Trends in Fertility by Education in Japan, 1966–2000

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Rising levels of education—especially woman's education—are a major driving force behind the transition from high to low fertility (Coale, 1973; Caldwell, 1978). Despite this, the influence of education on fertility is not well documented in Japan. There are two main reasons. One is that the vital registration system in Japan (as elsewhere) does not collect information on the education of the parents when a birth is registered. This means that fertility estimates by education cannot be calculated using birth registration data. The other reason is that most Japanese sample surveys, which have been the main source of information on fertility by education, have been confined to married women (either currently married or ever-married). From these surveys it is possible to compute age-specific fertility rates for married women but not for all women.

The lack of age-specific fertility rates by education for all women is problematic, because trends in marital fertility can be misleading when the mean age at marriage is rising, as has been the case in Japan since 1975. When women marry later, they often have their children more quickly once they do marry. As a consequence, age-specific marital fertility rates often rise, even while age-specific fertility rates for all women are mostly falling because of falling age-specific proportions married. If age at marriage rises faster for more-educated women than for less-educated women, then age-specific marital fertility rates may rise faster for more-educated women than for less-educated women, even while age-specific fertility rates for all women fall faster for more-educated women than for less-educated women.

As the above discussion makes clear, an adequate analysis of the effects of education on fertility trends requires not only age-specific marital fertility rates but also age-specific fertility rates for all women, irrespective of their marital status, as well as age-specific proportions married—all specified by woman's educational level. In this report we estimate these measures from Japan's 1980, 1990, and 2000 censuses. An innovation is that a woman's education is defined as the level of education that she ultimately completes, in contrast with the usual definition in terms of highest grade completed at the time of the census. The analysis also includes decompositions of fertility change into components—one due to changes in population composition by education within age groups, one due to changes in population composition by marital status within age-education groups, and one due to changes in ever-marital fertility within age-education groups.

EARLIER ESTIMATES OF FERTILITY BY EDUCATION IN JAPAN

Since World War 2, a number of demographers have analyzed the influence of socioeconomic factors on fertility in Japan, employing various data sets at both the macro and micro levels. In most studies undertaken during the 1950s and 1960s, the socioeconomic factors considered were limited mainly to urban/rural residence and occupation (Aoki, 1967; Tsubouchi, 1970). The relative lack of attention to the effects of woman's education on fertility was perhaps due partly to the low level (and hence low variability) of educational attainment among women in the early years of Japan's post-war economic development. After the mid-1950s, however, school enrolment ratios among girls began to rise rapidly as a consequence of rapid economic growth. As a result, studies on fertility differentials by education became an increasingly important topic of demographic research in Japan.

During the early 1970s, Hashimoto (1974) undertook an in-depth statistical analysis of the relationship between completed fertility and educational attainment. A goal of the study was to see whether the usual inverse relationship between parents' education and their completed fertility obtained in Japan and whether the magnitude of differential fertility by education has diminished over time in Japan, as it has tended to do in other industrialized countries (United Nations, 1973). Drawing upon data from various rounds of the National Fertility Survey undertaken by the Institute of Population Problems (now the National Institute of Population and Social Security Research), Hashimoto demonstrated that this historical pattern was also found in post-war Japan. In 1952, for example, the number of children ever born to currently married women age 45–49 was 4.57 among those with low education (less than 10 years of education) and 3.13 among those with high education (13 years or more). For later years, corresponding figures are 4.04 and 3.09 in 1962, and 3.48 and 2.69 in 1967, indicating a substantial decline in both completed fertility and differential completed fertility by education among Japanese married women.

Hashimoto additionally used prefecture-level data (for Japan's 46 prefectures) on completed fertility and a few socioeconomic variables, derived from Japan's 1960 census and other sources, in a prefecture-level regression analysis of the effects of socioeconomic variables on fertility. The results showed that woman's education and earnings affected completed fertility negatively and were the most important predictor variables in the regression. The results suggested that fertility models typical of the new home economics, which emphasize the role of woman's education, provide a useful basis for analyzing fertility differentials in Japan. Hashimoto also found from this cross-sectional analysis that woman's education was more important in accounting for fertility differentials than husband's education.

Atoh (1980) addressed the question of whether and how much fertility differentials by education have been converging in Japan, based on data from the censuses of 1950, 1960, and 1970. In contrast with Hashimoto's analysis, Atoh's analysis related husband's education to wife's number of children ever born. He found that fertility differences by husband's education tended to converge between 1950 and 1970. The difference in completed fertility between women whose husbands graduated from junior high school or less and women whose husbands graduated from senior high school or more was 1.3 children in 1950, 0.8 child in 1960, and 0.5 child in 1970.

Atoh also compared Japan's differentials in completed fertility by education with corresponding differentials in ten Western countries around 1970, ranging from 1966 to 1972. The ten countries were the United States, England and Wales, France, Denmark, Belgium, Hungary, Czechoslovakia, Poland, Yugoslavia, and Finland. In the case of Japan, he used data from the 1974 Japan World Fertility Survey and the seventh round of the National Fertility Survey conducted in 1977. He found that Japan's differentials in completed fertility by wife's education were smaller than those in the other countries selected for comparison.

Employing the seventh round of the National Fertility Survey of 1977, Atoh and Aoki (1984) undertook a multiple regression analysis of the number of children ever born. After controlling for both demographic variables (e.g., wife's age and age at marriage) and socioeconomic variables (e.g., her work status and the size of her community of residence), they found that the wife's educational attainment was an important factor accounting for fertility differentials by the other predictor variables.

Along somewhat similar lines, Hodge and Ogawa (1991) undertook a regression analysis of the number of children ever born to married women of reproductive age. They used individual data from the 1981 round of the National Survey on Family Planning, conducted by the Mainichi Newspapers of Japan. After controlling for a number of demographic and socioeconomic predictors in the regression, they found that husband's education was a more powerful predictor of the couple's fertility behavior than wife's education. This finding based on individual data is the opposite of Hashimoto's finding based on prefecture-level data from the 1960 Population Census, discussed earlier.

All the studies reviewed thus far examined the relationship between the education of one or both parents and the number of children ever born, which is a cohort measure of fertility. In the early 1980s, the own-children method, which produces estimates of period fertility (age-specific birth rates and total fertility rates) by characteristics asked on a census or household survey, caught the attention of Japanese demographers. In addition, as part of its publication activities, the Statistics Bureau of Japan began to produce and publish the tabulations that serve as input data for the own-children method. The own-children method is described in more detail in the next section.

In the mid-1980s, Kawasaki (1985) applied the own-children method to Japan's 1980 census to estimate total fertility rates by socioeconomic characteristics, including educational attainment. This work yielded the first estimates in Japan of total fertility rates by woman's education. Estimates were presented for the years 1970 and 1980. Kawasaki's estimates for these two years agree closely with estimates presented below in the present report.

Itoh (1990) subsequently applied the own-children method to Japan's 1985 census. Japan's mid-decade censuses do not contain information on education, however, so it was not possible for Itoh to compute own-children fertility estimates by education from this data source. The characteristics examined by Itoh included prefecture, urban/rural residence, and occupation.

More recently, Matsumura (2000) applied the own-children method to data from the 1990 Population Census and computed estimates of total fertility rates for four educational categories (junior high school, senior high school, junior college, and university) over the period 1976-1990. Matsumura's estimates shed light on the influence of education on below-replacement fertility, which is a topic of considerable concern to the Japanese government. The estimates showed that the total fertility rate for those with university education declined substantially between 1976 and 1990, and that the fertility difference between women with a junior high school education and women with university education increased from 0.27 to 0.37 between 1984 and 1990. He concluded that an increase in the number of university-educated women was a key factor explaining the fall of fertility in Japan during the 1980s. Matsumura's estimates also agree closely with the estimates presented later in this report.

DATA AND METHODS

Data for this study are the complete household record files from the 1980, 1990, and 2000 censuses of Japan.

In these censuses, the question on education actually is a combination of two questions, one on level of schooling (categories are primary or junior high school, senior high school, junior college, and university) and one on whether the respondent is still attending that level, has graduated that level, or has never attended school. In our analysis we use these questions to define education as the highest level that the respondent has graduated, conditional on no longer attending school at the time of the census—the intent being to measure completed education. In our analysis, the education categories are: primary or junior high school (which we refer to simply as junior high school), senior high school, junior college, university, and "still attending school." (The latter category includes the very small number of women who never attended school.) In Japan, completion of junior high means completion of ninth grade, and completion of senior high means completion of twelfth grade. In the censuses and in our analysis, women currently attending a university graduate school are classified as "still attending school" rather than "university," even though they have completed the four-year baccalaureate degree.

We calculated fertility estimates from the three censuses using the own-children method of fertility estimation (Cho, Retherford, and Choe 1986). The own-children method is a reverse-survival method for estimating age-specific fertility rates (ASFRs) for years previous to a census or household survey. Enumerated children are first matched to mothers within households, based on answers to questions on age, sex, marital status, and relation to head of household. A computer algorithm is used for matching. The matched (i.e., own) children, classified by their own age and mother's age, are reverse-survived to estimate numbers of births by age of mother in previous years. Reverse-survival is similarly used to estimate numbers of women by age in previous years. After adjustments are made for unmatched (i.e., non-own) children, age-specific fertility rates are calculated by dividing the number of reverse-survived births by the number of reverse-survived women.

Estimates are normally computed for each of the 15 years before the census. Estimates are not usually computed further back than 15 years because births must then be based on children age 15 or older at enumeration, a large proportion of whom do not reside in the same household as their mother and hence cannot be matched. All calculations are done initially by single years of age and time. Estimates for grouped ages or grouped calendar years are obtained by appropriately aggregating single-year numerators (births) and denominators (women) and then dividing the aggregated numerator by the aggregated denominator. Such aggregation is useful for minimizing the distorting effects of age misreporting on the fertility estimates (Cho, Retherford, and Choe 1986). In Japan, however, age reporting is very accurate, so that such distortions are absent.

Reverse-survival requires life tables. We used official life tables by sex that are available for each calendar year, thereby allowing for annual changes in mortality. The same life tables were used regardless of level of education, because life tables by education are not available. This introduces bias, because mortality tends to be lower among those with more education. The own-children fertility estimates are affected very little by this bias, however, for two reasons. The first reason is that the reverse-survival ratios used to back-project children and women are both close to 1.00, and the second reason is that the errors in the reverse-survival ratios used to back-project births from children in the numerators of age-specific fertility rates cancel to some extent the errors in the reverse-survival ratios used to back-project women in the denominators of age-specific fertility rates (Cho, Retherford, and Choe, 1986).

