Cohort Effects on Nonmarital Fertility

by

Jean Stockard*
Department of Planning, Public Policy and Management

Jo Anna Gray
Department of Economics

Robert O'Brien
Department of Sociology

Joe Stone
Department of Economics

University of Oregon
Eugene, OR 97403

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*Corresponding author: Jean Stockard
Department of Planning, Public Policy and Management
University of Oregon
Eugene, OR   97403
(541-346-5005, jeans@uoregon.edu)

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Abstract

The authors employ a newly developed method to disentangle age, period and cohort effects on nonmarital fertility ratios (NFR) from 1972 to 2002 for U.S. women aged 20-44 – with a focus on three specific cohort factors: family structure, school enrollment, and the ratio of men to women. All play significant roles in determining NFR and vary substantially for whites and blacks. Indeed, if black women and white women had cohort characteristics typical of the other group, age-specific NFRs for black women would decline markedly, while those for whites would increase markedly. Hence, cohort related variables contribute substantially to black-white differences in NFR in adulthood. Early family structure and education are particularly crucial in the racial differences. Most distinctively, while the impact of school enrollment on NFR is significantly negative for whites, the impact is significantly *positive* for blacks, perhaps due to the dominance of the "independence" effect.

Cohort Effects on Nonmarital Fertility

One of the most striking demographic changes in recent decades has been a sharp upturn in the United States and a number of other countries in the nonmarital fertility ratio (i.e., the percentage of births occurring to unmarried women, for simplicity NFR). For instance, in 1940, only 3.8% of all births in the United States were out of marriage; by 1999 this figure had risen to 33.0% (Ventura and Bachrach 2000). While NFR has historically been higher for blacks than for whites, it has increased substantially for both groups. Researchers have offered a number of explanations for these changes, including liberalization of social attitudes and controls, generous welfare policies, and changing absolute and relative economic opportunities for women and men (e.g., Aassve 2003; Bitler et al. 2004; Cherlin 1990, 1992; Duncan and Hoffman 1990; Fitzgerald and Ribar 2004; Harding and Jencks 2003; Moffitt 2001; Pagnini and Rindfuss 1993; Parnell et al. 1994; Seltzer 2000; Sweeney 2002; Teachman, et al. 2000; White and Rogers 2000; Willis and Haaga 1996; Zavodny 1999).

As with many other demographic processes, however, these changes probably reflect a combination of age, period, and cohort effects. Because younger women are more likely than older women to have nonmarital births, changes in the age composition of the population can result in a higher ratio of nonmarital births to total births. At the same time, changes in societal norms that promote more accepting attitudes toward nonmarital childbearing may produce higher NFR for people of all age groups, a history or period effect. Finally, increases in nonmarital fertility may occur because more recent birth cohorts are especially prone to such births and, through a simple process of cohort replacement, the share of these births increases.

Understanding the extent to which changing nonmarital fertility reflects age, period, and/or cohort effects can add to our substantive understanding of changing family lives and demographic processes. In addition, disentangling these effects can offer insights into the most appropriate public policies. For instance, one could imagine that policy interventions would differ substantially if changes in NFR primarily reflected period effects rather than cohort effects. For the former, interventions would target an entire population, but, for the latter, interventions would be more effectively targeted at specific cohort populations (cf. Smith and Cutright 1988).

It is difficult to obtain accurate estimates of age, period and cohort effects on demographic processes, since any two are perfectly collinear with the third. Even so, much scholarly discussion of changes in nonmarital births implies that such changes reflect cohort or history effects, and some analyses on the individual level explore such variations in individual behavior (e.g. Carlson, et al. 2004; Hoffman and Foster 1997; South 1999; Upchurch et al. 2002). There appear, however, to have been no studies estimating the *relative* impacts of age, period, and cohort on macro-level trends in NFR or, more importantly, empirical estimates of factors believed to account for the magnitude of these effects. This paper begins to fill this gap, examining changing age-specific rates of nonmarital fertility in the United States over the last 30 years of the 20th century.

We first use newly developed analytic techniques (O'Brien et al. 2006) to estimate the extent to which changes in NFR reflect historical changes (period effects), age-based norms (age effects), and/or changing behaviors of people born in different eras (cohort effects). Extending our analysis, we utilize cohort theory and the notion of cohort opportunity structures to examine the extent to which three factors associated with cohorts can explain variations in age-specific nonmarital fertility ratios: 1) the prevalence of nonmarital births during a cohort's birth years, indicative of family structure during childhood; 2) the school enrollment of the cohort in the late teens and early twenties, indicative of early investment in human capital formation; and 3) the sex ratio (males to females) in young adulthood, traditionally seen as indicative of the availability of marriage partners. In this analysis we are careful to control for the effects of both age and period. Building on the notion of contextual influences on cohort effects (Stockard and O'Brien 2002, 2006), we conduct separate analyses for whites and blacks. Results indicate a greater portion of the variation in nonmarital fertility can be uniquely associated with cohort factors for whites than for blacks and that there are substantial differences in the patterns of influence on cohort variations in black and white NFR.

Background

A number of years ago Ryder (1965) described birth cohorts as moving in a two-dimensional space of time and age. For instance, a cohort born in the early 1950s has grown older (moving through age) as years have passed (moving through time). Cohort theory and research have been used to examine how this movement affects age and period variations in a variety of areas including criminal behavior (O'Brien 1989; O'Brien et al., 1999; O'Brien and Stockard 2002; Savolainen 2000), suicide (Stockard and O'Brien 2002a,b), anti-black prejudice (Firebaugh and Davis 1988), opinions on democracy and Nazism (Weil 1987), parental values (Alwin 1990), political orientation and voting (Firebaugh and Chen 1995; Alwin and Krosnick 1991), sex role attitudes

(Mason and Lu 1988), and intellectual skills (Alwin 1991).

There are two major tenets of cohort theory: the “life stage principle” and the “lasting effects principle.” The “life-stage principle” posits that the experiences of members of one cohort differ from those of another because they experience historical events at different ages or developmental periods. Infants experience historical events, such as the establishment of universal suffrage or the transition to a market economy, differently than those who are twenty-one, those of middle age, and those who have retired (Elder and Caspi 1990, Elder 1974, 1979; Firebaugh and Chen 1995; Elder, Modell, and Parke 1993). The “lasting effects principle” suggests that certain events can produce lasting changes in the attitudes and behaviors of cohort members. To be labeled cohort effects, however, these changes must be analytically distinct from those associated with age and period.

