This is true for all of the other cuts of the data we examined as well. In sum, these different groups are looking more and more alike in their fertility behavior over time, both in terms of the overall averages, and in the way person by person differences in the group vary with income.

Following the analysis in Section 4, we again compute two measures of the sensitivity of fertility to income. First, we compute income elasticities group by group for all cohorts and secondly, we computed the differences in fertility between the top and bottom half of the income distribution for each cohort for each sub-group.

The estimated income elasticities give an overall similar, but much noisier picture, especially in the first half of the time period under consideration. Note that some groups make up only a small fraction of the population (e.g. blacks 15%), which brings down the sample size by a large factor. In some cases, this results in estimated elasticities changing substantially from cohort to cohort.

Since whites constitute between 85% and 95% of the population during this time period, it is not surprising that the estimated elasticities for whites follow closely those of the overall population (see Table A8 in the Appendix). Average CEB of black women also experienced a widening at first followed by a compression. However, the decline in elasticities started later and was slower, so that the stabilization at around -0.20 did not occur until the peak of the baby boom (birth cohort 1933), compared to 1918 for the overall population. Similarly, while the difference in CEB between the bottom and top half had already fallen well below 0.5 for whites by the 1913 cohort, this did not happen until 1928 for blacks.

The time series of our estimated elasticities for the four regions under consideration is also in parallel with the overall trend: first a widening then a compression of CEB by income. What is interesting is that New England, the region with the lowest fertility overall, and the lowest elasticity of CEB across income, also experienced the earliest income compression. Elasticities fell below -0.2 already by the 1908 cohort in that part of the country, while in the overall data this did not occur until the 1928 cohort. West South Central, on the other hand, experienced fertility highly sensitive to income until very recently, and only with the 1958 cohort reached a level of -0.22. Figure A7 in the Appendix shows the compression within regions as measured by the difference in CEB of the bottom to top half of the income distribution. This picture, though noisy, is quite striking. It shows that the size of the top to bottom widening in fertility that occurred in the late 19th century differed greatly by region, and was much larger in the West South Central and South Atlantic regions than it was in the Northeastern part of the country. For example, the gap from top to bottom was around 0.15 children in New England and the East North Central areas in the period between the 1825 and 1845 cohorts, much less than the overall gap of about 0.8 children, and about 0.65 in the South Atlantic and West South Central regions. Between the 1855 and 1900 cohorts, this gap had increased to about 1.35 in the south and west and only to about 0.63 in the north and east. Thus, the change was about 0.7 CPW in the SA and WSC and a bit more than half as much in NE and the ENC regions. As a point of comparison, overall this gap increased to about 1.2 CPW, about the same as in the SA and WSC.[48] By the 1958 birth cohort, the size of

[48]The average gaps between the 1828 and 1843 cohorts were .12 for NE, .23 for the ENC, .54 for the

this gap had converged to about 0.25 CPW in all regions of the country.

Whether women are born in the United States or abroad, or are second generation immigrants, matters a lot for fertility choice, as we have seen in Section 3. As Table 4 shows, the fertility decision of foreign born women is most sensitive to income. This was not always the case, however. We find that the widening of CEB across incomes occurred for foreign born women did not occur until 1868, compared to 1838 for the overall group. The compression, as measured by a decline in the estimated elasticity, had begun among foreign born women by 1883, about 15 years before this occurred with women as a whole. American-born women with native parents, on the other hand, experienced very elastic fertility already as early as 1848, with values ranging between -0.4 and -0.5 between 1848 and 1908, when the compression started very rapidly mirroring the observed overall compression. The experience of second generation Americans lies somewhere in between.

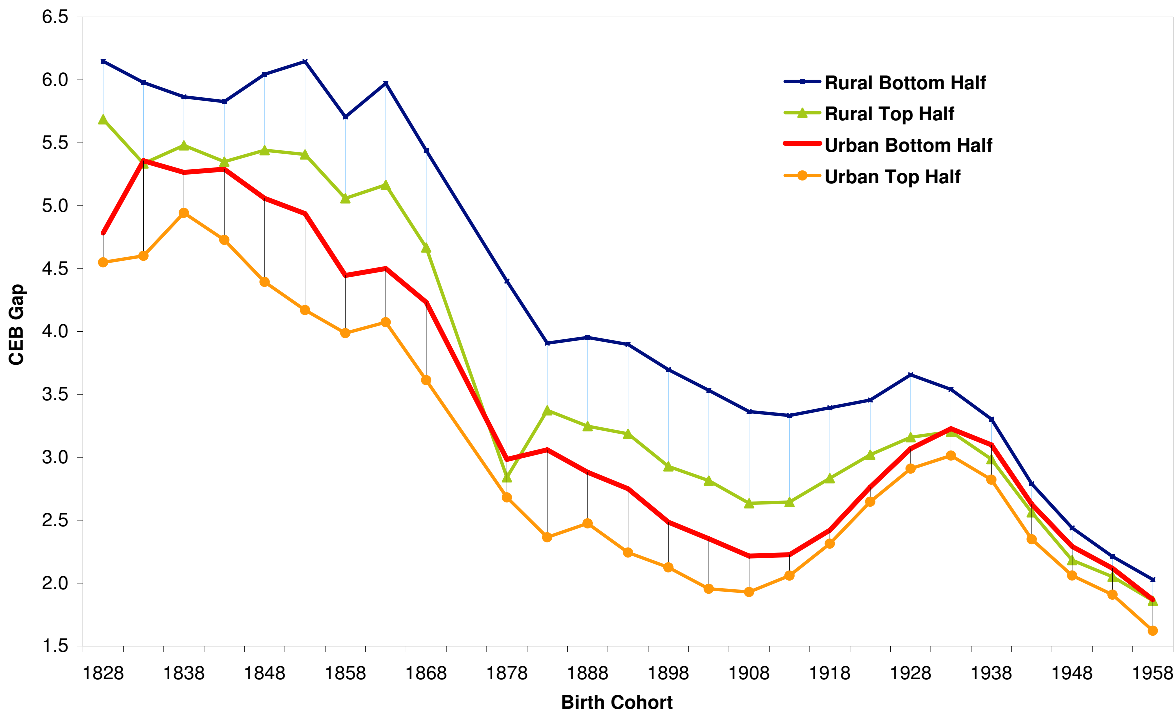
In our analysis of urban vs. rural households, we again find a widening at first and then a compression of CEB across income. However, the compression both for rural and urban households is much milder than the overall compression. The average gap of CEB between the top and bottom half of the income distribution narrowed from 0.7 to 0.4 for rural households and from 0.5 to 0.2 for urban households, compared to an overall decline in the gap from 1 to 0.3. This is even more striking when comparing farm and non-farm households, where until 1913 the top to bottom difference for each group is substantially below the overall top to bottom difference (0.6 for urban, 0.1 for rural and 1.0 overall). These numbers suggest that at least part of the observed pattern, a spreading followed by compression, is due to the movements from rural to urban (resp. farm to non-farm) locations of the population at large.

An interesting observation is that the relative CEB for richer vs. poorer households narrowed substantially between 1883 and 1913 for urban households (from 0.7 to 0.17), but did not compress at all during this time period for rural households (roughly stable around 0.7). This can be seen in Figure 14. These results are also apparent from our elasticity estimates, where we find generally much lower values for urban women between 1908 and 1933 – see Table A8 in Appendix B.

The farm/non-farm cut on the data is one place in which the overall pattern of first a widening of fertility from top to bottom, then a contraction, is not seen. The top to bottom spread among the farm group itself increased monotonically over time. This seems to have more to do with a significant widening of the 'occupation spread' over time than

SA and .74 for the WSC. The averages between the 1863 to 1898 cohorts were .61 for NE and .65 for the ENC, and 1.44 for the SA and 1.25 for the WSC.

Figure 14: CEB gap top and bottom half, urban vs. rural



anything else– viz., early on almost everyone who lived on a farm was a farmer and hence, had the same OI, while now, even though a much smaller fraction of the population reports living on a farm, the range of occupations listed is much wider. This by itself causes the top to bottom differential for households living on farms to increase independent of any other shifts over time.

In sum, we find that women in different parts of the income distribution have become more similar to each other in their fertility behavior for birth cohorts since the turn of the century. We find that this general compression of fertility of women with respect to income holds conditional on many characteristics – race, geography, and whether the women are immigrants or not.

6 Conclusions

In this paper, we have used data from the US Census to document the major fertility patterns in the US for women born between 1826 and 1960 and relate them to measures of economic well-being.

We have found that in each cohort there is a strong negative correlation between fertility level of a woman and a measure of her wealth proxied by husband's occupation, Adjusted Occupational Income. Overall, the wealth elasticity of demand for children is estimated to be -0.38 for the period. We find that much of the difference in fertility experiences (e.g. over time, and between groups such as blacks and whites and between regions) can be accounted for by differences in income alone. However, we also document that a single, simple, isoelastic relationship between wealth and fertility misses some key and, we think, interesting features of the data. Among these are:

1. An increased spread in fertility from top to bottom of the income distribution between the 1828 and 1898 birth cohorts, or, related, an increase in the wealth elasticity of demand for children over this period (in absolute value);

2. A dramatic compression in fertility levels with respect to wealth that took place primarily during the Baby Bust of the 1930's and the Baby Boom of the 1950's;

3. A resulting overall pattern through which the Fertility Transition seems to have begun early and taken place gradually among the upper income families and began later and was much quicker for lower income families;

4. The sensitivity of fertility to income was in place well before married women began participating in the labor market in any significant number;

5. The patterns identified in 1 through 4 above occurred in a widespread fashion, across races, regions of the country, in both urban and rural areas and by place of birth of the mother;

6. Overall, as a result of these facts, modern fertility in the US is compressed – it varies little by income (the estimated elasticity of the last cohorts are lower than they have ever been), by race or by other key demographic factors.

Although these facts are of considerable interest to researchers doing quantitative studies in positive theories of fertility choice, there is still much more that could be done. Throughout, we have focused only on marital fertility, a restriction that has become more and more important in recent years. Although a useful and interesting starting point, our use of occupational income leaves much to be desired. Occupation is only a weak proxy for true economic wealth for a variety of reasons, and even given those short-comings we do not have adequate data to perfectly map the implications for changes over time on the wealth of even an average worker in an occupational class. Moreover, due to the fact that occupation data was not collected for individuals not in the labor force until recently, we were restricted to using only husband's occupation in this study. To do more would have required handling the serious sample selection bias issues that arise when some women work and others don't. These issues are present here too of course, but we think that the findings are of sufficient interest even given these limitations to be useful to researchers.

References

[1] Ahn, Namkee and P. Mira, (1999), "A Note on the Changing Relationship Between Fertility and Female Employment Rates in Developed Countries," *Journal of Population Economics* 15(4), pp. 667-682.

[2] Akmam, Wardatul, (2002), "Women's Education and Fertility Rates in Developing Countries, with Special Reference to Bangladesh," *Eubios Journal of Asian and International Bioethics*, 12, pp. 138-143.

[3] Alter, George, (1992), "Theories of Fertility Decline: A Non-Specialist's Guide to the Current Debate on European Fertility Decline," *The European Experience of Declining Fertility, 1850-1970*, Cambridge, MA: Blackwell, pp. 13-27.