The ASFRs are aggregated into a total fertility rate (TFR), which is the summary measure of fertility used in this report. The TFR is calculated as five times the sum of ASFRs over 5-year age groups. The TFR for a specified time period (a single calendar year or group of calendar years) is interpreted as the hypothetical number of births that a woman would have if she lived through her reproductive years (15–49) experiencing the ASFRs for that time period.

In the second part of the analysis, we decompose the change in the TFR ($\triangle$TFR) into three components: one from compositional changes by education of women within each age group, one from compositional changes by marital status within each age-education group, and one from changes in age-education-marital status-specific birth rates. In more detail, the methodology is as as follows:

To begin with, we have the following definitions:

k_{xe} Proportion of women in the xth age group (x to x+5) who have education e (five education categories, including "still attending school," as discussed earlier)

k_{xem} Proportion of the x-eth age-education group in marital status m (ever-married or never-married)[1]

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[1]A more detailed breakdown of marital status would have been preferable (allowing calculation of age-specific fertility rates for currently married women instead of ever-married women) but could not be done.

F_{xe} Age-education-specific birth rate

F_{xem} Age-education-marital status-specific birth rate

(It is assumed that fertility among the never-married is zero, which is a reason able assumption for Japan, where out-of-wedlock births are rare. Age-education-specific ever-marital birth rates— F_{xem}— are obtained by dividing the age-education-specific birth rates for all women, derived by the own-children method, by the age-education-specific proportions ever-married. The own-children estimates pertain to the year before the census, and the age-specific proportions married pertain to the time of the census.)

We have the following formulae for the TFR:

$$TFR = 5\sum_{x} F_x$$

$$TFR = 5\sum_{x}\left[\sum_{e} k_{xe} F_{xe}\right] = 5\sum_{x,e} k_{xe} F_{xe}$$

In this formula, F_x is expressed as a weighted sum of age-education-specific birth rates for women in age group x to x+5, where the weights are the proportions of women in each educational category within that age group. This formula can be further elaborated as

$$TFR = 5\sum_{x,e}\left\{k_{xe}\left[\sum_{m} k_{xem} F_{xem}\right]\right\} = 5\sum_{x,e,m} k_{xe}\, k_{xem} F_{xem}$$

In this formula, F_{xe} is expressed as a weighted sum of age-education-marital status-specific birth rates for women in the x-eth age-education group, where the weights are the proportions of women in each marital status category within that age-education group. The terms for never-married drop out because it is assumed that the fertility of never-married women is zero.

The above formulae for the TFR lead to two formulae for decomposing the change in the TFR into components. The first is:

$$\Delta TFR = 5\sum_{x,e} \overline{F_{xe}}\, \Delta k_{xe} + 5\sum_{x,e} \overline{k_{xe}}\, \Delta F_{xe}$$

This formula decomposes △TFR into two components, one from compositional changes by education of women within each age group, and one from changes in age-education-specific birth rates. A bar over a quantity indicates a mean value, calculated by adding the values at the beginning and end of the period and dividing the sum by two.

The second formula, which provides a more detailed breakdown, is:

$$\Delta TFR = 5\sum_{x,e} \overline{F_{xe}}\, \Delta k_{xe} + 5\sum_{x,e,m} \overline{k_{xe}}\, \overline{F_{xem}}\, \Delta k_{xem} + 5\sum_{x,e,m} \overline{k_{xe}}\, \overline{k_{xem}}\, \Delta F_{xem}$$

This formula decomposes △TFR into three components, one from compositional changes by education of women within each age group, one from compositional changes by marital status within each age-education group, and one from changes in age-education-marital status-specific birth rates. Again the terms for never-married drop out because it assumed that the fertility of never-married women is zero.

These decomposition formulae are used to analyze changes in the TFR for three time periods—1980 to 1990, 1990 to 2000, and the overall period 1980 to 2000.

RESULTS

Validation of the own-children method

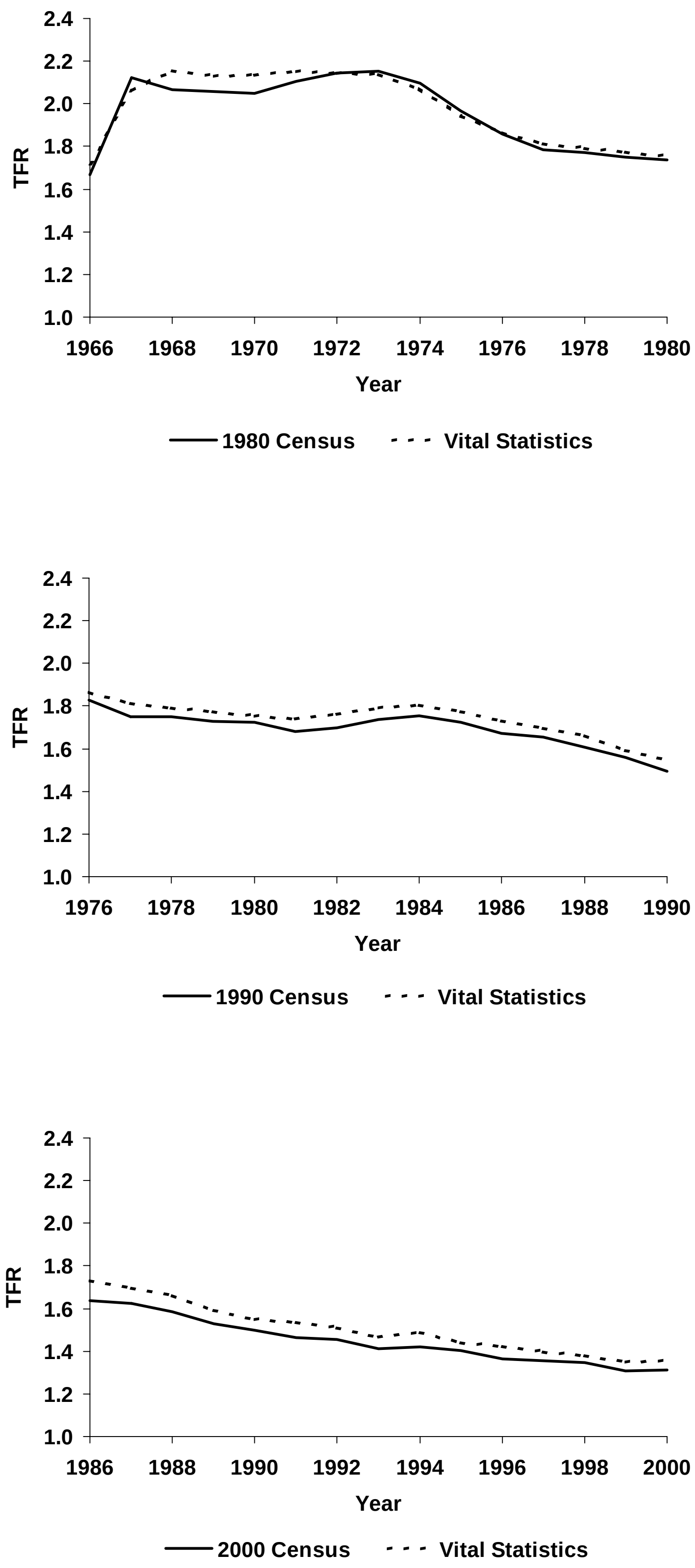
The analysis first validates the use of the own-children method by comparing estimates of the TFR derived by the own-children method applied to census data with official estimates of the TFR based on birth registration. This is done for all women, regardless of level of education, because the birth registration system does not collect information on education of parents. In the comparison for all women, a remaining problem is that the official estimates of the TFR are for calendar years that run from January 1 to December 31, whereas the own-children estimates are for years before the census that run from October 1 to September 30. In the latter case, for example, the year that we label 1980 actually runs from October 1, 1979, to September 30, 1980. To make the comparison between the official estimates and the own-children estimates of the TFR more precise, we interpolated the official estimates so that years run from October 1 to September 30, the same as for the own-children estimates. This is done by recomputing the official estimate for year t as $TFR'(t) = (.75)(TFR(t)) + (.25)(TFR(t–1))$.

Results of the comparison are shown in Figure 1, which contains three graphs, corresponding to own-children estimates derived from the 1980, 1990, and 2000 censuses. In each case, the trend is estimated for the 15-year period before the census. The agreement between the own-children estimates and the vital statistics estimates of the trend in the TFR is close but not perfect. One reason for the discrepancies may be differences in the way that eligible persons are defined in the official estimates, based on registered births, and the own-children estimates, based on census data. In the case of vital statistics, a birth is registered only if it is a Japanese citizen. If the mother is a Japanese citizen but the father is not a Japanese citizen, the child is not a Japanese citizen and the birth is not registered. In contrast, the own-children estimates are based only on women of Japanese nationality as determined by the nationality question in the census, for which the categories are “Japanese” and “other.” Thus, the births on which the official fertility estimates are based are not quite the same as the births on which the own-children fertility estimates are based.

The own-children estimates of the TFR based on the 1980 census in Figure 1 tend to be slightly higher than the official estimates for years close to the census, whereas the reverse tends to be true for years further back from the census. The dip in the TFR for 1966 occurs because 1966 was the Year of the Fire Horse, traditionally considered an unlucky year in which to give birth to a girl, and it occurs and is about the same magnitude in both the own-children estimates and the official estimates. In the second and third graphs in the figure, the own-children estimates of the TFR derived from the 1990 and 2000 censuses tend to be slightly lower than the comparable official estimates. On the whole, however, the own-children estimates and official estimates of the TFR agree closely, thus validating the use of the own-children method in the remainder of this report.

Figure 2, which shows overlapping trends in the TFR and ASFRs estimated by the own-children method from the 1980, 1990, and 2000 censuses, provides a further test of the accuracy of the own-children fertility estimates. The trends estimated from each pair of successive censuses (one pair being the 1980 and 1990 censuses and the other being the 1990 and 2000 censuses) overlap for a period of five years, as shown in the figure. The two periods of overlap are 1976–80 and 1986–90. The extent to which

Figure 1 Own-children estimates of the trend in the TFR (total fertility rate), based on the 1980, 1990, and 2000 censuses of Japan, compared with official estimates of the TFR based on birth registration data



the two trends coincide during the period of overlap is another indicator of the accuracy of the estimates. The first graph in Figure 2 indicates that the two TFR trends agree closely during both periods of overlap. The remaining graphs of ASFR trends for the age groups 15–19, 20–24, ..., 40–44 (45–49 is left out because of the very small number of births) show that the trends for each age-specific fertility rate (ASFR) also agree closely during both periods of overlap. Note that in the various graphs that constitute Figure 2, the vertical scale is not always the same. When fertility is very low, the scale is stretched out.