Cohort Opportunity Structures

Understanding why cohort differences arise is a crucial theoretical issue. Elder (1996: 5) suggests that one can view the historical periods in which cohorts are born and grow to maturity as “opportunity structures.” These structures may result from historical events, such as wars and revolutions, economic depression, transformations of economic systems, or opportunities to participate in education or the electoral process. Demographic differences between cohorts such as increased immigration, changes in sex ratios, relative size, and variations in family structure also generate differences in opportunity structures. Whatever the genesis of these opportunity structures, they affect the resources of, and constraints on, the members of different birth cohorts.

We examine the extent to which variation in nonmarital fertility arises from variation across time and race in the opportunity structures faced by successive cohorts of women. We hypothesize three different demographic factors related to opportunity structures that may influence cohort variations in NFR: 1) childhood family structure, 2) access to and investments in education, and 3) the availability of marriage partners. A growing literature has documented the relationship of early childhood family structure to early sexual activity and nonmarital fertility (e.g. Albrecht and Teachman 2003; DeLeire 2002; Kahn and Anderson 1992; Musick 2002; South 1999; Teachman 2003) as well as cohort variations in other risky behaviors such as lethal violence (O'Brien and Stockard 2002). We use as our measure of cohort family structure the proportion of births that were nonmarital at the time of the cohort's birth. O'Brien and Stockard (2002) note that this measure, not surprisingly, is very highly correlated with estimates of the percentage of cohort members growing up in single parent families from 1910 to 1990.

The measure of family structure has the advantage of being directly associated with a cohort's time of birth and, in addition, is available for a large group of birth cohorts. We hypothesize that it will be positively related to age-period-specific NFRs for the cohort in later life. In line with earlier work in this tradition, we view this influence as structural in nature, reflecting the extent to which members of birth cohorts with more nonmarital births tend to grow up in situations with less adult supervision and monitoring, greater influence of peers, and fewer monetary resources. In line with cohort theory, we suggest that these influences impact not just those in nontraditional families, but all members of a birth cohort.

Nonmarried fertility ratios (NFR) may be influenced by women's access to higher education and other forms of human capital acquisition during the late teens and young adulthood. We measure access to higher education and skill levels by school enrollment in the late teens and early 20s and propose two offsetting influences at play in the relationship of this variable to NFR. First, increased education may enhance the effectiveness of social controls that discourage nonmarital childbearing, thus reducing nonmarital fertility ratios. Moreover, individual women seeking more education may choose to delay childbearing, especially nonmarital births. East (1999, p. 159), for example, concludes that girls' school and job aspirations are an important determinant of their attitudes toward nonmarital births, regardless of race or socioeconomic status.

A second possible influence, however, is the "independence" effect, where women with more education (and, hence, likely greater potential earnings) are less reliant on a marriage partner in order to bear and raise children (Becker 1981; Bennett et al 1989; Espenshade 1985: 222-225). Thus, a cohort's higher enrollment in education during the late teens and early adult years could be positively, negatively or not associated with NFR throughout a cohort's primary childbearing years, contingent on the relative magnitudes of the "discouragement/delay" versus "independence" effects.[1]

While our focus is primarily on early family structure and education, we also include a simple measure of mate availability. A relatively large literature documents the relationship of mate availability to marriage (Billy and Moore 1992; Blau, et al. 2000; Cready, et al 1997; Fossett and Kiecolt 1990; Guttentag and Secord 1983; Lichter, et al. 1991, 1992; McLaughlin and Lichter 1997; Raley, 1996; South 1996; South and Lloyd 1992; Willis 1999; Wilson 1987). Simply put, when there are more available men (e.g., a higher sex ratio), the chances of marriage, and thus of bearing children within marriage, are greater. Based on this work we expect that the cohort's sex ratio will be negatively related to NFR throughout the childbearing years. Despite the logical appeal of measures of mate availability, even studies using well-articulated measures (e.g., incorporating the ratio of males to females and incarceration rates) typically find only modest effects, at least within the variation in the data. South and Lloyd (1992), for example find only a small proportion of racial differences in NFR are attributable to differences in mate availability. [2] We include only a relatively simple cohort-based measure here: the sex ratio, the number of men divided by the number of women in the cohort when the cohort was in young adulthood (20-24). [3] Unlike incarceration rates or other factors related to mate availability, ones captured by period and age effects, this variable has the advantage of being intrinsic to specific cohorts.

Finally, it is possible that the influence of cohort opportunity structures may vary depending upon a cohort's age (cf. Kahn and Mason 1987; Pampel 1996). Particularly, it is possible that a cohort's opportunity structures would affect the probability of nonmarital births during the teen years in different ways than during the adult years. This could be expected given both differences in the dynamics surrounding marriage decisions in the teen and adult years as well as differences in impulse control and general decision making patterns between teens and adults (see Gray et al 2006a,b). In addition, at least for blacks, and increasingly for whites, the incidence of marriage after conception has become quite low for teens. Thus we focus most of our analysis on adults (women ages 20-44), for whom, especially for blacks, there is much greater variability in nonmarital births, but also report results when teens are included. We expect to find that cohort influences vary from teen ages to adulthood.

The Contextual Effect of Race

Recent cross-cultural studies (e.g. Pampel, 1996, 2001; Stockard and O'Brien, 2002, 2006) have added to understandings of cohort effects by demonstrating that the impact of cohort opportunity structures may vary across different social contexts. In other words, the extent to which a given factor may produce risk or opportunities for a cohort may vary from one society to another, as a societal context either buffers or exacerbates a cohort's risks or opportunities. We suggest that such contextual effects may be relevant in understanding the ways in which opportunity structures have affected black and white women's nonmarital fertility.

A large literature has documented extensive segregation in American society, both historically and in contemporary times, and especially between African Americans and whites. The vast majority of blacks and whites have remarkably little meaningful or repeated contact with someone from the other race group in their communities (e.g. Massey and Denton, 1993), schools (Orfield et al, 1997), churches (Lincoln and Mamiya 1990; Roof and McKinney 1987), peer and friendship groups (Moody, 2002; Berry 2006), workplaces (Landry 1987), or families (Tucker and Mitchell-Kernan 1990). A large literature has also examined the way in which the different neighborhoods in which blacks and whites typically live contribute to racial differences in early sexual activity, premarital childbearing and rates of marriage (e.g Brewster 1994a,b; Browning 2004; Browning and Olinger-Wilborn 2003; Crane 1991; Miller, et al 2001; Roche et al 2005; South and Baumer 2000; South and Crowder 1999).