[4] Alvarez, Fernando, (1999), "Social Mobility: The Barro-Becker Children Meet the Laitner-Loury Dynasties," *Review of Economic Dynamics*, 2(1), pp. 65-103.

[5] Anderton, D. L. 1986. "Urbanization, Secularization, and Birth Spacing - a Case-Study of an Historical Fertility Transition." Sociological Quarterly 27:43-62.

[6] Barro, Robert J. and Gary S. Becker, (1989), "Fertility Choice in a Model of Economic Growth," *Econometrica*, 57(2), pp. 481-501.

[7] Barro, Robert J. and Xavier Sala-i-Martin, (1995), *Economic Growth* McGraw-Hill, Inc.

[8] Becker, Gary, (1960), "An Economic Analysis of Fertility, in Demographic and Economic Change in Developed Countries," Conference of the Universities, National Bureau Committee for Economic Research, Princeton University Press, Princeton, pp 209-240.

[9] Becker, Gary S., (1992), "Fertility and the Economy," *Journal of Population Economics*, 5(3), pp. 185-201.

[10] Becker, Gary S. and Robert J. Barro, (1988), "A Reformulation of the Theory of Fertility," *Quarterly Journal of Economics*, 103(1), pp. 1-25.

[11] Becker, Gary S. and H. Gregg Lewis, (1973), "On the Interaction between the Quantity and Quality of Children," *Journal of Political Economy*, 81(2), pp. S279-S288.

[12] Boldrin, Michele B. M. and Larry E. Jones, (2002), "Mortality, Fertility and Saving in Malthusian Economy," *Review of Economic Dynamics*, 5(4), pp. 775-814.

[13] Boldrin, Michele B. M., Mariacristina De Nardi and Larry E. Jones, (2005), "Fertility and Social Security," *NBER Working Paper* No. 11146.

[14] Boldrin, Michele, Jones, Larry E. and Alice Schoonbroodt, (2006), "The Fertility Response to Productivity Fluctuations in the Medium Run," University of Minnesota, mimeo.

[15] Bongaarts, J. and G. Feeney, (1998), "On the Quantum and Tempo of Fertility," *Population and Development Review,* 24, pp. 271-91.

[16] Borg, Mary O. Malley, (1989), "The Income-Fertility Relationship: Effect of the Net Price of a Child," *Demography*, 26(2), pp. 301-310.

[17] Breierova, Lucia and Esther Duflo, (2004), "The Impact of Education on Fertility and Child Mortality: Do Fathers Really Matter Less than Mothers?" *NBER Working Paper*, No. 10513.

[18] Buttet, S. and A. Schoonbroodt, (2005), "Life Cycle Labor Supply, Fertility and Wages of Women born between 1940 and 1960," working paper.

[19] Butz, William P. and Michael P. Ward, (1979), "The Emergence of Countercyclical U.S. Fertility" *American Economic Review*, 69(3), pp. 318-328.

[20] Caldwell, John C., (1979), "Education as a Factor in Mortality Decline: An Examination of Nigerian Data," J. C. Caldwell, *Population Studies*, 33(3), pp. 395-413.

[21] Caldwell, John C., (1982), *A Theory of Fertility Decline*, New York: Academic Press.

[22] Chenais, Jean-Claude, (1992), *The Demographic Transition: Stages, Patterns and Economic Implications; A Longitudinal Study of Sixty-Seven Countries Covering the Period 1720-1984*, Clarendon Press, Oxford University Press, New York.

[23] Cho, Lee-Jay, (1968), "Income and Differentials in Current Fertility," *Demography* 5(1) 198-211.

[24] Clark, Gregory, (2005), "Human Capital, Fertility, and the Industrial Revolution," *Journal of the European Economic Association*, 3 (2-3), pp. 505-515.

[25] Clark, Gregory, (2007), "A Farewell to Alms: A Brief Economic History of the World," Princeton University Press, forthcoming.

[26] Clark, Gregory and Hamilton, Gillian, (2006), "Survival of the Richest: The Malthusian Mechanism in Pre-Industrial England," *Journal of Economic History* 66(3), pp. 707-736.

[27] Cleland, John, (2004), "Education and Future Fertility Trends, with Special Reference to Mid-Transitional Countries" *United Nations Population Bulletin*, forthcoming.

[28] David, Paul A. and Warren C. Sanderson, (1987), "The Emergence of a Two-Child Norm among American Birth-Controllers," *Population and Development Review*, 13(1), pp.1-41.

[29] De la Croix, David and Matthias Doepke, (2003), "Inequality and Growth: Why Differential Fertility Matters," *American Economic Review*, 93(4), pp. 1091-1113.

[30] De Tray, Dennis N., (1973), "Child Quality and the Demand for Children," *Journal of Political Economy*, 81(2), pp. S70-S95.

[31] Docquier, Frederic, (2004), "Income Distribution, Non-Convexities and the Fertility-Income Relationship" *Economica*, 71(282), pp. 261-273.

[32] Doepke, Matthias, (2004), "Accounting for Fertility Decline During the Transition to Growth," *Journal of Economic Growth*, 9(3), pp. 347-383.

[33] Doepke, Mattias, (2005), "Child Mortality and Fertility Decline: Does the Barro-Becker Model Fit the Facts?" *Journal of Population Economics*, 18(2), pp. 337-366.

[34] Easterlin, Richard A., (1966), "On the Relation of Economic Factors to Recent and Projected Fertility Changes," *Demography*, 3(1) pp. 131-153.

[35] Falcao, Bruno L. S. And Rodrigo R. Soares, "The Demographic Transition and the Sexual Division of Labor, " *Working Paper*.

[36] Fernandez-Villaverde, Jesus, (2001), "Was Malthus Right? Economic Growth and Population Dynamics," *Working Paper, University of Pennsylvania.*

[37] Ferrie, Joseph P., (2003), "The Rich and the Dead: Socioeconomic Status and Mortality in the U.S., 1850-60," in Dora Costa (ed.), Health and Labor Force Participation over the Life Cycle: Evidence from the Past (Chicago: University of Chicago Press, 2003).

[38] Fleisher, Belton M. and George Rhodes, (1979), "Fertility, Women's Wage Rates, and Labor Supply," *American Economic Review*, 69(1), pp. 14-24.

[39] Freedman, Deborah S. and Arland Thornton, (1982), "Income and Fertility: The Elusive Relationship," *Demography*, 19(1), pp. 65-78.

[40] Galor, Oded and David N. Weil (1996), "The Gender Gap, Fertility, and Growth," *The American Economic Review*, 86(3), pp. 374-387.

[41] Galor, Oded and David N. Weil (1999), "From Malthusian Stagnation to Modern Growth," *American Economic Review Papers and Proceedings*, 89 (2), pp. 150-154.

[42] Galor, Oded and David N. Weil, (2000), "Population, Technology, and Growth: From Malthusian Stagnation to the Demographic Transition and Beyond," *The American Economic Review* 90(4), 806-828.

[43] Gjerde, J. and A. McCants. 1995. "Fertility, marriage, and culture: Demographic processes among Norwegian immigrants to the rural middle west." Journal of Economic History 55:860-888.

[44] Goldin, Claudia and Lawrence F. Katz, (1999), "The Returns to Skill across the Twentieth Century United States," *NBER Working Paper* no. 7126.

[45] Greenwood, Jeremy and Nezih Guner, (2005), "Social Change," *Economie d'avant garde Research Report No. 9*, University of Rochester, May 2005.

[46] Greenwood, Jeremy and Ananth Seshadri, (2002), "The U.S. Demographic Transition," *American Economic Review*, 92(2), pp. 153-159.

[47] Greenwood, Jeremy, Nezih Guner and John Knowles, (2003), "More on Marriage, Fertility, and the Distribution of Income," *International Economic Review*, 44(3), pp. 827-862.

[48] Greenwood, Jeremy, Ananth Seshadri and Guillaume Vandenbroucke, (2005), "The Baby Boom and Baby Bust," *American Economic Review*, 95(1), pp.183-207.

[49] Greenwood, Jeremy, Ananth Seshadri and Mehmet Yorukoglu, (2005), "Engines of Liberation," *The Review of Economic Studies*, 72(1), pp. 109-133.

[50] Hacker, J. D. 2003. "Rethinking the "early" decline of marital fertility in the United States." Demography 40:605-620.

[51] Haines, M. R. 1978. "Fertility Decline in Industrial America - Analysis of Pennsylvania Anthracite Region, 1850-1900, Using Own Children Methods." Population Studies-a Journal of Demography 32:327-354.

[52] Haines, Michael R., (1976), "Population and Economic Change in Nineteenth Century Eastern Europe: Prussian Upper Silesia, 1840-1913." *The Journal of Economic History*, 36(2), pp. 334-358.

[53] Haines, Michael R., (1979), "Fertility and Occupation: Population Patterns in Industrialization," Academic Press, New York.

[54] Haines, Michael R., (1994), "Estimated Life Tables for the United States, 1850-1900," *NBER Historical Paper* No. 59.

[55] Haines, Michael R., (2000), "The Population of the United States, 1790 to 1920," *The Cambridge Economic History of the United States*, 3, pp. 143-205.

[56] Haines, Michael R. and Samuel H. Preston, (1996), "The Use of the Census to Estimate Childhood Mortality: Comparisons from the 1900 and 1910 United States Census Public Use Samples," *NBER Historical Paper* No. 85.

[57] Hansen, Gary D. and Edward C. Prescott, (2002), "Malthus to Solow," *American Economic Review*, 92(4), pp. 1205-1217.

[58] Heckman, James J. and Walker, James R., (1990), "The Relationship between Wages and the Timing and Spacing of Births: Evidence from Swedish longitudinal Data," *Econometrica*, 58(6), pp. 1411-1441.

[59] Hotz, V. Joseph and Robert A. Miller, (1988), "An Empirical Analysis of Life Cycle Fertility and Female Labor Supply, " *Econometrica*, 56(1), pp. 91-118.

[60] King, Miriam and Steven Ruggles, (1990), "American Immigration, Fertility, and Race Suicide at the Turn of the Century," *Journal of Interdisciplinary History*, XX:3, 347-369.

[61] Livi-Bacci, Massimo (1990), "Population and Nutrition: An Essay on European Demographic History," Cambridge University Press, Cambridge.

[62] Lucas, Robert E., (2002), "The Industrial Revolution: Past and Future," *Lectures on Economic Growth*, pp. 109-188.

[63] Macunovich, Diane J., (1996), "Relative Income and Price of Time: Exploring Their Effects on US Fertility and Female Labor Force Participation," *Population and Development Review*, 22(S), pp. 223-257.

[64] Macunovich, Diane J., (1998), "Fertility and the Easterlin Hypothesis: an Assessment of the Literature," *Journal of Population Economics*, 11(1), pp. 53-111.

[65] Malthus, Thomas J. "An Essay on the Principle of Population," London, 1798.

[66] McKeown, Thomas, (1979), *The Role of Medicine: Dream, Mirage, or Nemesis?*, Princeton University Press, Princeton, NJ.

[67] Merrigan, Philip and Yvan St. Pierre, (1998), "An Econometric and Neoclassical Analysis of the Timing and Spacing of Births in Canada from 1950-1990," *Journal of Population Economics*, 11(1), pp. 29-51.