Figure 2 shows that, apart from the Year of the Fire Horse in 1966, fertility peaked slightly in 1967 (no doubt reflecting some catchup from delayed births), dropped slightly in 1968, and rose slightly between 1968 and 1974. In 1973, the year of the first oil shock, Japan's economy tipped into recession and the TFR fell fairly steadily starting in 1974. As the country pulled out of recession, the TFR rose slightly during the first half of the 1980s, then continued falling until 2000, the latest year that we consider. In 2000, the TFR reached 1.36 according to official statistics and 1.35 according to the own-children method.

Own-children fertility estimates by education: consistency checks

It is useful to begin by examining how women are distributed by education in each of the three censuses. The distributions, which are specified for each age group as well as for all women considered, are shown in Table 1. The table shows five-year age groups out to age 65, because our fertility estimates go back 15 years before each census, implying that women age 49 (the oldest reproductive age) 15 years ago were age 64 at the time of the census. The first thing to note is that, because the average level of education has been increasing over time, there is enormous variation over age in the proportion of women who have completed any given level of education and gone no further. For example, in the 1980 census the proportion of women who have completed junior high school but gone no further ranges from 17 percent at age 25–29 (by which age the proportion still attending some level of schooling is close to zero) to 65 percent at age 60–64. At the other extreme, the proportion who have completed college or university ranges from 8 percent at age 25–29 to less than 1 percent at age 60–64. The second thing to note is the changes that occurred by the time of the 2000 census. In 2000, the proportion who have completed junior high school and gone no further ranges from 5 percent at age 25–29 to 46 percent at age 60–64, and proportion who have completed university ranges from 16 percent at age 25–29 to 3 percent at 60–64. Among women who have graduated some level of tertiary education, the percentage whose completed education was junior college was 68 percent in both the 1980 and 2000 censuses.

The huge increases in the average level of education among Japanese women, as shown in Table 1, illustrate the need for caution when interpreting TFRs by education and changes in them over time. Among women who have completed junior high but gone no further, for example, the women age 15–19 are clearly a much more select group than the women age 60–64 in the same census. Because of this, the TFR for junior high-educated women pertains to the number of children borne to a hypothetical cohort of women that in no way resembles any real cohort of women. We shall return to this point later, when interpreting the results of decomposing the change of the TFR into components.

Figure 3 shows estimates of the TFR by woman's completed level of education. The figure includes three graphs, one for each census, with each graph showing own-children estimates of the trends in the TFR by education over the 15-year period preceding the census. In the first graph, corresponding to estimates derived from the 1980 census, the dip in the TFR in 1966, the Year of the Fire Horse, is steeper

Figure 2 Overlapping trends in the TFR (births per woman) and age-specific fertility rates (births per 1,000 women), as estimated by the own-children method applied to the censuses of 1980, 1990, and 2000

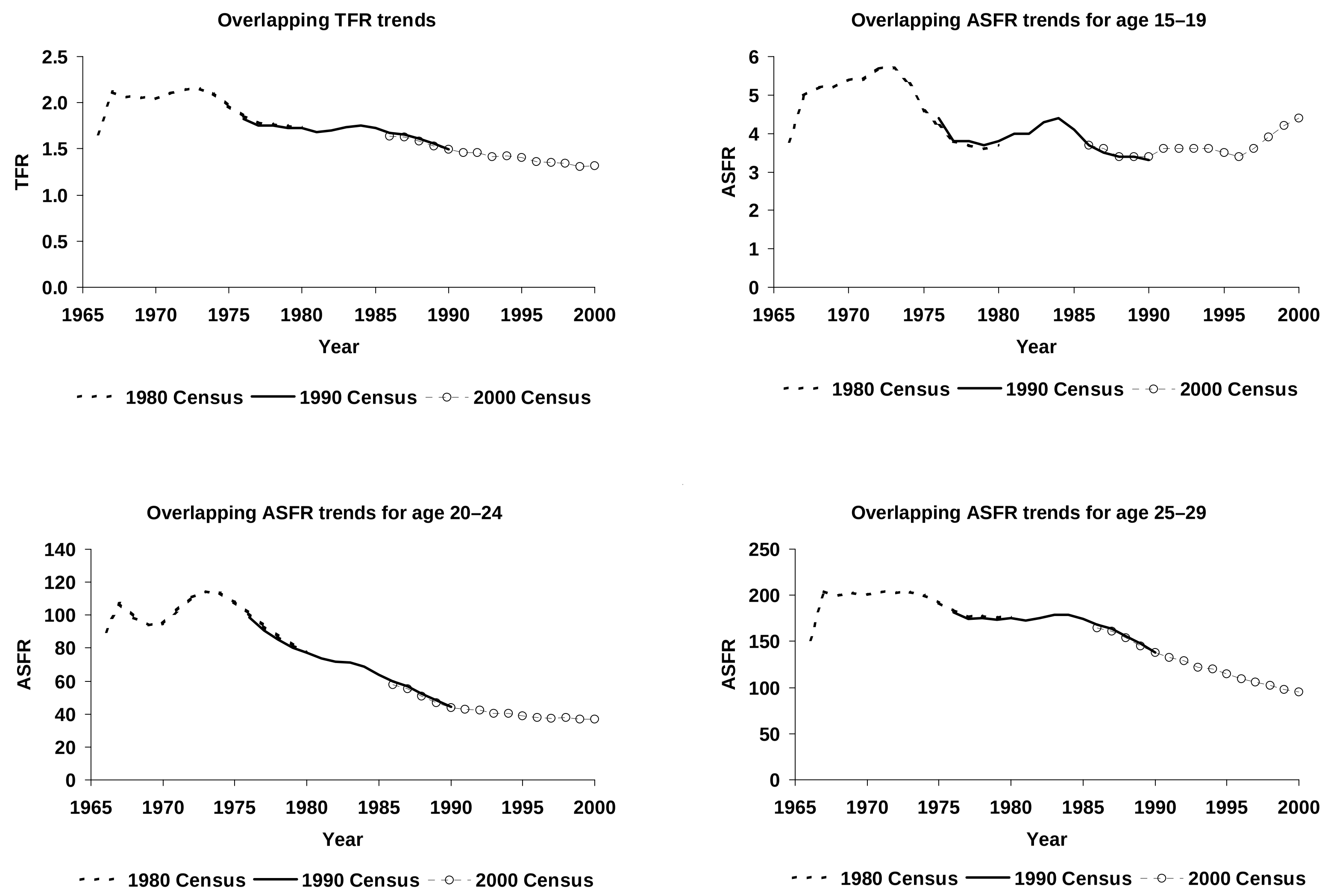
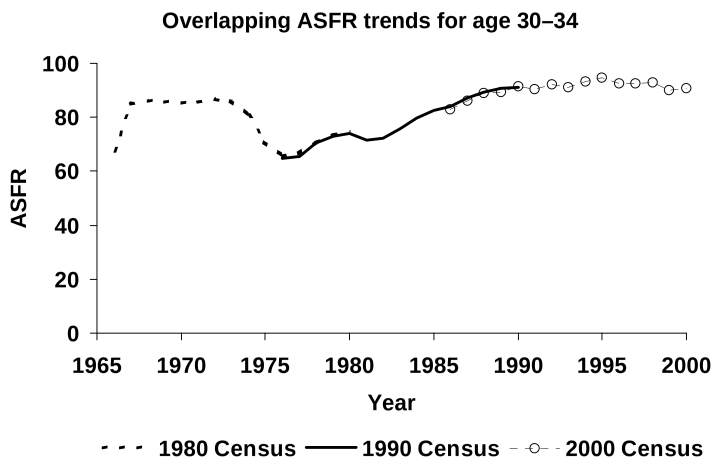
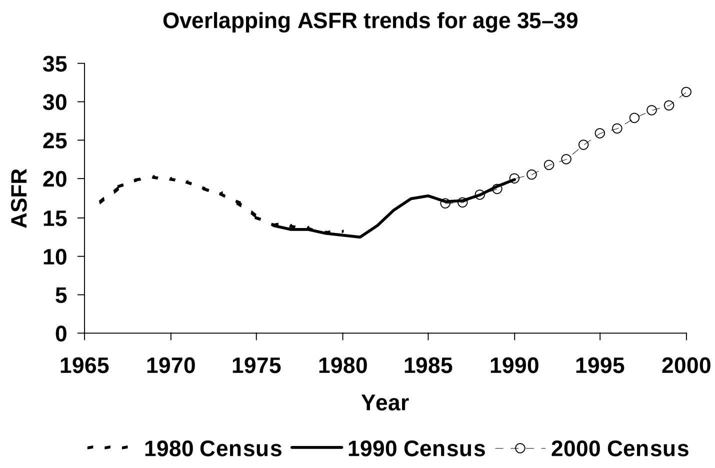


Figure 2, cont. Overlapping trends in the TFR and ASFRs (age-specific fertility rates), as estimated by the own-children method applied to the censuses of 1980, 1990, and 2000





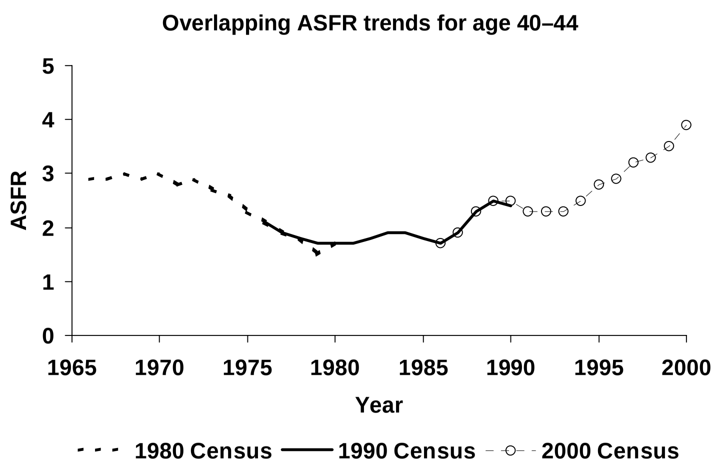


Table 1 Percent distribution of women in each age group by level of completed education: 1980, 1990, and 2000 censuses of Japan