We extend this line of thinking by noting that *cohorts* of white and black women in the United States grow up within different social contexts – in neighborhoods, schools, churches, and families that are largely separate. Given large differences between white and black communities in demographic characteristics and economic well being, these differences result in different cohort opportunity structures. Theoretically, these different opportunity structures could affect African Americans and whites in two ways. First, to the extent that the cohorts within the two groups differ in average levels of cohort characteristics (e.g. different average family structures, educational levels, and/or sex ratios), they can contribute to different levels of nonmarital births throughout the life cycle.

In addition, however, it is possible that the impact of cohort related variables could vary from one social context to another. For instance, numerous researchers have noted that African American communities have developed strategies of coping with disadvantaged contexts that can compensate for lower levels of economic and social resources (e.g. Stack 1975,Taylor et al 1988, Taylor et al, 1997). To the extent that such coping strategies compensate for losses in opportunities experienced by a cohort, it would be expected that cohort characteristics could have different effects from one race group to another.

Summary and Hypotheses

To summarize: In this paper we examine variation in age-period-specific nonmarital fertility ratios (the percentage of live births to unmarried women) for whites and blacks over the latter third of the 20th century. We examine the extent to which this variation represents age, period, and/or cohort effects and then the extent to which variations in opportunity structures for individual cohorts can account for these effects. We hypothesize that birth cohorts experiencing less traditional family structures will have higher nonmarital fertility ratios throughout their childbearing years, and that the influence of higher early enrollment in education on cohorts' nonmarital fertility may be positive, negative or non-existent, depending on the relative influence of decisions to delay childbearing versus the influence of greater independence that education and potentially higher earnings can bring for women. We anticipate cohorts with higher sex ratios will have lower nonmarital fertility ratios. We speculate that each of these variables reflects varying opportunities that accrue to cohorts and that have varied across cohorts born throughout the 20th century. We also compare results between the race groups to consider the ways in which opportunity structures and their effects vary across the different social contexts associated with race in the United States. Finally, we explore the extent to which these influences may differ between teens and adults.

Detecting Cohort Effects

To test these hypotheses we employ a newly developed methodology for disentangling age-period-cohort effects based upon calculations of age-period-specific nonmarital fertility ratios for whites and blacks separately. Data on unmarried births were taken from National Vital Statistics Reports (2000, 48:16 and 2002, 50:10). Data on total births are from Vital Statistics of the United States (www.cdc.gov/nchs/births.htm).

Structure of the Cohort Data

The cohorts used in the analysis, their birth years, and the years at which they reached ages 15-19 and 40-44 are given in Table 1. As is typical in cohort analyses, 5-year birth cohorts are used, providing a range that is wide enough to provide reliable statistical estimates but narrow enough to ensure that members of a group have had relatively similar life experiences. Table 2 illustrates the structure of the data set by providing the data for whites. Table 3 presents summary descriptive statistics on each variable for both whites and blacks. We limit our analysis to cohorts for which full data are available for whites and blacks and, for most of our analysis, to cohorts born over the period 1928-1982 (cohorts 1-11).[4]

[Tables 1, 2 and 3 about here]

In Table 2, data for each age group are portrayed in the rows, and data for each year are in the columns. The first element of each cell is the percentage of nonmarital births (NFR) for a given age and period, and the second element is the number assigned to each birth cohort, corresponding to those listed in Table 1. For whites, values of NFR vary from 2.7, for 25-29 year-olds in 1972, the first year for which we have data, to 44.6, for 20-24 year-olds in 2002. As shown in Table 3, values for blacks are consistently higher. The minimum NFR for black women is 23.1, for 30-34 and 35-39 year-olds in 1972. The maximum is 81.3, which occurred for the same age group and period as the maximum for whites: 20-24 year olds in 2002.[5]

The rows at the bottom of Table 2 report the values of the measures of cohort characteristics for whites for each of the cohorts in the analysis. The first row is the cohort number, corresponding to Table 1, and the second row is the percentage of the birth cohort born outside of marriage, our measure of cohort variation in family structure. Values for this measure are substantially lower for the older cohorts than for more recent cohorts, although the trend is not strictly linear. The lowest value occurs with cohort 5 (born 1948-1952) and the highest value with cohort 11. Again, values are substantially higher for blacks than for whites. In fact, as shown in Table 3, the range of values for white cohorts and black cohorts on this variable do not overlap: the maximum value for whites is 10.6 (for cohort 11), while the minimum value for blacks is 14.7 (for cohort 1).

The third row at the bottom of Table 2 gives the percentage of women enrolled in school at ages 18-21, when the cohort was 18-22 years of age.[6] These data were obtained from the U.S. Bureau of the Census (2006). Values range from 16.6 to 61.2 for whites and 14.3 to 51.4 for blacks, with the lowest values for the earliest cohorts. For each cohort, whites have higher school enrollment in young adulthood than blacks, although the values are much closer than for the other cohort characteristics.[7]

The final row at the bottom of Table 2 gives the sex ratio when the cohort was 20-24, which we calculated by simply dividing the number of men in this age group for a given cohort by the number of women and multiplying by 100.[8] Values range from 100.9 to 107.0 for whites and 88.6 to 97.5 for blacks. The lowest sex ratios occur with the earlier cohorts and the larger sex ratios with the later cohorts, reflecting increased life expectancy for males in more recent periods. Note that the range of values for whites and blacks do not overlap.[9]

The influence of age on nonmarital fertility ratios can be seen by comparing data in the rows in Table 2. In general, younger age-groups have higher NFR than older age groups, although the pattern is not strictly linear (e.g. compare ages 40-44 and 35-39 with earlier ages). Comparing the columns in Table 2 shows the extent to which NFR has changed over historical periods. Strong changes can be seen in each age group (across each row). For instance, the percentage of births to white unmarried women increased from 6% for 20-24 year-olds in 1972 to 45% in 2002. Changes in other age groups are also dramatic. For instance births to unmarried white women in their later 20s rose from only 3 percent in 1972 to over a fifth of all births by the turn of the century.