[68] Mikevska, Maja B. and Paul J. Zak, (2002), "What Accounts for the Emergence of Mathusian Fertility in Transition Economies?" *Working Paper, Claremont University.*

[69] Moffitt, Robert, (1984), "Profiles of Fertility, Labour Supply and Wages of Married Women: A Complete Life-Cycle Model," *The Review of Economic Studies*, 51(2), pp. 263-278.

[70] Notestein, Frank W., (1945), "Population: The Long View," In Schultz, T. W.,(ed.), *Food for the World*, University of Chicago Press, Chicago, IL, pp. 36-69.

[71] Prescott, Edward C., (2002), "Prosperity and Depressions: 2002 Richard T. Ely Lecture," *Minneapolis Federal Reserve Bank Working Paper*, No. 618.

[72] Preston, Samuel H., (1976), "Family Sizes of Women and Family Sizes of Children," *Demography*, 13(1), pp. 105-114.

[73] Rosenzweig, Mark R., (1990), "Population Growth and Human Capital Investment: Theory and Evidence," *Journal of Political Economy*, 98(5), pp. S38-S70.

[74] Ruggles, Steven, Matthew Sobek, Trent Alexander, Catherine A. Fitch, Ronald Goeken, Patricia Kelly Hall, Miriam King, and Chad Ronnander, (2004), *Integrated Public Use Microdata Series: Version 3.0*, Minneapolis: Minnesota Population Center.

[75] Russell, Louise B. (1982), "The Baby Boom Generation and the Economy," the Brookings Institution, Washington, D.C.

[76] Ryder, Norman B., (1969), "The Emergence of a Modern Fertility Pattern: United States 1917-66," pp. 99-123 in *Fertility and Family Planning: A World View*, edited by S.J. Behrman, L. Corsa, Jr., and R. Freedman, Ann Arbor, MI: University of Michigan Press.

[77] Ryder, Norman B., (1980), "Components of Temporal Variations in American Fertility," pp. 15-54 in *Demographic Patterns in Developed Societies*, edited by R.W. Hiorns, London: Taylor and Francis.

[78] Ryder, Norman B., (1986), "Observations on the History of Cohort Fertility in the United States," *Population and Development Review,* 12, pp. 617-43.

[79] Schoen, Robert, (2004), "Timing Effects and the Interpretation of Period Fertility," *Demography*, Volume 41-Number 4, November, 801-819.

[80] Schoonbroodt, Alice, (2003), "Cross-sectional Properties of Female Labor Force Participation: Theory and Data," University of Minnesota, mimeo.

[81] Schultz, Theodore W., (1973), "The Value of Children: An Economic Perspective," *Journal of Political Economy*, 81(2) *New Economic Approaches to Fertility*, pp. S2-S13.

[82] Schultz, T. Paul, (1986), "The Value and Allocation of Time in High-Income Countries: Implications for Fertility," *Population and Development Review*, 12(S), pp. 87-108.

[83] Schultz, T. Paul, (1997), "The Demand for Children in Low-Income Countries," *Handbook of Population and Family Economics*, 1A, pp. 349-430.

[84] Schultz, T. Paul, (1985), "Changing World Prices, Women's Wages, and the Fertility Transition: Sweden, 1860-1910," *The Journal of Political Economy*, 93(6), pp. 1126-1154.

[85] Simon, Julian L., (1969), "The Effect of Income on Fertility," *Population Studies*, 23(3), pp. 327-341.

[86] Simon, Julian L., (1977), *The Economics of Population Growth*, Princeton University Press, Princeton, New Jersey.

[87] Strulik, Holger and Siddiqui Sikandar, (2002), "Tracing the Income Fertility Nexus: Nonparametric Estimates for a Panel of Countries," *Economics Bulletin*, 15(5), pp. 1-9.

[88] Tertilt, Michele, (2005), "Polygyny, Fertility, and Savings," *Journal of Political Economy*, 113(6), pp. 1341-1371.

[89] Tolnay, S. E., S. N. Graham, and A. M. Guest. 1982. "Own-Child Estimates of United-States White Fertility, 1886-99." Historical Methods 15:127-138.

[90] U.S. Census Bureau, (2006), "Estimated Median Age at First Marriage, by Sex: 1890 to the Present," *http://www.census.gov/population/socdemo/hh-fam/ms2.pdf*, Table MS-2, Internet Release: May 25,2006.

[91] Vandenbroucke, Guillaume, (2004), "The American Frontier: A Hundred Years of Western Settlement," University of Rochester, Economie D'Avant Garde Research Report No. 7.

[92] Ward, Michael P. and William P. Butz, (1980), "Completed Fertility and Its Timing," *Journal of Political Economy*, 88(5), pp. 917-940.

[93] Weir, David R., (1995), "Family Income, Mortality, and Fertility on the Eve of the Demographic Transition: A Case Study of Rosny-Sous-Bois," *The Journal of Economic History*, 55(1), pp. 1-26.

[94] Westoff, Charles F., (1954), "Differential Fertility in the United States: 1900 to 1952," *American Sociological Review*, 19(5), pp. 549-561.

[95] Willis, Robert J., (1973), "A New Approach to the Theory of Fertility Behavior," *Journal of Political Economy*, 81(2), pp. S14-S64.

[96] Wrigley, E. A., (1961), *Industrial Growth and Population Change*, Cambridge University Press, Cambridge.

[97] Wrigley, Edward A., (1988), *Continuity, Chance, and Change*, Cambridge University Press, Cambridge.

A Methodology

The data used throughout this paper is based on a 1% public use sample of the U.S. Census data, made available from the Minnesota Population Center at www.ipums.org (Ruggles et al 2004). We are interested in average fertility by cohorts of women. We define a cohort to be five years of birth years. Data on some cohorts is available from multiple censuses. For example, one could get information on the 1900 cohort by looking at 50 year old women in 1950 or 60 year old women in 1960, etc. Our goal was to use women who have already completed their child-bearing years, but are still young enough for selection not to be a big problem. We therefore chose to focus on 40-50 year olds. We supplement this with data from older and sometimes younger women to extend the time series backward and forward when necessary. Similarly, we use different ages to fill in missing cohorts due to the lack of fertility information in the 1920 and 1930 censuses. For any given cohort, we used ages as close as possible to (but older than) 50-60. We used information on 30-40 year old women to extend the time series by two additional cohorts, but these last two data points should be treated with caution, since not all women in this group will have completed their fertility. This methodology led us to the age-census combinations that are summarized in Table A1.

For each cohort, the mean number of children ever born (CEB) was derived by computing the weighted[49] average of CEB for all women in that cohort who are married when answering the census survey. Moreover, we included only women whose husbands have a valid occupational income score.

For some of the variables, we have to deviate from the age/cohort selections described in Table A1 because data is not available for all pairs. The modifications are as follows. Information on urban vs. rural is not available in the 1940 and 1950 census. Thus, all

[49] The weights are provided in the census data and are needed to correct for over-sampling of certain populations in some years.

Table A1: Census Year and Age Group used for Each Cohort

Birth Cohort	Cohort Label	Age	Census Year	CEB
1816-1820	1818	80-84	1900	4.99
1821-1825	1823	75-79	1900	6.07
1826-1830	1828	70-74	1900	5.46
1831-1835	1833	65-69	1900	5.40
1836-1840	1838	60-64	1900	5.50
1841-1845	1843	55-59	1900	5.36
1846-1850	1848	50-54	1900	5.34
1851-1855	1853	45-49	1900	5.27
1856-1860	1858	40-44	1900	4.88
1861-1865	1863	45-49	1910	4.92
1866-1870	1868	40-44	1910	4.48
1871-1875	1873	65-69	1940	3.53
1876-1880	1878	60-64	1940	3.31
1881-1885	1883	55-59	1940	3.25
1886-1890	1888	50-54	1940	3.17
1891-1895	1893	45-49	1940	3.05
1896-1900	1898	40-44	1940	2.83
1901-1905	1903	45-49	1950	2.60
1906-1910	1908	40-44	1950	2.30
1911-1915	1913	45-49	1960	2.41
1916-1920	1918	40-44	1960	2.59
1921-1925	1923	45-49	1970	2.85
1926-1930	1928	40-44	1970	3.11
1931-1935	1933	45-49	1980	3.21
1936-1940	1938	40-44	1980	3.02
1941-1945	1943	45-49	1990	2.56
1946-1950	1948	40-44	1990	2.22
1951-1955	1953	35-39	1990	2.05
1956-1960	1958	30-35	1990	1.81

Note: CEB designates the average number of Children ever Born per woman per cohort. Census year indicates the date on which the census that is used as source for the calculations took place. The age refers to the age of the women when the census took place. Source: Authors' calculations based on US Census, several years.

Table A2: Modifications for urban/rural Sub-Groups

Cohort	Census Year	age
1878	1960	80-84
1883	1960	75-79
1888	1960	70-74
1893	1960	65-69
1898	1960	60-64
1903	1960	55-59
1908	1960	50-54

cohorts that are based on information from these two censuses in the main data need to be derived from a different age/census combination for information on urban/rural fertility. We use instead the 1960 census, and respectively older ages. Moreover, we excluded the 1873 cohort entirely. The modifications we made for the urban/rural Sub-Groups are listed in Table A2.

Information on immigration is not available in the 1980 and 1990 census. Thus, we used only the cohorts between 1828 and 1928 reported in Table A1. We added one additional cohort by looking at 35-39 year old women in the 1970 census, which allows us to include the 1933 cohort, the peak of the baby boom.

Similarly, education data is not available for all years because information on education was collected beginning only with the 1940 census. The 1950 census data has information on education only on one (randomly drawn) person in a household, which means that there is never information on both spouses simultaneously. We therefore had to make some replacements for the 1903 and 1908 cohorts as well. The age/cohort combinations used for the education analysis are listed in Table A3.

For any calculations based on OIS deciles, we always compute the deciles first within each group (i.e. age/cohort or age/cohort/race etc.) and then calculate means of all observations that do not have a missing CEB entry. That is, we make no correction for any bias in answering these questions.

The income elasticities reported are regression coefficients from the following regressions:

$$\log(CEB_{it}) = b_{0t} + b_{1t}\log(OI_{it}) + \epsilon_{it}$$

where each observation it is an average of all women with husbands in the i-th decile of

Table A3: Cohorts for Education Data

cohort	age	census year	cohort	age	census year
1868	72	1940	1918	42	1960
1873	67	1940	1923	47	1970
1878	62	1940	1928	42	1970
1883	57	1940	1933	47	1980
1888	52	1940	1938	42	1980
1893	47	1940	1943	47	1990
1898	42	1940	1948	42	1990
1903	57	1960	1953	37	1990
1908	52	1960	1958	32	1990
1913	47	1960			

the occupational income distribution in year t. We run this regression based on averages rather than individual observations both because this approach allows us to handle the 10-20% of women with zero children and also because OI_{it} is likely to suffer from errors in variables. This methodology seems reasonable given that we are more interested in planned fertility than realized fertility.