Age group	Year	Junior high	Senior high	Junior college	University	Still attending
15–19	1980	4	14	0	0	81
	1990	4	12	0	0	84
	2000	4	9	0	0	87
20–24	1980	8	52	22	5	13
	1990	5	47	27	5	16
	2000	5	35	28	9	22
25–29	1980	17	57	17	8	0
	1990	5	51	30	12	1
	2000	5	40	34	16	1
30–34	1980	25	58	12	6	0
	1990	7	53	27	12	0
	2000	5	47	31	13	1
35–39	1980	36	53	7	4	0
	1990	14	57	18	9	0
	2000	5	51	29	12	0
40–44	1980	44	48	5	3	0
	1990	22	58	13	6	0
	2000	7	52	26	13	0
45–49	1980	49	46	4	2	0
	1990	33	53	8	4	0
	2000	14	56	18	9	0
50–54	1980	44	51	4	1	0
	1990	42	48	6	3	0
	2000	21	57	13	6	0
55–59	1980	56	40	3	1	0
	1990	47	45	4	2	0
	2000	33	52	8	4	0
60–64	1980	65	31	2	0	0
	1990	51	42	4	1	0
	2000	42	46	6	3	0
Total[a]	1980	33	46	8	3	10
	1990	22	46	14	5	11
	2000	17	45	18	8	9

Note: "Still attending" pertains to any level of schooling (including university graduate school). This category also includes a very small number of women who never attended school. Percentages do not always add to 100 percent. This may occur because of rounding, but it can also occur because the total of 100 percent (not shown) includes cases with missing information on education. There are hardly any such cases in the 1980 census, but the percentage with missing information on education increases with each successive census and reaches as much as 4 percent in some age groups in the 2000 census.

[a]Total includes age groups 15–19 through 60–64.

the lower the level of education, consistent with the expectation that those with less education are more likely to hold the traditional belief that girls born in that year are unlucky. In subsequent years, fertility is lower the higher the level of education, as expected, although early in the 15-year period the fertility of university-educated women is indistinguishable from the fertility of junior college-educated women. After 1973 (the first oil shock), fertility took a downward turn in all education groups, but somewhat more so for university-educated women than for women with less education. As a consequence, the TFR for university-educated women dropped below the TFR of junior college-educated women and remained lower after that. On the whole, fertility differentials did not change much over the 15-year period from 1966 to 1980.

The second graph in Figure 3, corresponding to fertility estimates derived from the 1990 census, shows a slight narrowing of TFR differentials by education between 1980 and 1984, when the overall TFR recovered slightly (the recovery being somewhat greater for university-educated women than for women in the other education groups), followed by a gradual divergence (again greater for university-educated women) between 1984 and 1990. An exception to this divergence is the convergence of TFRs for junior high- and senior high-educated women after1983.

The most salient feature of the third graph in the figure, corresponding to fertility estimates derived from the 2000 census, is that the TFR for university-educated women drops well below the TFRs for the other education groups, reaching 1.16 in 2000 (a value we shall see later is slightly too high). Also noteworthy is that the TFR differentials by education during the period of overlap, 1986–90, are inconsistent between the second graph and the third graph. In the second graph, junior high school-educated women (along with senior high school-educated women) have the highest fertility of any group in 1986–90, whereas in the third graph, junior high school-educated women have the second-lowest fertility of any group in 1986–90.

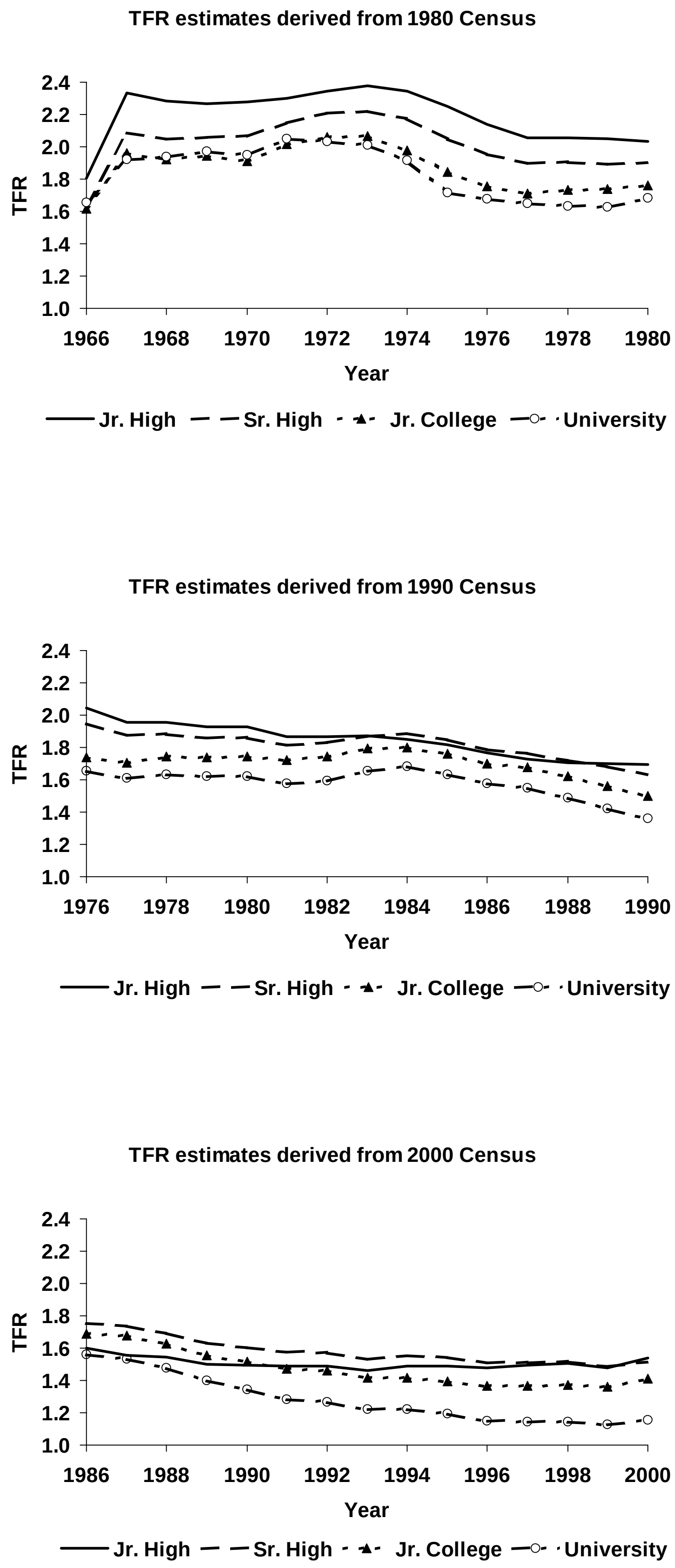
This is seen more clearly in Figure 4, which examines overlapping TFR trends for each education group separately. Figure 4 confirms close overlaps for all education groups except junior high-educated women, for whom the TFR trends are far from coinciding during the two periods of overlap, especially during the second period 1986–90.

To investigate the source of the discrepancies in the TFR estimates by woman's completed level of education, we examine overlapping trends in each ASFR at each educational level. Results are shown in Figures 5–6 for age groups 15–19 and 20–24. (Note that the vertical scale on these graphs is variable, depending on which ASFR is considered.)

Figure 5 shows overlapping trends in ASFR(15–19) for junior high and senior high but not for junior college or university, because of the very small numbers of women who graduated junior college and university before age 20. For both junior high-educated women and senior high-educated women—especially the latter—there is a sharp upturn in ASFR(15–19) in the four years before each census.

The reason for the upturn is explained more easily in the case of senior high-educated women (the second graph in Figure 5), so we consider them first. In the year before the census, most women age 15–19 are still attending senior high school (18 being the typical graduation age) and therefore fall in the "still attending" category rather than the "completed senior high school" category. Because of this, the 15–19 age group for senior high-educated women is actually, to a close approximation, an 18–19 age group, three years of the 15–19 age group being effectively truncated. Because single-year age-specific fertility rates climb steeply between ages 15 and 20, the estimate of ASFR(15–19) is calculated for what is essentially an 18–19 age group and is therefore biased substantially upward. In the second year before

Figure 3 Trends in the TFR by woman's completed level of education, as estimated by the own-children method applied to the 1980, 1990, and 2000 censuses of Japan



the census, ASFR(15–19) for senior high-educated women is derived from women age 16–20 at the time of the census, but these women are mostly age 18–20. The upward bias in the estimate of ASFR(15–19) is now smaller, because only two years are truncated from the 15–19 age group instead of three years. By the fourth year before the census, the upward bias is mostly eliminated (except for those few women who graduate senior high school after age 18), because the estimate of ASFR(15–19) is based on women age 18–22 at the time of the census.

A similar mechanism explains the upturns in the estimates of ASFR(15–19) in the first graph in Figure 5 for junior high-educated women, many of whom graduated after their fifteenth birthday. But the upward bias is smaller for junior high-educated women, because the typical graduation age for junior high school is 15, so that the average graduation age falls closer to the start of the 15–19 age group than is the case with senior high-educated women.

Another major difference between the trends in ASFR(15–19) for junior high-educated women and senior high-educated women is that, if one ignores the upturns during the four years before each census, the trends in ASFR(15–19) coincide during the periods of overlap for senior high-educated women but are sharply divergent for junior high-educated women, as also shown in Figure 5. It is also evident from the first graph in this figure that the discrepancies in the estimates of ASFR(15–19) for junior high-educated women are more pronounced during 1986–90 than in 1976–80. In 1976, just preceding the upturn during the four-year period before the 1980 census, the estimates of ASFR(15–19) derived from the 1980 and 1990 censuses differ little, but in 1986, ten years later, the estimates of ASFR(15–19) derived from the 1990 and 2000 censuses differ by about 25 percent (with the estimate from the 1990 census taken as the base of comparison).

Is the 1986 estimate of ASFR(15–19) for junior high-educated women derived from the 2000 census too low because reverse-survived women are relatively too numerous or because reverse-survived children are relatively too few? To answer the first question, it is useful to consider the ratio of the number of junior high-educated women age 30–34 in the 2000 census to women age 20–24 in the 1990 census. (This group of women approximates the group of women on which the 1986 estimate of ASFR(15–19) is based.). We expect this ratio to be slightly less than 1.00 because some women died in the intervening ten years. The ratio turns out to be 0.97, indicating that the number of reverse-survived women is not overestimated.