The diagonals can be compared to examine cohort effects. The oldest cohort for which full information is available is cohort 5, born in 1948-1952 and age 20-24 in 1972. Following the data for cohort 5, from the upper-left cell through the diagonal, it can be seen that its age-period-specific NFR was 5.7% in 1972, the lowest for all years for that age group. It fell somewhat when the cohort was in its late twenties and early thirties, but then rose to 8.9% in 1987, when the cohort was 35-39 years of age and rose again to 15.1% in 1992 when the cohort was 40-44 years of age. Cohort 6, in the next diagonal to the right, had an age-period-specific NFR of 8.3% in 1977, at the age of 20-24. The value was smaller over the next ten years, but then rose to a value of 11.4 for 35-39-year-olds in 1992 and 14.2% when the cohort was 40-44 in 1997.

Identifying Age, Period and Cohort Effects

While we could continue to follow the experiences of each birth cohort by tracing descriptive data through the diagonals of the table, such comparisons do not allow us to parsimoniously and statistically separate the impact of age patterns and historical trends from cohort effects. Traditionally, the most difficult problem facing analysts who wish to understand the presence of cohort effects is the linear dependence of age, period and cohort. If one knows the age and period, one knows the cohort associated with the age-period-specific NFR. This linear dependence has impeded the development of reliable and accurate estimates of the existence and extent of cohort effects, independent of age and period, using OLS techniques.

One way around this impediment is to substitute one or more characteristics of the cohorts that are theorized to affect the dependent variable rather than to use dummy variables for cohorts. For example, we might measure the percentage of the birth cohort born to unwed mothers (the cohort measure of family structure used here). This breaks the linear dependency between the age-group dummy variables, period dummy variables and the effects of cohorts. It also may provide an explanation for the variation of cohorts on the dependent variable (the variation may be significantly associated with the variation in the cohort characteristic). A disadvantage is that the cohort characteristics may not account for all of the variation associated with cohorts that is not associated with the age and period dummy variables.

The approach that we use overcomes this disadvantage by estimating the amount of variation in the age-period-specific NFR associated with cohorts after controlling for age and period dummy variables and then using cohort characteristics to account for a portion of that variance. This method was recently introduced (O'Brien et al., 2006) and involves a mixed model in which age and period dummy variables are treated as fixed effects and cohorts are treated as random effects. The dummy variables for age and period provide strong controls for the effects of maturation and history, while the remaining variation associated with cohorts (after this strong control) is estimated by the variance associated with the random effect of cohorts.

In such a model, the sum of squares associated with age, period, and cohort is calculated in the following manner. We calculate the total sum of squares for NFR from the age-period-specific rates. From the residual variance reported in a mixed model containing the age and period dummy variables as fixed effects and cohorts as random effects, we can calculate the sum of squares not accounted for by these age, period, and cohort effects. The total sum of squares minus the sum of squares unaccounted for by age, period, and cohort equals the sum of squares accounted for by these three factors.

The sum of squares uniquely associated with cohorts can be determined by running a model containing only the age-group and period dummy variables and then using the residual to calculate the sum of squares unaccounted for when cohorts are not in the model. The difference between the sum of squares accounted for by age, period, and cohort minus the sum of squares accounted for by age and period alone is the sum of squares accounted for by cohorts that is not accounted for by age and period – the sum of squares uniquely associated with cohorts.[10] Using a similar procedure, we calculate the sum of squares uniquely associated with age-groups and periods. Later, using these sums of squares, we report the proportion of the total variation in NFR associated with age, period, and cohort and the proportion of the total variation uniquely associated with each of these factors.[11]

Empirical Specifications

We implement this approach using the Proc Mixed procedure in SAS (2004, version 9.1), which also allows us to estimate the autocorrelation of "adjacent" observations within cohorts (they are treated as repeated measures). For example, from Table 2 we see that cohort 2 (those born between 1933 and 1937) has several age-period-specific NFR as does cohort 3 (those born between 1938 and 1942), etc. We estimate an AR(1) model that takes into consideration the correlation between the residuals for these observations within the cohorts.

We label this approach the Age-Period-Cohort Mixed Model (referred to as Model 1). When we add cohort characteristics to specifically model the cohort effects, we label this approach the Age-Period-Cohort Characteristic Mixed Model (referred to as Model 2). The second approach: 1) provides estimates of the variation uniquely associated with cohorts, with age groups, and with periods; 2) allows us to model autocorrelation within cohorts; and 3) permits the addition of cohort characteristics to the model to help explain the cohort variation. The model also provides improved estimates of age and period effects.

We use the natural log of the age-period-specific nonmarital fertility ratio as the dependent variable in all of our analyses. The use of the natural log can incorporate likely nonlinearities in the relationships, in that we anticipate specific cohort variables (esp., family structure and school enrollment) to have initially larger and then smaller effects, which is consistent with the logarithmic specification. Put differently, we expect cohort related variables to affect age-period-specific nonmarital fertility ratios proportionately whether those rates are for the youngest or oldest age groups or the earliest or latest periods in our data. Following O'Brien and Stockard (2003) we also log the measures of the cohort characteristics. The double logarithmic transformation ensures that proportionate shifts in the percentage of each cohort variable are associated with proportionate changes in NFR, thereby facilitating the interpretation of coefficients ("b") associated with the cohort characteristics: a one percent change in the independent variable will be associated with a "b" percent change in the dependent variable.[12]

We first examine the effects of age and period (as fixed effects) with cohorts as random effects (Model 1) and then add the three measures of cohort opportunity structure

(Model 2): family structure at birth (the prevalence of nonmarital births during the birth years of a cohort), investments in human capital in young adulthood (school enrollment from ages 18-21), and the availability of marriage partners (the sex ratio of males to females in young adulthood). In this model we also add an autocorrelation term. We compute the results separately for whites and blacks. We then examine more closely the implications of the race differences that we find. As noted above, the values of the cohort characteristics, as well as levels of NFR differ markedly between whites and blacks.

Through simple substitution in the regression equations we examine ways in which black and white NFR would theoretically alter if each group had the cohort characteristics of the other, while retaining the underlying pattern of age, period, and cohort effects. A predicted score is calculated for each age-group and year combination within each race group, the results are then converted from the logged values to the actual values, and then averages are computed across age and period. Finally, we briefly report the results of similar analyses when adding data for ages 15-19.