B Additional Data

Table A4: CEB by Decile, all Cohorts

Cohort	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
1828	5.42	6.22	6.22	6.22	6.22	5.89	5.88	4.96	4.77	4.07
1833	6.20	5.83	5.83	5.83	5.83	5.63	5.09	4.70	5.03	4.51
1838	5.57	5.94	5.94	5.94	5.94	5.46	5.49	4.93	5.18	4.57
1843	5.72	5.79	5.79	5.79	5.73	5.51	5.12	5.29	4.85	4.32
1848	5.72	6.12	6.12	6.12	5.83	5.36	4.80	4.81	4.55	4.12
1853	6.07	6.12	6.12	6.12	5.50	5.15	4.99	4.87	4.35	3.71
1858	5.69	5.69	5.69	5.69	4.84	4.51	4.61	4.59	4.01	3.69
1863	5.66	5.97	5.97	5.93	5.22	4.29	4.39	4.35	4.10	3.78
1868	5.19	5.47	5.47	4.92	4.61	4.20	4.11	4.00	3.56	3.44
1873	3.96	4.20	4.20	3.76	3.45	3.13	3.26	2.73	2.84	2.61
1878	3.84	4.13	4.13	3.62	3.17	3.12	2.83	2.77	2.42	2.45
1883	4.20	4.18	3.93	3.62	3.17	2.81	2.72	2.51	2.61	2.41
1888	3.99	4.04	3.51	3.80	3.03	2.88	2.90	2.54	2.49	2.32
1893	3.95	3.99	3.38	3.26	2.98	2.89	2.81	2.43	2.47	2.32
1898	3.76	4.07	3.12	2.83	2.66	2.57	2.53	2.43	2.22	2.04
1903	3.52	3.14	2.78	2.64	2.46	2.41	2.55	2.28	2.12	1.96
1908	3.14	2.72	2.46	2.37	2.25	2.25	2.23	2.04	1.77	1.79
1913	3.27	2.68	2.46	2.36	2.36	2.38	2.33	2.13	2.04	2.05
1918	3.28	2.83	2.64	2.56	2.51	2.57	2.48	2.37	2.33	2.36
1923	3.30	3.01	2.98	2.73	2.83	2.88	2.70	2.66	2.67	2.72
1928	3.54	3.33	3.21	3.04	3.12	3.11	3.02	2.91	2.89	2.92
1933	3.49	3.41	3.22	3.31	3.20	3.21	3.10	3.07	2.98	2.97
1938	3.35	3.24	3.02	3.18	3.04	3.02	2.89	2.88	2.77	2.73
1943	2.89	2.76	2.56	2.65	2.57	2.53	2.41	2.37	2.37	2.35
1948	2.48	2.46	2.23	2.28	2.29	2.12	2.14	2.07	2.06	2.05
1953	2.27	2.20	2.05	2.12	2.08	2.02	1.98	1.94	1.91	1.89
1958	2.03	1.99	1.86	1.87	1.83	1.78	1.74	1.66	1.67	1.58

Note: Each cohort groups five years, and its label is the mid-point (See Table 4). D1 ... D10 refers to deciles which are calculated based on Occupational Income as defined in Section 4.1. Source: Authors' calculations based on US Census, several years.

Table A5: Income Elasticities of CEB by Birth Cohorts

Cohort	CEB	OI	Elasticity
1828	5.59	4154	-0.33
1833	5.45	4587	-0.24
1838	5.49	5064	-0.20
1843	5.39	5591	-0.22
1848	5.36	6173	-0.32
1853	5.30	6816	-0.38
1858	4.90	7525	-0.35
1863	4.97	8308	-0.35
1868	4.50	9173	-0.34
1873	3.41	10128	-0.37
1878	3.25	11182	-0.42
1883	3.22	12346	-0.47
1888	3.15	13631	-0.45
1893	3.05	15050	-0.44
1898	2.82	16616	-0.50
1903	2.59	18345	-0.41
1908	2.30	20255	-0.42
1913	2.41	22363	-0.35
1918	2.59	24690	-0.25
1923	2.85	27260	-0.17
1928	3.11	30097	-0.17
1933	3.20	33230	-0.16
1938	3.01	36688	-0.19
1943	2.54	40507	-0.21
1948	2.22	44723	-0.20
1953	2.05	49378	-0.17
1958	1.80	54517	-0.22

Note: CEB indicates average Children ever Born and OI is average Occupational Income per cohort. Cohorts comprise five years each (labelled by the mid-point), and the construction of the variable OI is described in Section 4.1. The income elasticity is estimated with a log-log regression of CEB on OI where each observation corresponds to the average CEB and OI of an income decile within the cohort. Source: Authors' calculations based on US Census, several years.

Table A6: Average CEB by Cohorts and Sub-Groups

coh.	all	R	U	W	B	NE	ENC	SA	WSC	NAT	FP	FB	NF	F
1828	5.59	5.92	4.67	5.46	7.12	3.44	5.22	6.46	6.46	5.49	7.24	5.67	4.97	6.09
1833	5.45	5.66	4.98	5.24	7.93	4.21	5.42	6.21	6.79	5.30	5.64	5.72	5.11	5.79
1838	5.49	5.67	5.10	5.36	7.02	4.29	5.45	6.02	6.64	5.34	5.05	5.93	5.07	5.92
1843	5.39	5.59	5.01	5.29	6.64	3.95	5.19	6.07	6.42	5.17	4.87	6.09	5.00	5.81
1848	5.36	5.74	4.73	5.18	7.25	3.66	5.12	6.56	6.82	5.25	4.98	5.75	4.82	6.03
1853	5.30	5.78	4.55	5.14	6.93	4.06	4.89	6.27	6.98	5.21	4.87	5.80	4.70	6.10
1858	4.90	5.38	4.22	4.76	6.50	3.83	4.45	6.16	6.17	4.81	4.55	5.45	4.38	5.68
1863	4.97	5.57	4.29	4.80	6.62	4.06	4.44	6.29	6.61	4.92	4.30	5.62	4.41	5.97
1868	4.50	5.05	3.92	4.37	5.91	3.81	4.05	5.60	5.96	4.48	3.91	5.02	4.07	5.39
1873	3.41	–	–	3.29	5.41	3.27	2.69	4.50	4.54	3.38	3.23	3.94	3.02	4.19
1878	3.25	3.62	2.83	3.21	3.93	2.79	2.99	4.28	4.25	3.21	3.07	3.64	2.82	4.19
1883	3.22	3.64	2.71	3.15	4.21	2.88	2.78	4.01	4.23	3.27	2.65	3.66	2.85	4.16
1888	3.15	3.60	2.68	3.11	3.73	3.05	2.97	3.68	3.86	3.12	2.93	3.53	2.81	4.12
1893	3.05	3.54	2.50	3.01	3.49	2.86	2.89	3.58	3.48	3.02	2.79	3.42	2.76	3.99
1898	2.82	3.31	2.30	2.78	3.21	2.61	2.72	3.33	3.17	2.93	2.55	2.80	2.48	4.04
1903	2.59	3.17	2.15	2.56	2.87	2.49	2.48	2.97	2.82	2.69	2.40	2.44	2.35	3.73
1908	2.30	3.00	2.07	2.26	2.78	2.11	2.25	2.60	2.43	2.40	2.09	2.19	2.12	3.36
1913	2.41	2.99	2.14	2.36	2.92	2.30	2.37	2.57	2.62	2.50	2.18	2.24	2.31	3.23
1918	2.59	3.11	2.37	2.55	3.04	2.43	2.59	2.71	2.82	2.68	2.38	2.38	2.51	3.41
1923	2.85	3.24	2.71	2.80	3.43	2.85	2.90	2.81	2.96	2.92	2.68	2.57	2.81	3.45
1928	3.11	3.41	2.99	3.04	3.86	3.10	3.19	3.04	3.26	3.17	3.00	2.77	3.08	3.67
1933	3.20	3.37	3.12	3.14	3.92	3.25	3.36	3.01	3.27	3.20	3.08	2.78	3.18	3.55
1938	3.01	3.14	2.96	2.96	3.61	2.99	3.11	2.84	3.17	–	–	–	3.00	3.29
1943	2.54	2.68	2.49	2.52	2.86	2.48	2.61	2.40	2.65	–	–	–	2.53	2.94
1948	2.22	2.31	2.18	2.19	2.54	2.11	2.29	2.10	2.33	–	–	–	2.21	2.57
1953	2.05	2.13	2.01	2.03	2.28	1.89	2.11	1.91	2.18	–	–	–	2.04	2.45
1958	1.80	1.94	1.75	1.79	1.97	1.65	1.87	1.67	1.90	–	–	–	1.79	2.33

Note: Cohorts comprise five years each (labelled by the mid-point). CEB=Children ever born, R=Rural, U=Urban, W=White, B=Black, NE=New England, ENC=East North Central, SA=South Atlantic, WSC=West South Central, NAT=U.S. born, U.S. parents, FP=U.S. born, foreign parents, FB=Foreign born, NF=Non-Farm, F=Farm. Source: Authors' calculations based on US Census, several years.

Table A7: Fertility Gap between Bottom and Top Half of the Income Distribution by Cohorts and Sub-Groups

Coh.	all	R	U	W	B	NE	ENC	SA	WSC	NAT	FP	FB	NF	F
1828	0.95	0.46	0.23	0.87	0.86	-0.09	0.19	0.33	0.59	1.16	-1.39	0.57	1.26	-0.08
1833	0.91	0.64	0.76	0.71	1.06	0.75	0.29	1.32	0.64	1.26	0.14	0.48	0.69	0.13
1838	0.74	0.39	0.32	0.62	-0.12	0.00	-0.21	0.13	1.18	0.80	1.03	0.29	0.38	0.08
1843	0.74	0.48	0.56	0.64	0.78	0.27	0.20	0.39	0.52	0.94	-0.43	0.81	0.56	0.00
1848	1.26	0.60	0.66	1.07	1.01	0.89	0.60	0.89	1.24	1.57	0.89	0.50	0.67	0.15
1853	1.37	0.74	0.77	1.22	1.51	0.66	0.70	1.70	0.99	1.81	0.67	0.83	0.82	0.14
1858	1.24	0.65	0.46	1.10	1.55	0.00	0.77	1.24	1.05	1.68	0.63	0.51	0.59	0.05
1863	1.57	0.81	0.43	1.24	1.88	0.40	0.94	1.59	1.88	1.95	0.67	0.64	0.56	0.22
1868	1.27	0.77	0.62	1.11	1.31	0.55	0.77	1.27	1.73	1.76	0.95	0.43	0.75	0.13
1873	1.00	–	–	0.82	0.46	0.52	0.35	1.88	0.24	1.34	0.47	0.83	0.60	0.01
1878	1.06	1.56	0.30	0.98	1.15	0.70	0.55	1.63	0.97	1.39	0.63	1.00	0.56	0.00
1883	1.21	0.53	0.70	1.11	2.04	1.25	0.74	1.57	1.51	1.23	0.98	1.37	0.71	0.09
1888	1.05	0.71	0.41	0.99	1.28	0.97	0.91	0.96	1.11	1.16	0.99	0.85	0.64	0.11
1893	0.93	0.71	0.51	0.87	1.79	0.54	0.45	1.18	1.46	0.98	0.63	0.87	0.56	0.25
1898	0.93	0.77	0.36	0.90	0.46	-0.02	0.53	1.42	1.07	1.05	0.60	0.61	0.42	0.14
1903	0.64	0.72	0.40	0.61	1.01	0.41	0.28	0.98	0.91	0.71	0.41	0.47	0.32	0.18
1908	0.57	0.73	0.29	0.54	0.49	0.00	0.51	0.83	0.71	0.63	0.39	0.44	0.33	0.09
1913	0.44	0.69	0.17	0.39	0.62	0.14	0.24	0.68	0.71	0.51	0.22	0.43	0.30	0.34
1918	0.34	0.56	0.11	0.28	0.71	-0.03	0.14	0.59	0.72	0.41	0.14	0.19	0.21	0.30
1923	0.24	0.43	0.12	0.18	0.48	0.04	0.11	0.52	0.49	0.31	0.02	0.20	0.21	0.13
1928	0.27	0.50	0.16	0.19	0.27	0.01	0.17	0.45	0.66	0.32	0.12	0.29	0.25	0.24
1933	0.26	0.34	0.21	0.18	0.47	0.11	0.20	0.33	0.46	0.29	0.18	0.36	0.24	0.23
1938	0.31	0.32	0.28	0.26	0.29	0.23	0.20	0.37	0.45	–	–	–	0.30	0.42
1943	0.28	0.23	0.28	0.27	0.36	0.09	0.17	0.27	0.45	–	–	–	0.28	0.10
1948	0.26	0.26	0.23	0.23	0.41	0.11	0.19	0.24	0.38	–	–	–	0.26	0.24
1953	0.20	0.16	0.21	0.19	0.15	0.11	0.11	0.17	0.30	–	–	–	0.19	0.47
1958	0.23	0.17	0.25	0.21	0.24	0.22	0.15	0.24	0.22	–	–	–	0.23	0.19