It thus appears that the 1986 estimate of ASFR(15–19) for junior high-educated women derived from the 2000 census is too low because the number of reverse-survived children is too small. This could occur in several ways, mostly relating to out-of-wedlock pregnancies. Out-of-wedlock pregnancy is a common reason why young women drop out of senior high school. These women show up in the census as women who have completed junior high school but are no longer attending school; i.e., they show up in our category of junior high-educated women. Although some of these pregnant women get an abortion, some decide to have the baby instead. This is indicated by official birth registration statistics, which indicate that the proportion of births occurring out of wedlock at age 15–19 increased from 6 percent in 1976 to 9 percent in 1986 to 15 percent in 2000. The official statistics do not provide additional detail by mother's education, since, as mentioned earlier, information on mother's education is not obtained on the birth registration certificate. It is virtually certain, however, that the proportion of births occurring out of wedlock is much higher for junior high-educated women than for women with more education.

At the time they get pregnant and drop out of senior high school, virtually all of these junior high-educated women are living with their parents. Figure 5 is thus consistent with the hypothesis that, as the

Figure 4 Overlapping trends in the TFR by woman's completed level of education, as estimated by the own-children method applied to the 1980, 1990, and 2000 censuses of Japan

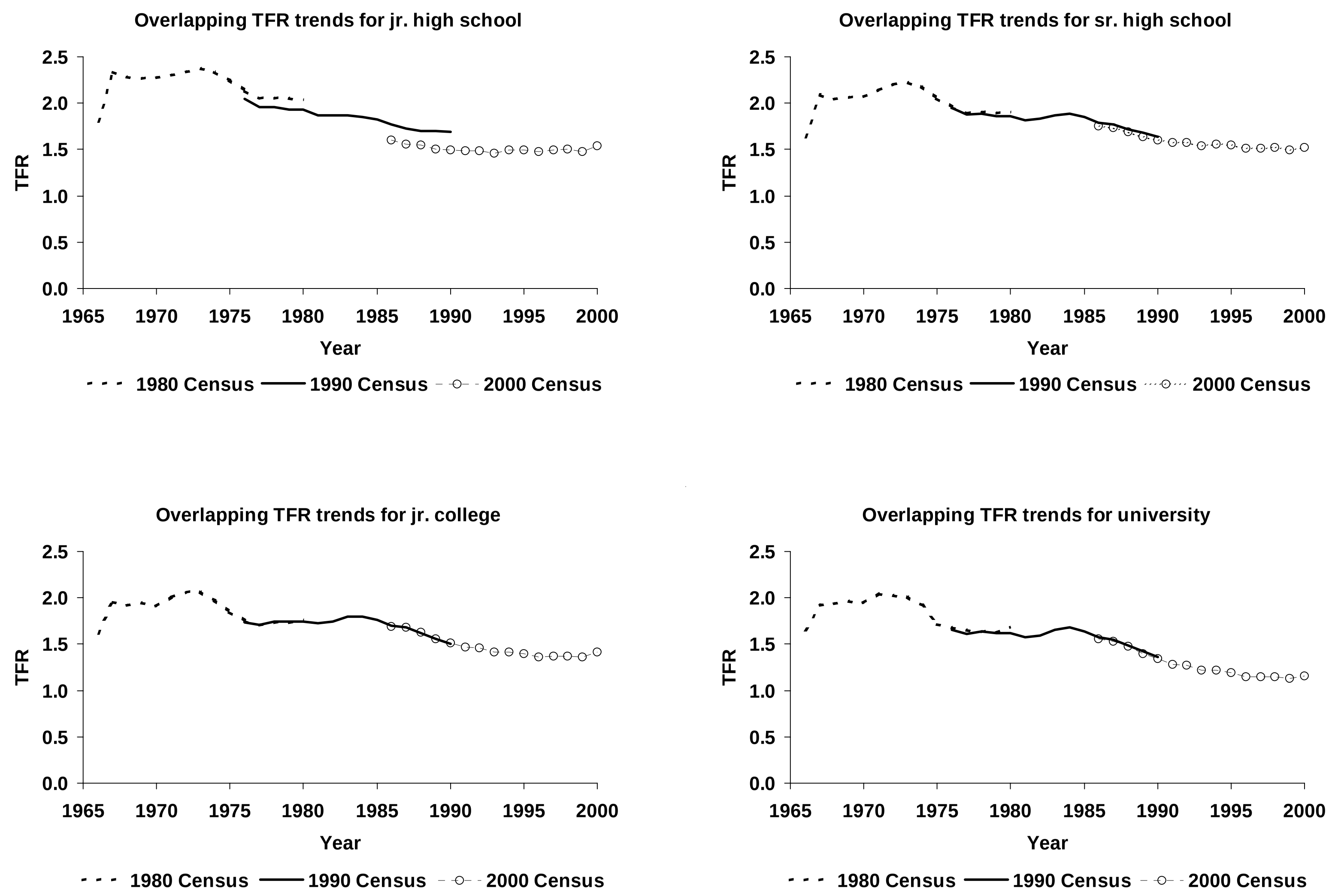
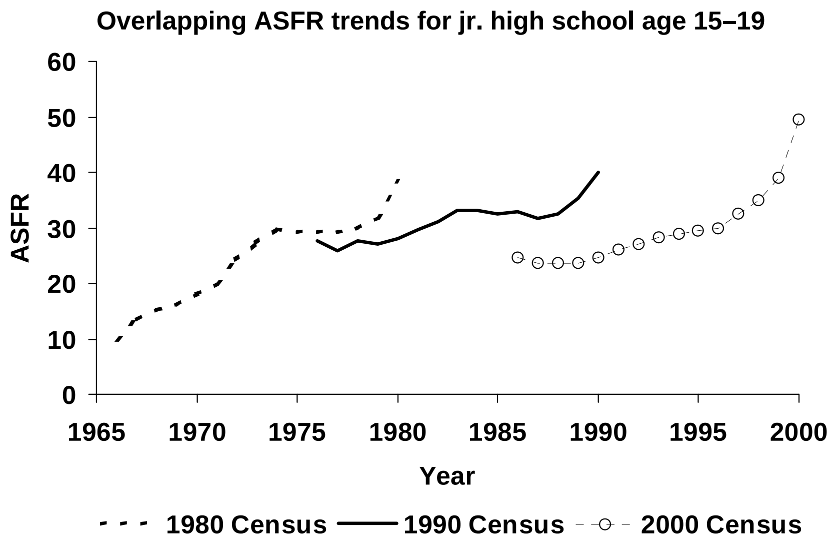
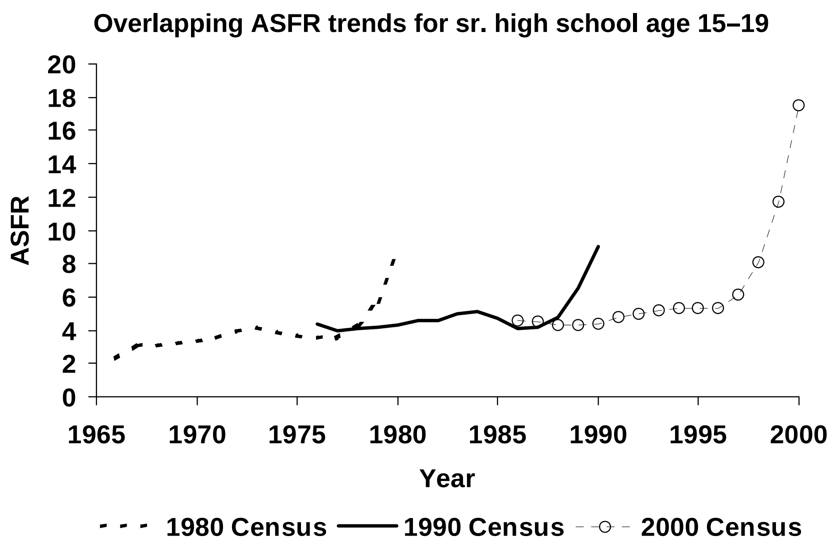


Figure 5 Overlapping trends in ASFR(15–19) for women who have completed junior high school and women who have completed senior high school, as estimated by the own-children method applied to the 1980, 1990, and 2000 censuses of Japan (rates per 1,000 women age 15–19)





baby gets older, the young mother is increasingly likely to move out of her parents' home, perhaps to get a job, so that the child is raised by the grandparents, at least for significant periods of time.

Alternatively, the young mother may get married before having her baby if the father is older and already holding down a job. But such marriages tend to be unstable and often end in divorce, in which case the young mother is usually in the position of having to get a job. Again the child is likely to end up being raised by the grandparents, at least for significant periods of time. According to official statistics, the divorce rate (divorces per 100 marriages per year) at age 15–19 has increased from 2.1 in 1980 to 3.7 in 1990 to 5.8 in 2000 for all women regardless of education (National Institute of Population and Social Security Research 2002), implying that the proportion of marriages at age 15–19 ending in divorce within five years increased from 11 percent in 1980 to 19 percent in 1990 to 29 percent in 2000. Again these proportions are probably much higher for junior high-educated women than for all women. It is likely that, in addition to increases in out-of-wedlock birth rates and divorce rates, there has also been an increase in the propensity of young mothers without husbands to go out and work and leave a child to be raised by grandparents.