Results for Cohort Models

Results for adults for both race groups are in Table 4. Estimates for Model 1, i.e., the model with age-period-specific fixed effects along with cohort random effects, indicate that there are significant differences among cohorts in nonmarital fertility ratios, even after controlling for age and period (at the 1 percent level for whites and at the 5 percent level for blacks). In addition, most of the age and period effects are highly significant.

[Table 4 About Here]

Employing the techniques described above, we calculated the percentage of the total sum of squares for the nonmarital fertility ratio that is associated with age, period, and cohort in each of our analyses, both in total and uniquely. For both whites and blacks age, period, and cohort together account for 97% or more of the total sum of squares. In other words, these three factors account for the vast majority of the variation in the age-period-specific NFR. For whites slightly more than one-fourth of the variation (28 percent) is associated uniquely with one of these factors: 6 percent with cohorts, 15 percent with age groups, and 7 percent with periods. For blacks, the explained variation is more confounded, with only 16% of the total variation uniquely explained. One percent is uniquely associated with cohorts, 8 percent uniquely associated with age, and 7 percent uniquely associated with period.

Model 2 adds the three measures of cohort opportunity structure. Recall that we had expected that the influence of cohort family structure would be positive, offered several theoretical possibilities for the influence of educational investments, and expected the influence of sex ratio would be negative. Our hypothesis regarding cohort family structure receives strong support with the results for both whites and blacks. For both race groups, cohorts born in environments with more nonmarital births are more likely to have nonmarital births themselves throughout adulthood. As noted above, because we have logged both the independent and dependent variables, the coefficients may be easily interpreted in (approximate) percentage terms. For whites, an increase of 1 percent in a cohort's nontraditional family structure is related to a .46 percent increase in nonmarital births throughout the cohort's lifespan as covered in our analysis; for blacks, a similar increase in childhood family structure is related to a .39 percent increase in adult nonmarital births.

The influence of education works in opposite directions for whites and blacks. For whites, education enrollment in young adulthood significantly *reduces* nonmarital fertility throughout the adult years, perhaps reflecting the hypothesized “discouragement” or “delay” effect. A one percent increase in enrollment from when the cohort was 18-21 is related to a 1.1 percent decline in nonmarital fertility throughout adult ages. For blacks, education enrollment in young adulthood is significantly related to *higher* nonmarital fertility ratios, perhaps due to the dominance of the “independence” effect. A one percent increase in school enrollment is related to a .26 percent increase in the nonmarital birth ratio.

While our focus is primarily on family structure and education, the predicted negative influence of the sex ratio is supported only for blacks, where, as expected, cohorts with more males relative to females are significantly less likely to have nonmarital births throughout adulthood. The magnitude of the coefficient indicates that a one percent increase in the ratio of males to females in young adulthood is related to a 2.2 percent decrease in the NFR for black adult cohorts. For whites, there is a positive, but insignificant, relationship.

For both whites and blacks, most of the age and period effects that were significant in Model 1 remain so when the cohort characteristics are included (compare Models 2 and 1). The substantive pattern of coefficients for these dummy variables is also similar from Model 1 to Model 2. This suggests that, at least for the age groups and periods included within our sample, variations in unmarried fertility across time periods and age groups occur independently of variations related to cohort characteristics. However, the random cohort effects so significant for both blacks and whites in Model 1 are no longer significant in Model 2, indicating that the three cohort variables capture most of the influence of cohort-specific factors.

A measure of the extent to which the cohort variables capture the random cohort effects is reported along with two other summary statistics in the bottom rows of Table 4. The first statistic, the logged likelihood is a measure of the fit of the model to the data, and we report minus 2 times the logged likelihood. This can be used to test whether the fit of two nested models are statistically significantly different. The difference between minus 2 times the logged likelihood for two models is approximately distributed as chi-square with degrees of freedom equal to the difference in the number of parameter estimates in the two models. Comparisons of these values for Models 1 and 2 show that, for both race groups, Model 2 is a significantly better fit than Model 1.

The second statistic, the Bayesian Information Criterion (BIC) assesses the fit of a model while taking into consideration the number of parameters estimated and the sample size. The lower the value of BIC the better the fit of the model, taking into consideration the number of parameter estimates and the sample size. The BIC values also indicate that Model 2 fits better than Model 1.

The third statistic is a calculation of the proportionate reduction of error measure comparing the variance between cohorts that is explained in Models 1 and 2. For whites, the addition of the cohort measures for whites in Model 2 explains *all* of the variation between cohorts in Model 1; for blacks, the addition of these measures explains *virtually all*, 91 percent [= ((0.001989 – 0.000184)/0.001989)×100] of the variance. [= ((0.001989

– 0.000184)/0.001989)×100]. We take this as a strong indication of the importance, in particular, for the role of early family structure and access to and investments in education.

What if White Cohorts Were Black, and Vice Versa?

Table 5 reports the values of hypothetical NFR calculated using the equations in Model 2 in Table 4 for each race group, but substituting the average values of the cohort characteristics for the other group.[13] These calculations assume that the magnitude of age, period, and cohort influences on NFR (and the intercept) remain the same for whites and for blacks, and that only the value of the cohort characteristics is altered.

[Table 5 About Here]

This theoretical manipulation results in dramatic changes in the values of the dependent variable. For whites, if the pattern of age, period, and cohort influences stayed the same but the magnitude of the cohort characteristics matched that of blacks, their age-period-specific nonmarital fertility ratios would rise substantially, more than doubling in size in almost all instances. For blacks, the opposite occurs. If their pattern of age, period and cohort influences stayed the same and their cohort characteristics matched those of whites, their age-period specific NFR would decline markedly, to far less than half of the actual values. Clearly, differences in the cohort factors play a persistent role in the racial differences in nonmarital fertility ratios. Inspection of the calculations indicates that the largest changes in this theoretical manipulation result from the different levels of the measure of family structure.

Are Teenage Cohorts Different?