Note: The fertility gap is calculated as the difference in average Children ever Born (CEB) between the bottom and top half of the income distribution, where income is measured according to Occupational Income (OI) as described in Section 4.1. Cohorts comprise five years each (labelled by the mid-point). R=Rural, U=Urban, W=White, B=Black, NE=New England, ENC=East North Central, SA=South Atlantic, WSC=West South Central, NAT=U.S. born, U.S. parents, FP= U.S. born, foreign parents, FB=Foreign born, NF=Non-Farm, F=Farm. Source: Authors' calculations based on US Census, several years.

Table A8: Income Elasticities by Birth Cohort and Sub-Groups

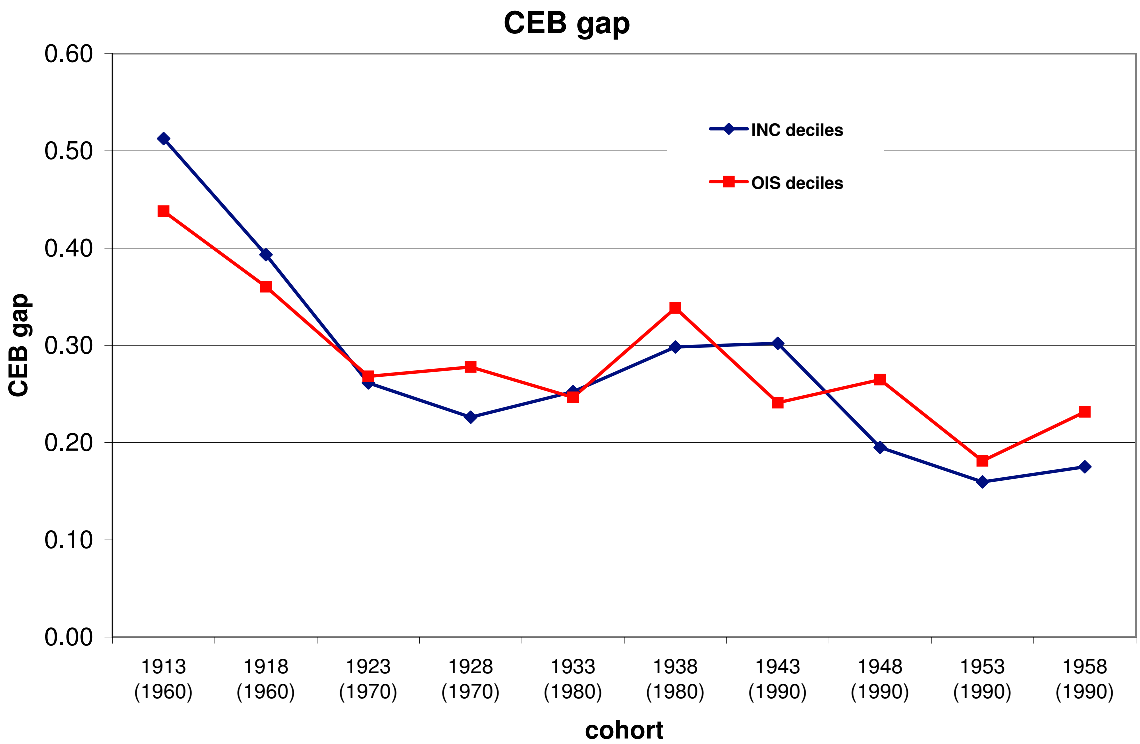
coh.	all	R	U	W	B	NE	ENC	SA	WSC	NAT	FP	FB	NF	F
1828	-0.33	-0.24	-0.07	-0.29	-0.17	0.51	-0.15	-0.20	-0.27	-0.41	-0.08	-0.21	-0.31	0.06
1833	-0.24	-0.21	-0.22	-0.19	-0.42	-0.20	-0.09	-0.53	-0.36	-0.37	0.08	-0.13	-0.25	-0.20
1838	-0.20	-0.20	-0.11	-0.16	0.11	-0.08	0.02	-0.11	-0.39	-0.26	-0.22	-0.10	-0.05	-0.13
1843	-0.22	-0.21	-0.22	-0.20	-0.23	-0.05	-0.07	-0.11	-0.09	-0.25	-0.12	-0.21	-0.21	0.01
1848	-0.32	-0.29	-0.30	-0.28	-0.29	-0.28	-0.16	-0.33	-0.43	-0.46	-0.19	-0.15	-0.23	-0.31
1853	-0.38	-0.31	-0.35	-0.34	-0.42	-0.15	-0.24	-0.59	-0.31	-0.50	-0.27	-0.23	-0.31	-0.21
1858	-0.35	-0.26	-0.28	-0.32	-0.39	-0.23	-0.24	-0.30	-0.26	-0.44	-0.26	-0.20	-0.25	-0.09
1863	-0.35	-0.33	-0.21	-0.30	-0.52	-0.09	-0.23	-0.37	-0.46	-0.49	-0.26	-0.18	-0.20	-0.28
1868	-0.34	-0.27	-0.31	-0.33	-0.32	-0.15	-0.26	-0.27	-0.42	-0.43	-0.34	-0.16	-0.28	-0.28
1873	-0.37	–	–	-0.33	-0.27	-0.18	-0.17	-0.52	-0.01	-0.42	-0.35	-0.30	-0.32	-0.02
1878	-0.42	-0.46	-0.30	-0.42	-0.52	-0.47	-0.30	-0.54	-0.29	-0.50	-0.28	-0.40	-0.30	-0.02
1883	-0.47	-0.20	-0.44	-0.44	-0.75	-0.75	-0.37	-0.47	-0.44	-0.46	-0.51	-0.50	-0.40	-0.04
1888	-0.45	-0.31	-0.30	-0.44	-0.46	-0.54	-0.43	-0.48	-0.37	-0.49	-0.49	-0.36	-0.38	-0.12
1893	-0.44	-0.29	-0.35	-0.43	-0.63	-0.19	-0.28	-0.54	-0.53	-0.46	-0.39	-0.38	-0.35	-0.21
1898	-0.50	-0.34	-0.33	-0.50	-0.23	-0.10	-0.38	-0.64	-0.39	-0.50	-0.48	-0.44	-0.32	-0.17
1903	-0.41	-0.33	-0.36	-0.41	-0.47	-0.37	-0.30	-0.52	-0.40	-0.42	-0.35	-0.34	-0.27	-0.06
1908	-0.42	-0.37	-0.30	-0.42	-0.29	-0.12	-0.38	-0.48	-0.41	-0.42	-0.37	-0.31	-0.30	-0.11
1913	-0.35	-0.34	-0.17	-0.32	-0.44	-0.16	-0.27	-0.44	-0.44	-0.37	-0.22	-0.31	-0.28	-0.25
1918	-0.25	-0.27	-0.10	-0.22	-0.42	-0.02	-0.15	-0.33	-0.36	-0.27	-0.17	-0.17	-0.18	-0.20
1923	-0.17	-0.23	-0.09	-0.14	-0.32	-0.05	-0.10	-0.30	-0.25	-0.20	-0.05	-0.15	-0.16	-0.11
1928	-0.17	-0.24	-0.11	-0.13	-0.33	-0.02	-0.13	-0.24	-0.32	-0.19	-0.10	-0.22	-0.16	-0.11
1933	-0.16	-0.18	-0.14	-0.12	-0.23	-0.06	-0.12	-0.21	-0.25	-0.16	-0.13	-0.16	-0.15	-0.10
1938	-0.19	-0.18	-0.17	-0.17	-0.20	-0.15	-0.13	-0.22	-0.27	–	–	–	-0.19	-0.16
1943	-0.21	-0.17	-0.21	-0.19	-0.27	-0.12	-0.15	-0.20	-0.31	–	–	–	-0.21	-0.05
1948	-0.20	-0.20	-0.19	-0.18	-0.28	-0.11	-0.15	-0.19	-0.29	–	–	–	-0.20	-0.13
1953	-0.17	-0.17	-0.17	-0.16	-0.16	-0.09	-0.11	-0.14	-0.25	–	–	–	-0.16	-0.24
1958	-0.22	-0.18	-0.22	-0.21	-0.25	-0.22	-0.16	-0.23	-0.22	–	–	–	-0.22	-0.11

Note: Cohorts comprise five years each (labeled by the mid-point). The income elasticity is estimated with a log-log regression of Children ever Born (CEB) on Occupational Income (OI) where each observation corresponds to the average CEB and OI of an income decile within the cohort. R=Rural, U=Urban, W=White, B=Black, NE=New England, ENC=East North Central, SA=South Atlantic, WSC=West South Central, NAT=U.S. born, U.S. parents, FP=U.S. born, foreign parents, FB=Foreign born, NF=Non-Farm, F=Farm. Source: Authors' calculations based on US Census, several years.