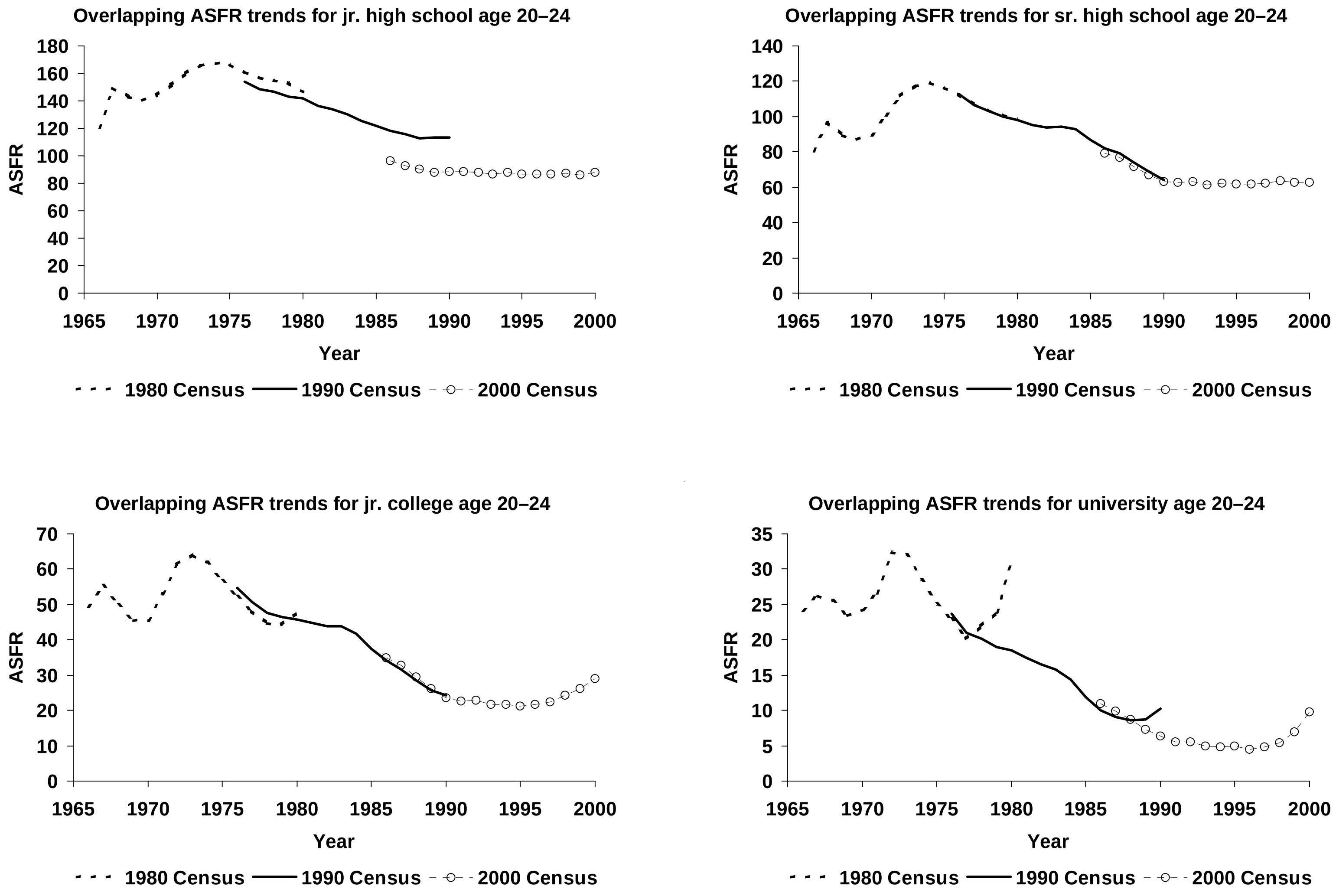
If the child is living with grandparents and the mother is living elsewhere, then, when the own-children method is applied to census data, the child cannot be matched to its mother in the same household, because the mother is not there. The child then shows up as a non-own (unmatched) child when calculating the own-children fertility estimates. In the own-children method, non-own children are allocated by multiplying each category of own children (i.e., matched children) of a given age by the ratio of all children (own plus non-own) at that age to own-children at that age. This adjustment cannot take into account mother's education because we do not know who the mother is in the case of the non-own children. In the case of junior high-educated women age 15–19, it is undoubtedly true that the adjustment allocates too many non-own children to women with more than a junior high education and not enough to the junior high-educated women. This, in our judgment, this is the main reason for the large discrepancies in overlapping estimates of ASFR(15–19) for junior high-educated women in Figure 5.

In this regard it should also be noted that adoption of out-of-wedlock births cannot explain the much lower estimate of ASFR(15–19) for junior high-educated women derived from the 2000 census than from the 1990 census. Adoption does not occur often in Japan, but when it does occur, it most likely occurs within days or weeks after the birth of the child. If adoption were the explanation of the discrepancies for junior high-educated women in Figure 5, the 1986 estimate of ASFR(15–19) derived from the 1990 census, which is based on children age 4 at the time of the 1990 census, would also be too low, since the child would be adopted out before age 4 and could then not be matched to its mother in either census. (It would likely be matched to its adoptive mother, but that mother would undoubtedly be older than age 20 and would usually have a higher level of education.)

Figure 6 shows overlapping trends of ASFR(20–24) by education. For junior high-educated women, the pattern of discrepancies is similar to that in Figure 5 for ASFR(15–19), indicating that the same mechanisms are still operating, relating to out-of-wedlock births and divorce. The overlaps for senior high school and junior college are close and pose no problems. At the university level, one sees upturns in the four years before each census, due to the fact that the average age at university graduation is well above age 20. If the upturns are ignored, the trends overlap closely, again posing no problem of interpretation.

In the case of ASFR(25–29), ASFR(30–34), ASFR(35–39), and ASFR(40–44), the overlapping trends at each education level (not shown) agree closely and pose no problem of interpretation.

Figure 6 Overlapping trends in ASFR(20–24) by woman's completed level of education, as estimated by the own-children method applied to the 1980, 1990, and 2000 censuses of Japan (rates per 1,000 women age 20–24)



Own-children fertility estimates by education: best estimates

Our strategy is to provide best estimates not for single calendar years but for five-year time periods beginning with 1966–70 and ending with 1996–2000. When overlapping trends are in close agreement, ascertaining the best estimates is not a problem. But when they are not in close agreement, it is necessary to make some choices, some of which involve an element of educated guesswork. The choices described below are based on visual inspection of the curves examined earlier in Figures 5–10 in conjunction with our conclusions about the reasons why discrepancies sometimes occur.

In the case of ASFR(15–19) for junior high-educated women, we use the own-children fertility estimates from the 1980 census for the periods 1966–70 and 1971–75, the own-children estimates from the 1990 census for 1976–80 and 1981–85, and the own children estimate for 1983–87 from the 1990 census for 1986–90. We then linearly extrapolate these best estimates for 1981–85 and 1986–90 to estimate ASFR(15–19) for 1991–95 and 1996–2000. These procedures and choices are based on visual inspection of the ASFR(15–19) curves for junior high school in Figure 5 in conjunction with our conclusions about how out-of-wedlock births and divorces distort the estimates derived from the 2000 census.

In the case of ASFR(15–19) for senior high-educated women, we use the own-children estimates from the 1990 census for 1976–80 and own-children estimates from the 2000 census for 1986–90. We linearly extrapolate the estimates for 1986–90 and 1991–95 to estimate ASFR(15–19) for 1996–2000.

In the case of ASFR(20–24) for junior high-educated women, we use the own-children estimates from the 1980 census for 1976–80, the own-children estimates from the 1990 census for 1986–90, and the own-children estimate for 1996–2000 from the 2000 census. We then calculate ASFR(20–24) for junior high-educated women for 1991–95 as the average of the final values for 1986–90 and 1996–2000.

In the case of ASFR(20–24) for senior high-educated women, we use the own-children estimates from the 1980 census for 1976–80 and the own-children fertility estimates from the 1990 census for 1986–90. In the case of ASFR(20–24) for junior college-educated women, we use the own-children estimates from the 1990 census for 1976–80 and for 1986–90, and we use the own-children fertility estimate for 1992–96 from the 2000 census for 1996–2000. In the case of ASFR(20–24) for university-educated women, we use the own-children estimate from the 1990 census for 1976–80, the own-children estimate from the 2000 census for 1986–90, and the own-children estimates for 1992–96 from the 2000 census for 1996–2000. Again, these choices are based on visual inspection of Figure 6 in conjunction with our earlier conclusions about the reasons for the various inconsistencies that are observed.

In the case of ASFRs at ages 25–29 and older age groups, we use the own-children estimates from the 1980 census for 1976–80 and the own-children estimates from the 1990 census for 1986–90.

Based on the above procedures and choices, our best estimates of the TFR and ASFRs by woman's level of completed education for the periods 1966–70, 1971–75, ..., 1996–2000 are shown in Tables 2–9. The best estimates of TFR trends by education are shown also in Figure 7.

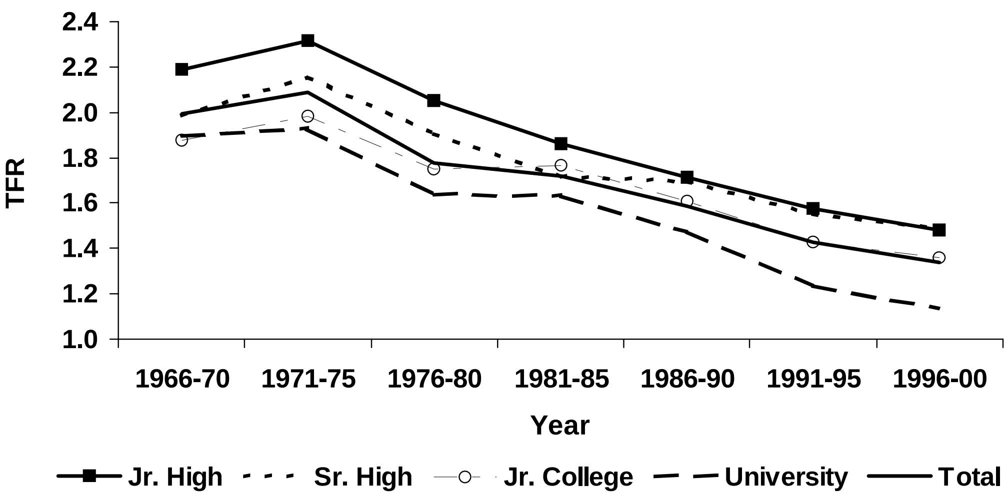
Table 2 and Figure 7 show that between 1966–70 and 1971–75, the TFR rose in all education groups, but less so for junior college- and university-educated women than for junior high- and senior high-educated women. During the economic downturn that occurred between 1971–75 and 1976–80, the TFR fell, especially for university-educated women. During the economic recovery between 1976–80 and 1981–86, the TFR leveled off for university-educated women and increased slightly for junior college-educated women while continuing to decline for junior high- and senior high-educated women. After 1986–90, the TFR for junior high- and senior high-educated women converged to the same values, the TFR for junior college-educated women was about a tenth of a child lower, and the TFR of university-

Table 2 Best estimates of the trend in the total fertility rate (TFR) by woman's level of completed education (births per woman)

Time period	Junior high	Senior high	Junior college	University	Total
1966–70	2.19	1.99	1.88	1.90	1.99
1971–75	2.32	2.16	1.98	1.93	2.09
1976–80	2.05	1.91	1.75	1.64	1.78
1981–85	1.86	1.72	1.77	1.63	1.72
1986–90	1.71	1.70	1.61	1.48	1.59
1991–95	1.57	1.56	1.43	1.24	1.43
1996–2000	1.48	1.49	1.36	1.14	1.34

Note: TFRs by education in this table are calculated from the ASFRs presented in Tables 3–9.