We also examined the data including the 15-19 year old age group. For blacks, once age and period effects were controlled (as in Model 1 in Table 4), there were no significant differences between cohorts.[14] With whites, however, variation between cohorts was significant after age and period were controlled ($z = 1.71$, $p < .05$). The coefficients associated with the cohort characteristics for whites indicated that the effects were substantially stronger during the teen age years than during the adult years. For instance, a one percent increase in the measure of childhood family structure would predict, after controlling for the other independent variables in model 2, a .55 percent increase in nonmarital fertility ratios for white adults, but a 2.71 percent increase in NFR for the cohorts when they were teens. A one percent increase in school enrollment was related to a .79 percent decrease in NFR for adults, but a 10.7 percent decrease for cohorts when they were teens.[15]

Discussion

Age, period and cohort effects account for much of the variation in age-period-specific NFR for both whites and blacks. While these effects account for similar proportions of the variation for both groups (over 97%), the three effects are more confounded for blacks than for whites. While 28 percent of the total variation for whites is unique to age, period or cohorts, only 16 percent of the variation for blacks is unique to those three components. The comparable figures when teens are included are 23 percent and 12 percent respectively. In addition, for whites, 20 percent of the unique variation is attributed to differences between cohorts; while, for blacks, it is only 9 percent. The comparable figures for teens are 37 percent and 36 percent.[16]

Our results support our hypotheses regarding both the influence of cohorts' opportunity structures and contextual effects associated with race. While childhood family structure, measured as the proportion of the cohort born to unwed mothers, has the expected positive association for both groups, the influence is somewhat stronger for whites than for blacks, especially in the analysis that includes data from 15-19 year olds. For both whites and blacks, and especially for whites in the teenage years, childhood family structure appears to be related to a cohort's probability of nonmarital births.

Our second measure of cohort opportunity structures – education – is negative and statistically significant for whites, and positive and statistically significant for blacks. We suggest that this may reflect different underlying dynamics of the relationship of cohort factors to NFR for whites and blacks. For whites, there is some indication of support for our hypothesis that education in young adulthood represents an investment in human capital that results in delaying child bearing and possibly marriage, as well. For blacks, the dynamics appear different, with greater investment in education resulting in a greater probability to be financially independent and thus making childbearing outside of marriage more economically feasible. Further research is, of course, needed to examine why the discourage/delay influence appears stronger than the independence effect for white women, while the reverse is true for black women.[17]

The third measure of cohort opportunity structure – mate availability, captured by the sex ratio – also produced sharply different results for blacks and whites, with significant results in the predicted negative direction only for blacks.[18] For whites, for all cohorts, there was an excess of men when the cohorts were in their early 20s; but for blacks, for all cohorts, there was no excess by that age. In addition, these figures may understate the low sex ratio available to black cohorts both because they do not adjust for the much higher incarceration rate for black men (Pettit and Western 2004) and because black women are far less likely than white women to marry interracially (Tucker and Mitchell-Kernan 1990). We suspect that, for whites, the large pool of potential mates results in little association between sex ratio and marriage while, for blacks, the presence of variation across cohorts results in a truer test (and support) of the hypothesis.

As an aside, results when the nonmarital fertility ratios for teenagers are included also suggest important differences for black and white cohorts. For whites, the effects of childhood family structure and educational investment are the same for cohorts in their teen and adult years, just enhanced for teens. For blacks, however, the effects of cohort related variables are insignificant, apparently confounded with age and period. It should be recalled that the nonmarital fertility ratios for blacks in their teen years are extremely high and exhibit relatively little variation (ranging from 69% in 1972 to 96% in 2002, and with values greater than 90% in 4 of the 6 periods examined). The nonmarital fertility ratio for white teens exceeded the minimum for black teens in only one period in our analysis (74.6 in 2002).

As shown in Table 5, the differences in NFR between blacks and whites are large at all age groups and periods: the average age-period specific rate for blacks is over three times as large as that for whites. Our results suggest that these differences may result from two different pathways, both involving the different contexts in which the cohorts have been raised. First, black cohorts have higher levels of risk factors included in our models: women more often grow up in single parent families and the pool of marriageable men is smaller. The calculations summarized in Table 5 illustrate the impact of these differences. If white cohorts had the characteristics of black cohorts, but the same underlying pattern of age, period, and cohort effects, their NFR measures would be much higher; and if black cohorts had the characteristics of whites, their NFR measures would be substantially lower.

Second, cohort effects have different levels of unique influence and cohort opportunity structures are related in different ways to NFR for the two groups. Perhaps most striking is the different relationship of greater investment in education. For whites, investing in education in the young adult years is related to lower nonmarital births throughout adulthood. We suggest that this may reflect the relationship of investment in education to delaying childbirth and marriage. It may also be related to white’s greater probability of marriage over the life span and after giving birth nonmaritally (Bennett, et al, 1989; Harknett and McLanahan 2004).

In contrast, for blacks, investment in education in the young adult years is positively associated with nonmarital fertility throughout the childbearing years, supporting the “independence hypothesis” and the suggestion that higher education can provide more opportunities for supporting a child outside of marriage. Thus, for whites, cohort opportunity structures related to higher levels of education are related to lower nonmarital fertility ratios, while for blacks such structures actually appear to promote higher ratios, net of other variables.[19] The differing influences of age, period, and cohort bolster this conclusion. Cohort factors have a much more important unique influence for whites than for blacks. For blacks, cohort factors explain a very small proportion of the total variation in NFR and the influence of age, period and cohort is much more confounded.

Conclusions

We examine age-period-cohort variations in the NFR of black and white women in the United States, focusing on the adult childbearing years (i.e., women aged 20-44). Our objective is to explore the role of opportunity structures for young adult women in protecting against nonmarital births throughout life (a cohort effect). We focus on three variables theoretically related to cohorts' opportunity structures: childhood family structure, investments in education in the late teens and young adulthood, and the ratio of males to females in young adulthood, with a particular focus on the ways in which the social context of race influences these relationships. A critical distinguishing feature of this paper is the recent theoretical and methodological innovations that we exploit to appropriately disentangle the hypothesized cohort effects from related age and period effects.

Overall, our findings indicate that cohort opportunity structures have powerful effects protracted across the childbearing lifespan for women, even with explicit age and period effects held constant, and that the pattern of these effects varies across the context of race. Early family structure has persistent effects for cohorts of both white women and black women, suggesting that policy interventions work against a strong inertia. While greater education appears to lower nonmarital fertility among white women (the "discouragement" or "delay" effect dominates the "independence" effect), greater education appears to increase nonmarital fertility among black women (the "independence" effect dominates). Greater availability of men within a cohort reduces nonmarital fertility for black women, but not for white women. These factors, taken together, capture most or all of the significant effects associated with cohort-specific effects in our data.