C Robustness

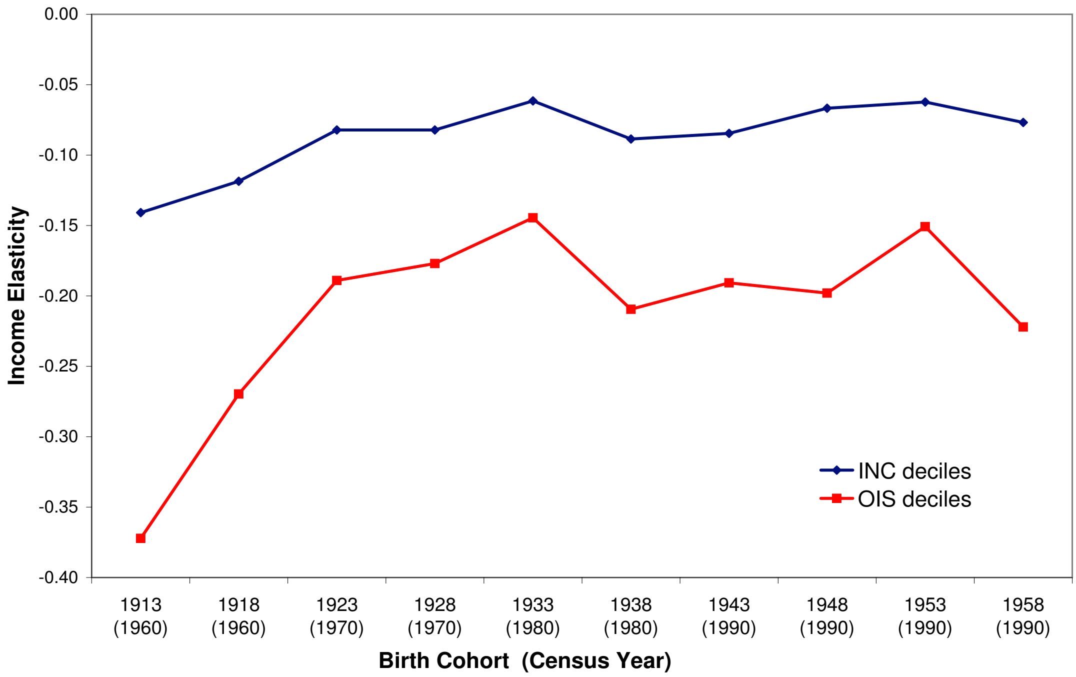
Actual income data is available from the 1960, 1970, 1980, and 1990 censuses. Using the same age-cohort pairs as in the paper, this allows us to construct CEB estimates by income deciles for the all cohorts between 1913-1958. In line with our previous analysis, we use information on husband's income only. We employ the variable INCTOT, which reports each respondent's total pre-tax personal income or losses from all sources for the previous year. Using current income as an alternative measure of life-time income, we recompute the fertility gap between the top and bottom halves of the income distribution and re-estimate the income elasticity of fertility. Figures 15 and 16 compare the new estimates with the original ones.

Figure 15: CEB gap top vs. bottom of income distribution, OI vs. Income



As the figures show, the fertility gap between top and bottom halves of the actual income distribution fell be an even larger amount between the 1913 and the 1958 cohorts than the gap as measured by our constructed occupational income. The gap as measured by current income is a fall of 65% compared to a 50% fall when income is approximated by OI. Similarly, our estimated income elasticities fall by a large amount from the 1913 to

Figure 16: Income Elasticity of Fertility, OI vs. Income



the 1958 cohorts, both when life-time income is proxied by current income (fall of 47%) and when OI is used as a proxy (fall of 22%).

One thing to note based on Figure 10 is that although the overall pattern of reduced elasticity is the same in both measures, the elasticities when estimated using current income are systematically lower. This is somewhat troubling and warrants both further discussion and further exploration. There are several possible reasons for this finding:

First, there are errors in variables problems in using one year of income data. That is, what most economic models would say that fertility depends on is the present value of the entire stream of incomes over the lifetime. Since incomes do vary year to year, using any one entry from this sequence will be an imperfect measure of true economic wealth – it proxies for wealth with error. As is well known, this will bias coefficient estimates toward zero. OIS suffers from similar problems, but is, perhaps, more immune.

A second, related problem is that income changes systematically over the life cycle, first rising and then falling after reaching a peak at around age 55. Moreover, this pattern is systematically related to the type of occupation one is in – high paying occupations have steeper life cycle profiles, low paying ones are flatter.[50] Because of this, and because

[50]See Buttet and Schoonbroodt (2005), Figure 34, for evidence on this.

we are only using data on women who are at least 40 (and their husbands are likely even older) the one year of income that we use is near the peak of their life cycle earnings. While this is a good proxy for true wealth for individuals with flat profiles (i.e., low income earners) it is upward biased for individuals with steep profiles (i.e., high income earners). This will also cause the estimates based on current income to be biased down.

These points do not resolve the issue, and it is possible that the estimates based on occupation are too high. This is clearly an area where more work would be fruitful.

D Definitions of Fertility Measures

Demographers use a variety of different measures to summarize the fertility behavior of a population over time. The most popular measures are the Crude Birth Rate (CBR) and the Total Fertility Rate (TFR) which is sometimes also known as Period Total Fertility Rate. These are both point in time estimates of average fertility in a population in that they are calculated for a given year using only data on fertility from that year.

The CBR is simply the number of children born in a year divided by the number of women in the population. This measure is useful for studying overall population dynamics but can be misleading as a measure of fertility. For example, CBR could be low in a given year either because women of child bearing ages are choosing to have a small number of children or because there are many women in the population who have already completed their fertility.

TFR attempts to correct for some of these weaknesses by correcting for the age distribution dependence of CBR. It does this by constructing age dependent fertility rates at a point in time and then summing them over ages. In this way, if, for example, there is an unusually large number of women in the population that are not of child bearing age TFR is unaffected. Formally, let $f_{a,t}$ be the number of children born to women of age a in period t divided by the number of women of age a in period t. Then TFR_t is defined as:[51] $TFR_t = \sum_{a=15}^{a=49} f_{a,t}$.

Note that since this measure uses data from different birth cohorts at a given point in time (i.e., it mixes cohorts) it will be a misleading measure of actual fertility choices in periods when fertility is changing from cohort to cohort. Examples include the Fertility Transition, the Baby Busts and the Baby Boom. If fertility choices are stable across time, however, TFR gives an accurate measure of the number of children a typical woman will

[51]Typically these age specific fertility rates are constructed for bands of ages of width 5 years and then summed. The limits of the sum, $a = 15$ to $a = 49$, are the ones usually used.

have over her life.

An alternative that is not used often is the Cohort Total Fertility Rate, defined as:

$$CTFR_t = \sum_{a=15}^{a=49} f_{a,t+a}.$$

This would be a measure of the lifetime fertility experience of the average woman born in period t (i.e., in the t-th birth cohort). Cohort TFR's are favored by some Demographers (see Ryder (1969, 1980 and 1986)) for analyzing fertility, but we do not know of any source that has constructed any long time series of CTFR for the US. The difficulty is that the census tracks only living people, not actual births, so that in periods in which infant and child mortality is significant many births never get counted. Unfortunately, actual Births and Deaths were not recorded in much of the US until the 1930's.

Other measures of fertility have also been proposed to try and adjust TFR for the fact that it tracks only a synthetic cohort. These include TFR* (see Bongaarts and Feeney (1998)) and Average Cohort Fertility (ACF) (see Schoen (2004)).

Completed Fertility (CF) is the number of children that a woman has had when she is done having children, and, as such, is the measure that is closest to what most economists have in mind when writing models of fertility choice. One difficulty is that one can never be completely sure that a woman has completed her fertility, so that age must be used as a proxy for this. This points to using as high an age as possible, but, if the assumed completion age is too high a substantial number of women will have died. If age at death is correlated with fertility choice, this introduces a bias.

The measure that we use, Children Ever Born (CEB), is most closely related to CF in that it is a self reported measure of CF for those women surveyed. Thus, it suffers from the same imperfections that CF does, but is available for a long period and can be checked for robustness to the choice of completion age by examining its value for the same birth cohort with data from different censuses.

Another issue that arises is the treatment of women that die during child-bearing years either from childbirth itself, or from other causes. These women will not be counted in a measure like CF or CEB, but would be in TFR or CTFR, at least for part of their reproductive lives. Whether or not this is an important shortcoming is likely to depend on what one is trying to model in the first place. That is, is the goal to try and model the expected number of children, or the expected number of children conditional on survival to completion of fertility? If it is the latter, then CF (and CEB) will provide unbiased estimates of this concept (subject to the proviso about death rates being uncorrelated with fertility choice).

E Additional Figures

Figure A1: CEB based on different Censuses

(numbers indicate age of women when answering survey)