Figure 7 Best estimates of the trend in the TFR by woman's level of completed education, from 1966-70 to 1996-2000 (births per woman)



educated women diverged to levels about two-tenths of a child lower than that of junior college-educated women. By 1996–2000, the TFR for university-educated women reached 1.14 children per woman, compared with an average TFR for the whole country of 1.34 children per woman, as estimated by the own-children method.

Tables 3–9 show corresponding trends for the ASFRs that make up the TFR. ASFR(15–19) was very low in all time periods for all education groups except junior high, and it tended to rise somewhat over time for both junior high- and senior-high educated women. At ages 20–24 and 25–29, ASFRs fell after 1976–80 in all education groups. At ages 30–34 and 35–39, ASFRs tended to rise after 1976–80 in all education groups, reflecting increasingly delayed childbearing in response to rapid increases in age at marriage in all education groups that commenced after the 1973 oil shock.

Table 3 Best estimates of the trend in ASFR(15–19) by woman's level of completed education: (births per 1,000 women)

Time period	Junior high	Senior high	Junior college	University	Total
1966–70	14	3	1	0	5
1971–75	25	4	1	0	5
1976–80	27[a]	4[a]	1[a]	0[a]	4[b]
1981–85	32	4	1	0	4
1986–90[a]	33[c]	4[d]	1[d]	0[d]	4[a]
1991–95	33[e]	5	0	0	4
1996–2000	34[e]	6[f]	1	0	4

Note: Rates for 1966–70 and 1971–75 are derived from the 1980 census, rates for 1981–86 are derived from the 1990 census, and rates for 1990–95 and 1996–2000 are derived from the 2000 census.

[a]Derived from the 1990 census.

[b]Derived from the 1980 census.

[c]For this value we used the estimate of ASFR(15–19) for 1983–87 derived from the 1990 census, for reasons explained in the text.

[d]Derived from the 2000 census.

[e]Linearly extrapolated from the best values for junior high for 1981–85 and 1986–90.

[f]Linearly extrapolated from the best values for senior high for 1986–90 and 1991–95.

Table 4 Best estimates of the trend in ASFR(20–24) by woman's level of completed education (births per 1,000 women)

Time period	Junior high	Senior high	Junior college	University	Total
1966–70	140	89	49	25	967
1971–75	162	113	60	29	110
1976–80	156[a]	87	49[b]	20[b]	87
1981–85	130	70	42	15	70
1986–90	115[b]	72	29	9[c]	51
1991–95	101[d]	62	22	5	41
1996–2000	87[c]	63	22[e]	5[f]	37

Note: Except where otherwise noted, rates for 1966–70, 1971–75, and 1976–80 are derived from the 1980 census, rates for 1981–85 and 1986–90 are derived from the 1990 census, and rates for 1991–95 and 1996–2000 are derived from the 2000 census.

[a]Derived from the 1980 census.

[b]Derived from the 1990 census.

[c]Derived from the 2000 census.

[d]Calculated as the average of the final values for 1986–90 and 1996–2000.

[e]For this value we used the estimate of ASFR(20–24) for 1991–95 derived from the 2000 census.

[f]For this value we used the estimate of ASFR(20–24) for 1992–96 derived from the 2000 census.

Table 5 Best estimates of the trend in ASFR(25–29) by woman's level of completed education (births per 1,000 women)

Time period	Junior high	Senior high	Junior college	University	Total
1966–70	188	197	194	190	193
1971–75	187	207	205	199	200
1976–80	159	185	187	173	179
1981–85	143	176	186	163	176
1986–90	124	155	157	129	155
1991–95	102	137	125	89	124
1996–2000	91	117	105	69	102

Note: Rates for 1966–70, 1971–75, and 1976–80 are derived from the 1980 census, rates for 1981–85 and 1986–90 are derived from the 1990 census, and rates for 1991–95 and 1996–2000 are derived from the 2000 census.

Table 6 Best estimates of the trend in ASFR(30–34) by woman's level of completed education (births per 1,000 women)

Time period	Junior high	Senior high	Junior college	University	Total
1966–70	75	86	103	121	82
1971–75	71	86	103	122	82
1976–80	55	72	93	107	70
1981–85	54	76	99	117	76
1986–90	56	88	108	123	88
1991–95	61	84	107	114	92
1996–2000	61	85	106	109	92

Note: Rates for 1966–70, 1971–75, and 1976–80 are derived from the 1980 census, rates for 1981–85 and 1986–90 are derived from the 1990 census, and rates for 1991–95 and 1996–2000 are derived from the 2000 census.

Table 7 Best estimates of the trend in ASFR(35–39) by woman's level of completed education (births per 1,000 women)

Time period	Junior high	Senior high	Junior college	University	Total
1966–70	19	19	25	37	19
1971–75	16	19	25	31	18
1976–80	12	14	19	24	14
1981–85	12	16	22	28	16
1986–90	13	18	24	31	18
1991–95	16	20	29	34	23
1996–2000	21	25	34	40	29

Note: Rates for 1966–70, 1971–75, and 1976–80 are derived from the 1980 census, rates for 1981–85 and 1986–90 are derived from the 1990 census, and rates for 1991–95 and 1996–2000 are derived from the 2000 census.

Table 8 Best estimates of the trend in ASFR(40–44) by woman's level of completed education (births per 1,000 women)

Time period	Junior high	Senior high	Junior college	University	Total
1966–70	3	3	4	6	3
1971–75	3	3	3	5	3
1976–80	2	2	2	3	2
1981–85	2	2	2	3	2
1986–90	2	2	3	4	2
1991–95	2	2	3	4	2
1996–2000	3	3	4	5	3

Note: Rates for 1966–70, 1971–75, and 1976–80 are derived from the 1980 census, rates for 1981–85 and 1986–90 are derived from the 1990 census, and rates for 1991–95 and 1996–2000 are derived from the 2000 census.

Table 9 Best estimates of the trend in ASFR(45–49) by woman's level of completed education (births per 1,000 women)

Time period	Junior high	Senior high	Junior college	University	Total
1966–70	0	0	0	1	0
1971–75	0	0	0	1	0
1976–80	0	0	0	0	0
1981–85	0	0	0	0	0
1986–90	0	0	0	0	0
1991–95	0	0	0	0	0
1996–2000	0	0	0	0	0

Note: Rates for 1966–70, 1971–75, and 1976–80 are derived from the 1980 census, rates for 1981–85 and 1986–90 are derived from the 1990 census, and rates for 1991–95 and 1996–2000 are derived from the 2000 census.

Decomposition of the change in the TFR into components

This section presents decompositions of the change in the TFR into components—one due to changes in population composition by education within age groups (which we shall refer to as changes in educational attainment), one due to changes in age-specific proportions ever married (ASPEMs) within education groups, and one due to changes in age-specific ever-marital fertility rates (ASEMFRs) within education groups. Changes over three time periods are examined: 1980–90, 1990–2000, and 1980–2000.

Five education groups are considered. As defined earlier, they are junior high school, senior high school, junior college, university, and "still attending school." The first four categories refer to completed education; for example, junior high school means that the woman graduated junior high school and is no longer attending school.

Own-children estimates of age-specific fertility rates (ASFRs) refer to the year before each census—1980, 1990, or 2000— whereas education and marital status are measured at the time of the census, assuming that education level and marital status did not change between the middle of the year before the census and six months later at the time of the census. ASEMFRs are then derived by dividing the ASFRs by the ASPEMs. This requires the assumption that all fertility occurs within marriage, contradicting our earlier analysis that concluded that some fertility at 15–19 and 20–24 occurs out of wedlock , particularly among junior high-educated women. But we are not able to estimate precise levels of out-of-wedlock fertility by woman's level of completed education, and this is why we assume in the decomposition analysis that all fertility occurs within marriage. Out-of-wedlock fertility is rare in Japan, however, so this assumption probably does not introduce much error in the decompositions.

When calculating own-children estimates of ASFRs for the year prior to each census, we make no adjustments to compensate for the upturns in the fertility estimates that occur during the four years before each census in some age-education groups. Again the lack of adjustment probably makes little difference in the decompositions, for three reasons: The first is that fertility is low in the age-education groups where the upturns occur. The second is that the upturns are compensated for by the inclusion of the "still attending" category of education in the decompositions, inasmuch as fertility is close to zero in the "still attending" group. The third is that errors of estimation tend to be similar in successive censuses, so that to some extent the errors cancel out when fertility change is analyzed. Errors are not completely absent, however, which means that the estimated decomposition components are only roughly accurate.

Table 10 shows decompositions of the change in the TFR for 1980–90, 1990–2000, and 1980–2000. Base calculations of the decompositions were done for five-year age groups, after which age-specific components were aggregated to ages 15–29 and 30–49.

Over the entire period 1980–2000, as shown in the third part of Table 10, changes in educational attainment accounted for only 1 percent of the decline in the TFR of 0.40 child. Changes in educational attainment at 15–29 contributed to the decline, because at these ages the shift toward higher levels of education means lower fertility due to later childbearing. Changes in educational attainment at 30–49 offset this contribution, because at these ages the shift toward higher education means higher fertility due to later childbearing. During the period 1980–2000 the components from changes in educational attainment in these two broad age groups almost exactly offset each other.

Changes in ASEMFRs within education groups over the period 1980–2000 acted to increase the TFR by 18 percent. Reductions in ASEMFRs at 15–29 acted to reduce the TFR, but increases in ASEMFRs at ages 30–49, due to increasingly delayed marriage and childbearing in all education groups, acted even more strongly to increase the TFR. By far the most important component of change in the TFR stems from changes in ASPEMs within education groups. This component accounts for 117 percent of the decline in the TFR—more than the actual change in the TFR—in order to compensate for the component from changes in ASEMFRs within education groups, which acts in the opposite direction.