Importantly, the role of cohort factors in nonmarital fertility varies substantially for blacks and whites. Indeed, if black women and white women had cohort characteristics typical of the other group, age-specific NFRs for black women would decline markedly, while those for whites would increase markedly. Hence, cohort related variables contribute substantially to black-white differences in NFR in adulthood.

An implication for public policy aimed at nonmarital births is that some policies should actively target specific opportunity structures for young adult women, since early family structure and investment opportunities for women have persistent effects. Such policies should also consider the large differences in opportunity structures available to the two race groups as well as the strong influence of age and period and the special issues that affect women in their teen years.

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Table 1: Cohorts Used in the Analysis and Birth Years

Cohort #	Age 15-19 in	Age 40-44 in	Birth Year
1	1947	1972	1928-1932
2	1952	1977	1933-1937
3	1957	1982	1938-1942
4	1962	1987	1943-1947
5	1967	1992	1948-1952
6	1972	1997	1953-1957
7	1977	2002	1958-1962
8	1982		1963-1967
9	1987		1968-1972
10	1992		1973-1977
11	1997		1978-1982

Table 2: Age-Period-Specific Nonmarried Fertility Ratios (NFR) and Cohort Characteristics - Whites, 1972-2002

Age		1972	1977	1982	1987	1992	1997	2002
20-24	NFR	5.7	8.3	13.4	21.6	31.7	38.4	44.6
	Cohort	5	6	7	8	9	10	11
25-29	NFR	2.7	3.6	6.2	9.7	14.3	16.9	20.7
	Cohort	4	5	6	7	8	9	10
30-34	NFR	3.2	3.6	5.1	7.4	10.2	10.5	11.8
	Cohort	3	4	5	6	7	8	9
35-39	NFR	4.0	5.1	6.9	8.9	11.4	11.2	11.8
	Cohort	2	3	4	5	6	7	8
40-44	NFR	5.0	7.8	10.8	12.9	15.1	14.2	15.3
	Cohort	1	2	3	4	5	6	7

Cohort	1	2	3	4	5	6
Childhood Nonmarital birth ratio (birth years)	1.9	2.1	1.9	2.0	1.7	1.8
School enrollment, 18-21	16.6	20.4	21.6	29.6	33.0	35.5
Sex Ratio, 20-24	100.9	101.0	101.3	102.1	102.4	102.8

Cohort	7	8	9	10	11
Childhood Nonmarital birth ratio (birth years)	2.4	3.9	5.6	7.2	10.6
School enrollment, 18-21	37.7	44.0	49.0	52.6	56.2
Sex Ratio, 20-24	101.9	101.3	105.0	104.5	107.0

Table 3: Descriptive Statistics, Whites and Blacks

	Whites	**Blacks**
Age-Period-Specific Nonmarital Births (Nonmarried Fertility Ratio)		
Mean	12.3	43.4
Minimum	2.7	23.1
Maximum	44.6	81.3
Standard Deviation	9.5	15.6
Cohort Nonmarital Birth Ratio		
Mean	3.1	23.2
Minimum	1.7	14.7
Maximum	10.6	48.4
Standard Deviation	2.1	8.8
Cohort Sex-Ratio		
Mean	102.5	93.6
Minimum	100.9	88.6
Maximum	107.0	97.5
Standard Deviation	1.4	2.1
Cohort School Enrollment (18-21)		
Mean	35.9	31.0
Minimum	16.6	14.3
Maximum	56.2	51.4
Standard Deviation	10.0	8.9
Number of cases	35	35

Table 4: Results for Blacks and Whites

	Whites				**Blacks**			
	Model 1		**Model 2**		**Model 1**		**Model 2**	
Level 1	Coef.	t	Coef.	t	Coef.	t	Coef.	t
Intercept	2.94	41.08 ***	-6.31	-0.79	3.76	177.55 ***	11.57	3.33 **
Age								
20-24	0.54	6.47 ***	0.71	3.84 **	0.57	25.07 ***	0.33	7.51 ***
25-29	-0.18	-2.78 **	-0.02	-0.15	0.21	10.44 ***	0.02	0.64
30-34	-0.41	-8.58 ***	-0.30	-3.12 **	0.02	1.01	-0.11	-4.68 ***
35-39	-0.27	-8.49 ***	-0.22	-4.21 ***	-0.02	-1.46	-0.09	-4.74 ***
40-44	-----	-----	-----	-----	-----	-----	-----	-----
Period								
1972	-1.53	-12.31 ***	-1.78	-6.45 ***	-0.65	-20.94 ***	-0.30	-4.58 ***
1977	-1.15	-10.92 ***	-1.33	-5.79 ***	-0.45	-15.88 ***	-0.15	-2.81 **
1982	-0.65	-7.54 ***	-0.80	-4.24 ***	-0.25	-9.96 ***	-0.02	-0.33
1987	-0.25	-3.66 **	-0.38	-2.71 *	-0.07	-3.09 **	0.12	3.24 **
1992	0.02	0.49	-0.06	-0.62	0.06	2.73 *	0.18	6.75 ***
1997	-0.01	-0.15	-0.04	-0.75	0.04	2.09 *	0.11	4.69 ***
2002	-----	-----	-----	-----	-----	-----	-----	-----
Cohort Variables								
Ln Nonmarital Birth	-----	-----	0.46	5.97 ***	-----	-----	0.39	7.01 ***
Ln School Enrollment	-----	-----	-1.10	-3.47 **	-----	-----	0.26	4.24 **
Ln Sex Ratio	-----	-----	2.72	1.55	-----	-----	-2.20	-2.72 *
Random Effects								
Cohort	0.04482	2.30 **	0.00		0.001989	2.03 *	0.000184	1.55
Residuals	0.001937	3.46 ***	0.004123	3.30 ***	0.000766	3.47 ***	0.00072	2.68 **
AR(1)	-----	-----	0.62	4.53 ***	-----	-----	-0.56	-1.72
Model Fit								
-2X log likelihood	-73.4		-104.4		-128.4		-151.2	
BIC	-30		-66.0		-97.3		-110.4	
Likelihood ratio c^2 from previous model			31.0				22.8	
Deg freedom			3				3	
Significance of change			<.001				<.001	
Proportion change in cohort variance			1.00				0.907491	