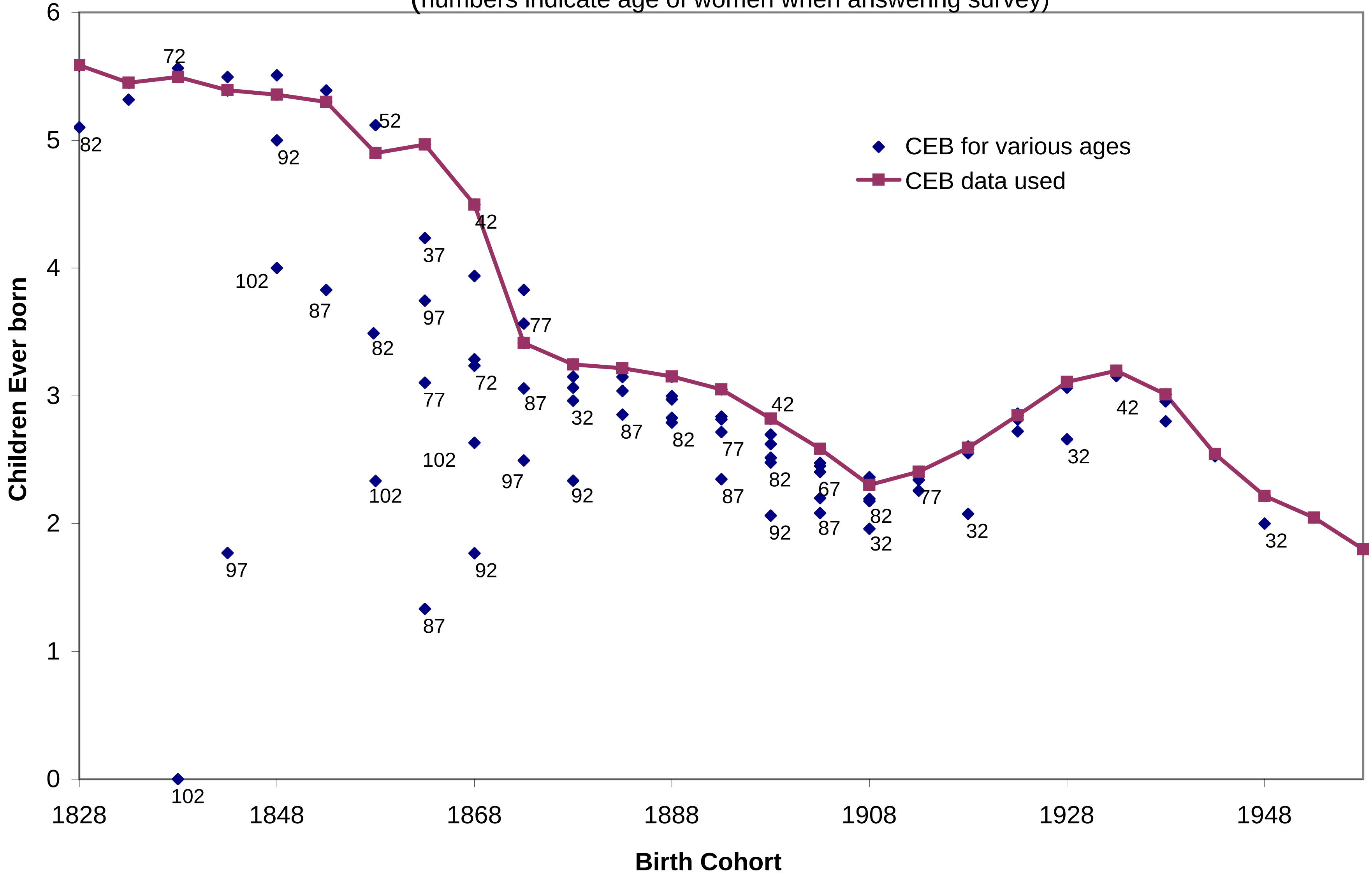


Figure A2: Distribution of CEB over Time

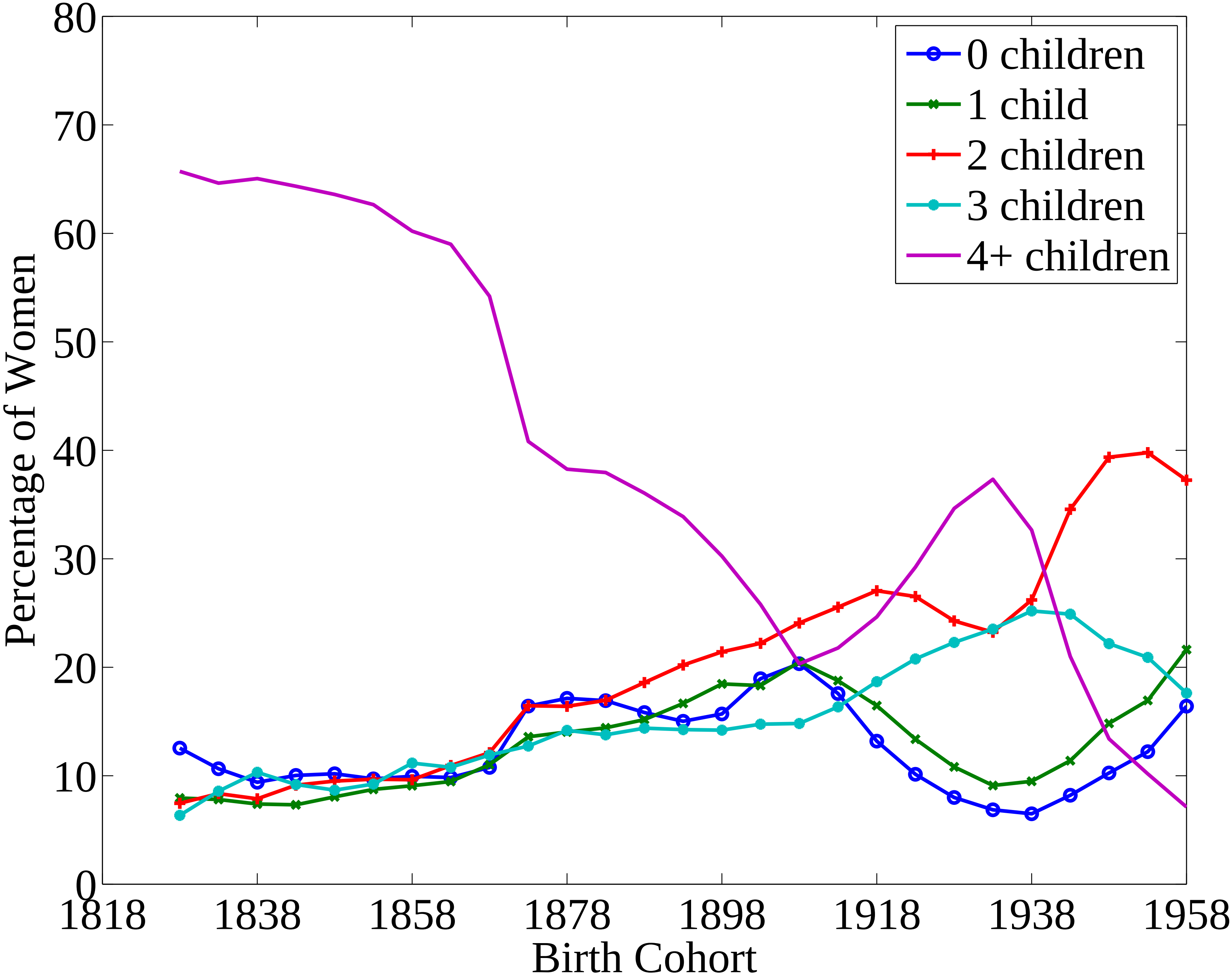
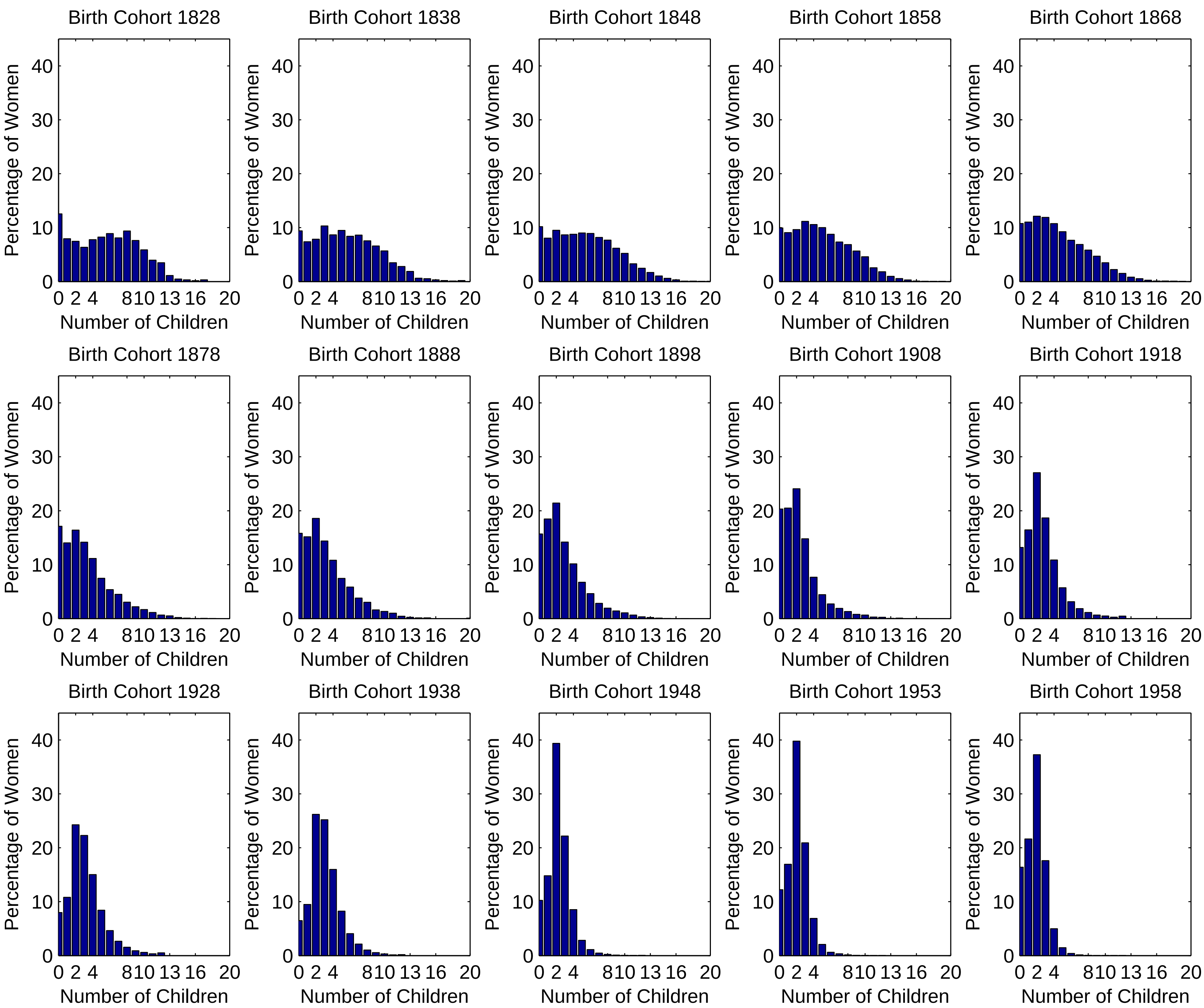


Figure A3


Birth Cohort 1828
Birth Cohort 1838
Birth Cohort 1848
Birth Cohort 1858
Birth Cohort 1868
Birth Cohort 1878
Birth Cohort 1888
Birth Cohort 1898
Birth Cohort 1908
Birth Cohort 1918
Birth Cohort 1928
Birth Cohort 1938
Birth Cohort 1948
Birth Cohort 1953
Birth Cohort 1958
Percentage of Women
Number of Children

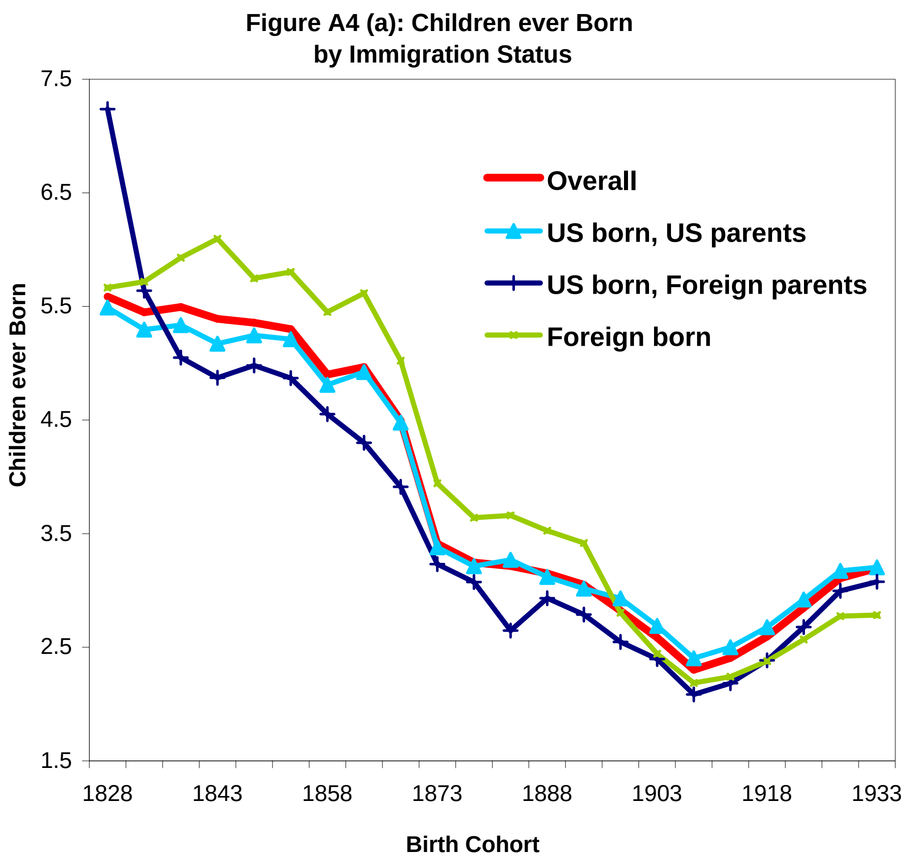


Figure A4 (a): Children ever Born
by Immigration Status
Children ever Born
Birth Cohort
Overall
US born, US parents
US born, Foreign parents
Foreign born
7.5
6.5
5.5
4.5
3.5
2.5
1.5
1828
1843
1858
1873
1888
1903
1918
1933