The first two parts of Table 10, pertaining to the two subperiods 1980–90 and 1990–2000, show that the contribution of changes in ASPEMs within education groups to the change in the TFR was somewhat larger for 1980–90 than for 1990–2000, and that the offsetting contribution from changes in ASEMFRs was somewhat smaller for 1980–90 than for 1990–2000. Interestingly, changes in educational attainment acted to increase the TFR between 1980 and 1990 but to decrease the TFR between 1990 and 2000. These opposite effects should not be interpreted to mean that the causal effect of education on individual behavior changed over these two periods. Instead, what the result shows is that compositional shifts by education can have unexpected effects on a complex measure such as the TFR, which combines the experience of many different birth cohorts caught at different ages in a particular calendar year.

Some insight as to how changes in education composition can act to increase the TFR can be gained by considering the subcomponent of change in the TFR between 1980 and 2000 that results from changes in educational composition within the 35–39 age group. From the decomposition formula given earlier in the data and methods section, this subcomponent is calculated as the change in the proportion in each education category within the 35–39 age group multiplied by the average level of fertility within that

Table 10 Decomposition of the change in the total fertility rate (TFR) into components due to changes in educational composition, age-education-specific proportions ever-married, and age-education-specific marital fertility rates

1980–1990

Age	Component due to change in: Educational attainment	Marriage	Marital fertility	Total
15–29	10	118	26	154
30–49	-26	8	-36	-54
Total	-17	126	-9	100

TFR fell by 0.24 child, from 1.74 to 1.50

1990–2000

Age	Component due to change in: Educational attainment	Marriage	Marital fertility	Total
15–29	31	68	39	138
30–49	-12	46	-72	-38
Total	19	114	-33	100

TFR fell by 0.17 child, from 1.50 to 1.33

1980–2000

Age	Component due to change in: Educational attainment	Marriage	Marital fertility	Total
15–29	20	94	33	147
30–49	-19	23	-51	-47
Total	1	117	-18	100

TFR fell by 0.40 child, from 1.74 to 1.33

Notes: Educational attainment is measured by the proportions in each education group within each age group. Marriage is measured by age-specific proportions ever-married within each education group. Marital fertility is measured by age-specific ever-marital fertility rates within each education group. Base calculations were done for five-year age groups and then aggregated to ages 15–29 and 30–49. Because of rounding errors, cell entries do not always add to totals. Women with missing information on age, education, or marital status are excluded from the calculations.

education category over the time period, yielding four products that are summed over the four education categories[2] to yield the subcomponent of change in the TFR that stems from changes in educational composition within the 35–39 age group. Between 1980 and 2000, the main compositional change that occurred within the 35–39 age group was that the proportion in the junior high category went down and the proportion in the junior college category went up. Because age at marriage and childbearing occur later in life for junior college women than for junior high women, the average level of fertility at 35–39 was higher for junior college-educated women than for junior high-educated women. As a result, the negative (fertility-reducing) sub-subcomponent stemming from the decrease in the proportion in the junior high category was more than offset by the positive (fertility-enhancing) sub-subcomponent stemming from the increase in the proportion in the junior college category. This simple example illustrates that the

[2]The fifth category, "still attending," is empty at 35–39 and contributes nothing.

Table 11 Decomposition of the change in the total fertility rate (TFR) over the period 1980–2000 into components due to changes in age-specific proportions ever-married (ASPEMs) and age-specific marital fertility rates (ASMFRs) for women at each level of completed education

Junior high

	Component due to change in:		
Age	**Marriage**	**Marital fertility**	**Total**
15–29	85	30	115
30–49	18	-33	-15
Total	102	-2	100

TFR fell by 0.50 child, from 2.03 to 1.54.

Senior high

	Component due to change in:		
Age	**Marriage**	**Marital fertility**	**Total**
15–29	98	32	130
30–49	20	-50	-30
Total	118	-18	100

TFR fell by 0.39 child, from 1.91 to 1.52.

Junior college

	Component due to change in:		
Age	**Marriage**	**Marital fertility**	**Total**
15–29	107	34	141
30–49	29	-70	-41
Total	136	-36	100

TFR fell by 0.35 child, from 1.76 to 1.41.

University

	Component due to change in:		
Age	**Marriage**	**Marital fertility**	**Total**
15–29	87	32	119
30–49	29	-47	-19
Total	116	-16	100

TFR fell by 0.53 child, from 1.69 to 1.16.

Total population

	Component due to change in:		
Age	**Marriage**	**Marital fertility**	**Total**
15–29	120	23	143
30–49	24	-67	-43
Total	145	-45	100

TFR fell by 0.42 child, from 1.74 to 1.31.

Note: Marriage is measured by age-specific proportions ever-married. Marital fertility is measured by age-specific ever-marital fertility rates. TFR values and the age marginals in the last panel of this table, pertaining to the total population of Japan, differ slightly from the TFR values and age marginals in the last panel of Table 10 because Table 10 excludes women (and their children) with missing information on education or marital status.

overall component of change in the TFR stemming from changes in educational composition in all age groups could be either positive or negative, depending on the relative sizes of the negative and positive subcomponents stemming from changes in educational composition in particular age groups.

Table 11 extends the decomposition analysis to show decompositions of the change in the TFR for each education group (except "still attending") over the period 1980–2000. The purpose of these decompositions is to provide additional evidence in support of our assertion that age at marriage increased in all education groups. The first four decompositions in the table support this assertion by showing that changes in ASPEMs account for all of the decline in the TFR in each education group. In all four groups, the contribution of changes in ASPEMs to the change in the TFR exceeds 100 percent, thereby offsetting contributions from changes in ASEMFRs within education groups that tended to increase the TFR. The fifth panel of the table shows a similar decomposition of the change in the TFR for the total population, irrespective of educational level. In this decomposition also, changes in ASEMFRs act to increase the TFR, and changes in ASPEMs account for all of the decline in the TFR.

SUMMARY AND CONCLUSION

The application of the own-children method in this report is unique in that education refers to the level of education that women ultimately complete. In earlier applications of the method in other countries, the education variable is based on a simple question on highest grade completed. In this latter case, many women at the youngest reproductive ages are still attending school, so that their level of education as indicated in a census or household survey does not necessarily indicate the level of education that they will ultimately complete. In contrast, the education variable in the present analysis of Japanese census data is based on a question about the level of education (junior high, senior high, junior college, university) and a second question on whether the woman has graduated that level or is still attending that level. Women not currently attending school are assigned the highest level of education from which they graduated and are assumed to have completed their education. (Some may return to school later, but in Japan the proportion who do so is quite small.)

This way of measuring education has led to some surprising findings. One unexpected finding is upturns in ASFR estimates for certain age-education groups in the four years before the census. At a particular level of education, an upturn typically occurs in the ASFR for the age group where the typical age of graduation from that level of education occurs within the age group. The upturn occurs because most persons in the younger part of the age group, where fertility is lower, are still attending school because they have not yet graduated and are therefore not included in the specified education category.

Another unexpected finding was that some of the overlapping trend estimates at ages 15–19 and 20–24 for junior high-educated women did not coincide closely at all. Especially in the period 1986–90, estimates of ASFR(15–19) and ASFR(20–24) derived from the 2000 census were much lower than corresponding estimates derived from the 1990 census. Ultimately this discrepancy was traced to rising numbers of women who dropped out of senior high because of an out-of-wedlock pregnancy. These women are classified as having completed junior high school. Our results suggest that, in their early childhood years, the children of these women tended to live with their mothers in the mother's parent's home and could therefore be matched to mothers in the 1990 census, so that they showed up as births to junior high-educated mothers age 15–19 in the period 1986–90. But a significant proportion of these children (roughly one-quarter of them), when they were ten years older in the 2000 census, appear to live only with grandparents or other relatives, in which case they cannot be matched to a mother within the same household. The own-children method allocates these unmatched children in a proportional manner to the various categories of women, but it is clear that, because of the relatively high rate of out-of-wedlock pregnancies and births to junior high-educated women, not nearly enough of the unmatched children are allocated to junior high-educated women at ages 15–19 and 20–24. Based on this diagnosis of the nature of the errors of estimation, we made corrections in those few cases where they were needed and arrived at a set of "best estimates" of ASFRs and TFRs by education for five-year time periods ranging from 1966–70 to 1996–2000.

Our "best estimates" indicate that between 1966–70 and 1971–75, the TFR rose in all education groups, but less so for junior college- and university-educated women than for junior high- and senior high-educated women. During the economic downturn that occurred between 1971–75 and 1976–80, the TFR fell, especially for university-educated women. During the economic recovery between 1976–80 and 1981–86, the TFR leveled off for university-educated women and increased slightly for junior college-educated women while continuing to decline for junior high- and senior high-educated women. After 1986–90, the TFR for junior high- and senior high-educated women converged to the same values, the TFR for junior college-educated women was about a tenth of a child lower, and the TFR of university-educated women diverged to levels about two-tenths of a child lower than that of junior college-educated women. By 1996–2000, the TFR for university-educated women reached 1.14 children per woman, compared with an average TFR for the whole country of 1.34 children per woman, as estimated by the own-children method.

We also undertook a decomposition analysis that decomposed the change in the TFR into three components: one due to changes in population composition by educational attainment, one due to changes in age-specific proportions ever-married within education groups, and one to changes in age-specific ever-marital fertility rates within education groups. The analysis showed that changes in educational attainment tended to increase the TFR between 1980 and 1990, to reduce the TFR between 1990 and 2000, and to contribute almost nothing to the decline in the TFR over the entire period 1980–2000.

The opposite contributions to change in the TFR from changes in population composition by educational attainment during 1980–90 and 1990–2000 should not be interpreted to mean that the causal effect of education on individual behavior changed over these two periods. Instead, what the result shows is that compositional shifts by education can have unexpected effects on a complex measure such as the TFR, which combines the experience of many different birth cohorts caught at different ages in a particular calendar year. A different kind of analysis of fertility change, based on individual women as the units of analysis, might show a very different result.

The decomposition analysis also showed that changes in age-specific ever-marital fertility rates within education groups tended to increase the TFR, both for the entire period 1980–2000 and the two shorter periods 1980–1990 and 1990–2000. In contrast, changes in marriage—i.e., changes in age-specific proportions ever-married within education groups—more than accounted for the decline in the TFR in all three time periods.

In sum, the main findings from the decomposition analysis are: (1) Changes in educational attainment contributed almost nothing to the decline in the TFR between 1980 and 2000. (2) Changes in marital fertility within age-education groups tended to increase the TFR over this period. (3) Later marriage and falling proportions ever-married within age-education groups account for all of the decline in the TFR in Japan between 1980 and 2000.

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