Table 5: Predicted Average Nonmarital Fertility Ratios of Whites and Blacks Given Cohort Characteristics of Other Group

	Whites		Blacks	
	Actual Values	Predicted with Black Cohort Characteristics	Actual Values	Predicted with White Cohort Characteristics
Total	12.3	29.5	43.4	15.3
Age				
20-24	23.4	54.0	64.6	20.4
25-29	10.6	26.0	44.9	15.0
30-34	7.4	19.7	36.4	13.1
35-39	8.5	21.3	35.0	13.4
40-44	11.6	26.6	36.2	14.7
Period				
1972	4.1	7.8	26.5	11.3
1977	5.7	12.2	32.4	13.1
1982	8.5	20.8	39.2	15.0
1987	12.1	31.6	46.5	17.2
1992	16.5	43.5	53.0	18.3
1997	18.3	44.4	53.6	17.0
2002	20.8	46.2	52.6	15.3

Note: Values were calculated by substituting mean values of logged cohort characteristics in Table 3 in the equations for Model 2 for each race group, as given in Table 4. Predicted logged values for each age group and year were calculated and average scores by age and period were then calculated by summing across the cases in each age or period and averaging across the 5 age groups or 7 periods.

Endnotes

[1] The youngest age group in part of our analysis is 15-19 years of age, and our measure of school enrollment is based on ages 18-21. We chose this measure because it has much more variability than a measure based on earlier ages, even though it taps investment in human capital after the point at which some women may have already experienced nonmarital child bearing. It is then possible that nonmarital fertility in the teen years may have influenced decisions regarding educational investment. Our strong controls for age and interactions with the teen years in our analysis help to control for this dynamic.

[2] Unlike the present analysis, their work looked at data for only one period and thus could not address cohort effects.

[3] We briefly report analyses that include ages 15-19 and for these analyses used both the ratio of males to females at ages 15-19 and the ratio of males ages 20-24 to females ages 15-19, recognizing that sexual partners and husbands are traditionally older than mothers and wives, especially for teens and in earlier periods (Cherlin 1992, Vanoss et al 2000). It is, of course, possible that additional dimensions of mate "availability" might be relevant, such as those that incorporate incarceration, employment and male earnings (cf. Goldman et al 1984, also Schoen 1983; South and Lloyd 1992,). We focus here only on the sex ratio, but return to other dimensions in the discussion section below.

[4] In our supplementary analysis that includes the teen ages (15-19) we also include "cohort 12," born 1983-1987.

[5] Rates for teens are consistently higher than those for adults, ranging from 19 (1972) to 75 (2002) for whites and from 69 (1972) to 96 (1997 and 2002) for blacks. For whites, for all periods from 1987 on, more than half of all teen births have been nonmarital

(cohorts 9-12). For blacks, the distribution is even more skewed. In all but 2 of the 6 periods included in our analysis, 92% or more of all births to teenaged black women aged 15-19 were nonmarital.

[6] Values for cohorts 3 and later were obtained from the U.S. Bureau of the Census (http://www.census.gov/population/www/socdemo/school.html). Values for earlier cohorts were predicted using regression techniques with median years of schooling at age 25-29 as a predictor (R squared = .93) and adjusting for differences between blacks and whites using historical trends. The value for the youngest cohort in our analysis with the teen ages was estimated based on data for the cohort born in 1982-86 (18-21 in 2004), omitting one year of the cohort in our analysis.

[7] For whites the percentage enrolled in school increases monotonically for the cohorts in the analysis. For blacks, however, the increase is not monotonic. The value for cohort 8 (32.5) is lower than that of the two adjacent cohorts (36.0 for cohort 7 and 38.0 for cohort 8), and the value for cohort 12 (51.1 and included only in the analysis with the teen ages) is slightly lower than that for cohort 11 (51.4).

[8] Data to calculate sex ratios also came from the U.S. Bureau of the Census: the web site at census.gov/popest/archives/pre-1980/PE-11.html for data before 1980 and selected editions of *Statistical Abstract of the United States* for later years.

[9] As noted above (footnote 3), for the analysis with teens we used the male-female ratio at age 15-19 and the ratio of males at age 20-24 compared to females at age 15-19, when the cohort was ages 15-19.

[10] This sum of squares is identical to that calculated from the random variance associated with cohorts in a model with age-group and period dummy variables as fixed effects and cohorts treated as random effects.

[11] As one would expect, the sum of squares accounted for by age, period, and cohort "dummy variables" does not depend on the choice of which two of these factors are fixed and which is treated as random. The details of this procedure appear in O'Brien et al. (2005).

[12] Results with unlogged variables are substantively similar to those reported here and are available upon request.

[13] Means for the logged cohort characteristics were as follows: ln cohort nonmarital births: black mean = 3.0866, white mean = .966899; ln sex ratio: black mean = 4.539, white mean = 4.6297; ln school enrollment, black mean = 3.389, white mean = 3.5379.

[14] The z value associated with the random intercept was .81.

[15] For whites in the analysis with the teen ages, the main effects coefficient associated with childhood family structure was .55 ($t=7.91$, $p < .001$), and the effect for the interaction with teen years was 2.16 ($t=3.59$, $p < .01$). The main effects coefficient associated with cohort school enrollment was -.79 ($t = -2.60$, $p < .05$), and the effect for the interaction with teen years was –9.92 ($t = -4.14$, $p < .001$).

[16] The total sums of squares for the ln(NFR) are much greater for whites: 15.83 versus 4.11 for whites and blacks, respectively, for the adults. With teens the figures are: 30.81 versus 7.54. This much greater variation for whites may contribute to the different proportions of unique variation explained.

[17] This result is at odds, at least implicitly, with evidence in Bennett *et al.* (1989) that increased education is associated with *higher* rates of eventual marriage among black women.

[18] Again, incarceration rates and other age- and time-varying factors are captured by the age and period effects. Hence, we use the sex ratio as a measure of mate availability intrinsic to a cohort.

[19] The differential impact of education on NFR affects, of course, the projections in Table 5. Whites have, on average, higher levels of school enrollment in young adulthood than blacks (see Table 5). While for whites higher levels of enrollment result in lower levels of NFR, for blacks higher levels, which result from the substitutions used in the calculations for Table 5, result in higher levels of NFR.