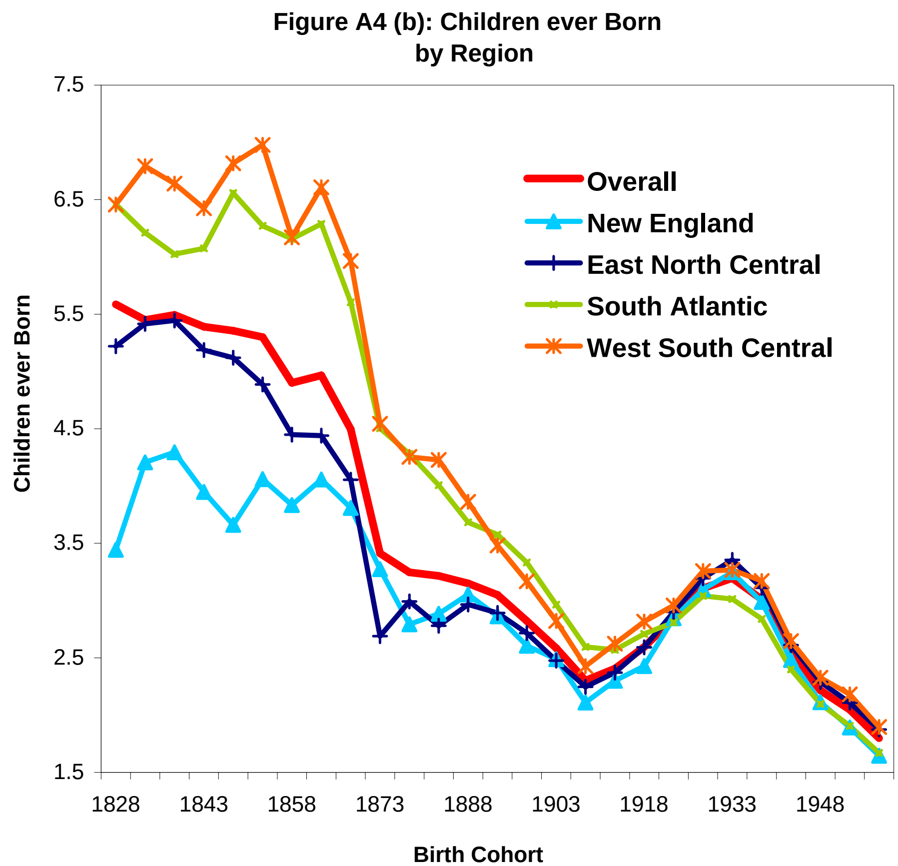
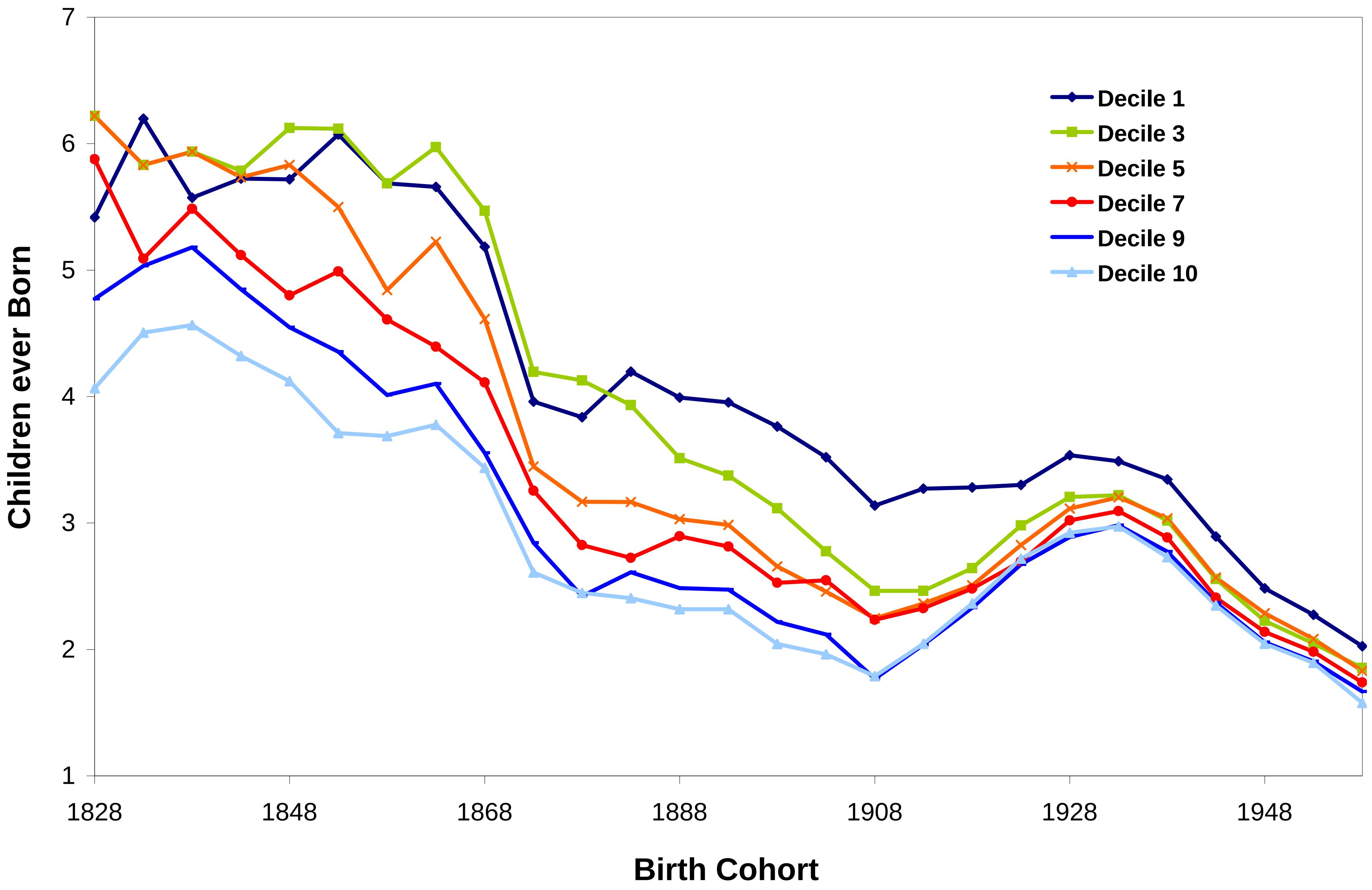


Figure A4 (b): Children ever Born
by Region
Children ever Born
Birth Cohort
Overall
New England
East North Central
South Atlantic
West South Central
7.5
6.5
5.5
4.5
3.5
2.5
1.5
1828
1843
1858
1873
1888
1903
1918
1933
1948

Figure A5: CEB by Decile and Birth Cohort



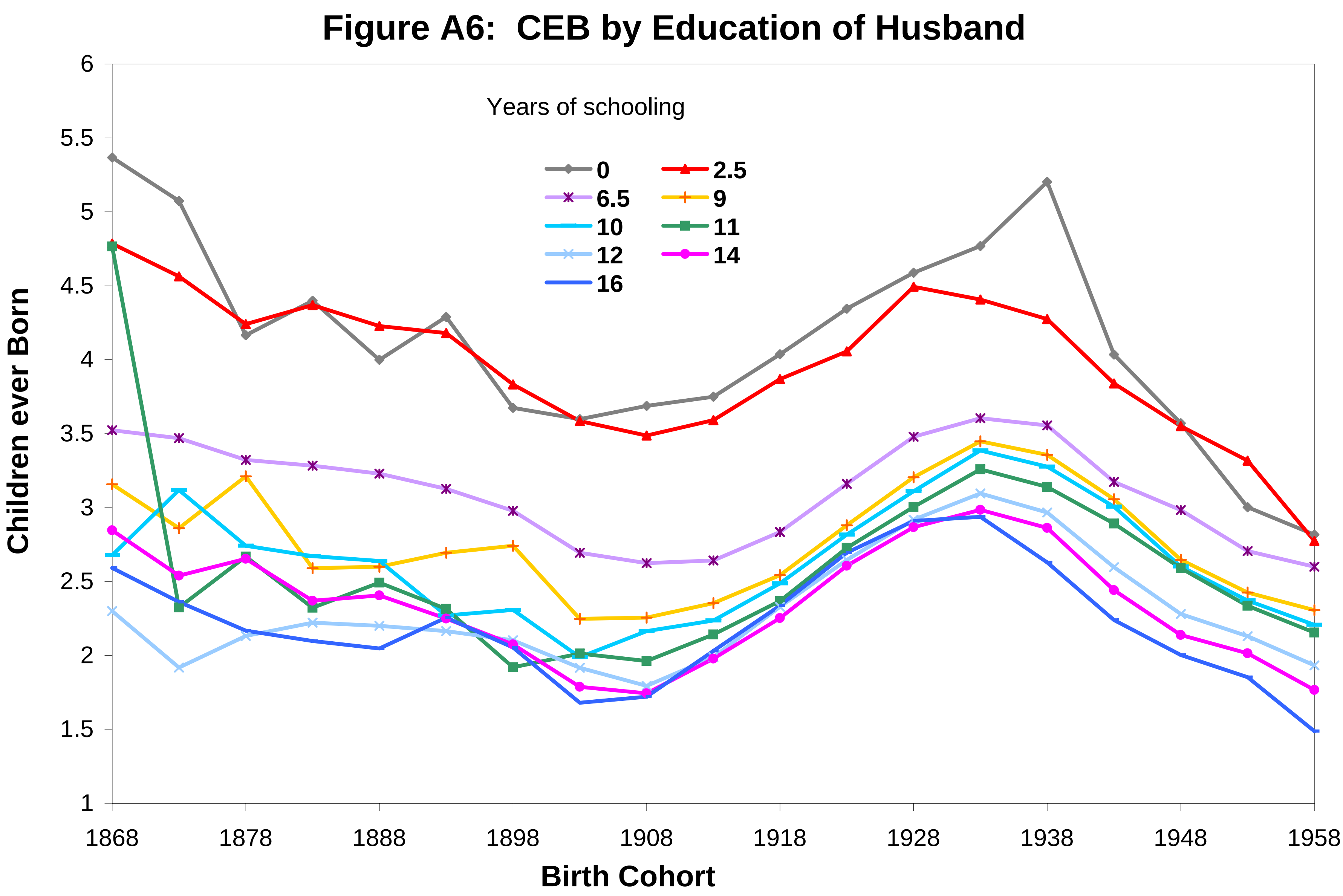


Figure A6: CEB by Education of Husband
Years of schooling
0
2.5
6.5
9
10
11
12
14
16
Children ever Born
Birth Cohort
1868
1878
1888
1898
1908
1918
1928
1938
1948
1958
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6

Figure A7: CEB Gap between Bottom and Top Half of Income Distribution by Region