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Life-course Transformation of Fertility Process in Japan[1]; Where did the Reduction occur to Which Cohort by What Causes?

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Abstract

In this study, first I reconstruct the historical development of the age specific fertility rates experienced by Japanese female cohorts to identify when the reduction was initiated by which cohort and what was followed among the successive cohorts. According to the observation on the Lexis mapping of reconstructed rates, it was the female cohort born in early 1950's that initiated the transformation process lasting until today with simple childbearing delay caused by marriage postponement. The detailed observation reveals more comprehensive view on the life course transformation in the society. Then I decomposed the rate changes into those caused by changes in marital composition and in marital fertility which is further decomposed into contribution of structural factors like educational upgrading and/or marriage delay, and of behavioral factor as residual of marital fertility by parity. The result reveals that the possibly intentional behavioral changes of married couples stated among those with wives born in 1960's.

Extended Abstract

Introduction

In this study, I describe the results of decomposition analysis of the historical development of the age specific fertility rates of Japanese female cohorts. Fertility rate is sum of the probabilities of having child by birth order, and each of the probability is composed of some structural and behavioral factors such as marital status and reproductive behavior of married couples. In Japan, it is observed that marriage delay have had major impact on the unprecedented fertility decline since mid 1970s. Especially in the former half of the process until the late 1980s, it is said that marriage delay was almost exclusive drive of the phenomenon, which means that rise in marital behavior like never marrying for life and divorce was not seen and marital fertility was stable, unlike the other developed countries experiencing fertility reduction(Kaneko 1999). Here I attempt to identify the uniqueness of Japanese fertility development by looking at the components of the fertility rate with the decomposition analysis technique. Since some effects of socioeconomic factors on the process mediated by components of the demographic dynamics are major concern, quantitative contribution of the educational upgrading to marital fertility change through or not through marriage delay is examined. I used the logistic

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regression to attribute reduction in the birth probability of each birth order to educational upgrading, and marriage delay induced and not induced by educational upgrading.

Since all of those phenomena evolve in the context of life course transformation, we come to have better understanding if the changes are traced on lives of successive cohorts. The locations of the events on age and cohort space are well identified by the Lexis mapping of fertility or probability developments. The Lexis mapping serves as a functional screen to express multi-dimensional changes in vital events(Vauple et al. 1997). It is especially useful when observation becomes with numerous dimensions such as parity and other characteristics as well as age, period and cohort. I demonstrate the technique to describe the fertility reduction from various dimensions and causes.

According to the result, the ever lasting delay in marriage spread until today is initiated by cohort (born in) early 1950's, though increase in the proportion never married did not started until those born in later 50's. The celibacy at age 50 seems prevail very rapidly among cohorts afterward. Marital fertility has almost no change until cohort of 1950. The reduction in younger ages (under age 35) is seen in the following cohorts by postponement of child bearing corresponding to marriage delay. However, the average number of children ever born to couples did not apparently change until those born in 60's. For cohort born in mid 60's and afterward, the delay is so massive that catch up in their later life could not compensate the loss in youth, even if it does exit. The distinctive stability in marital fertility in Japan is now dissolving. The second birth is most affected, which implies that only child family is diffusing. The early changes in marital fertility were mainly brought by educational upgrading (increase in proportion with higher education) among cohorts via delaying marriage, while it ceased from being cause after cohorts of 1957. In any case, the educational upgrading has not contributed ever to the reduction of the completed fertility of married couples, though it affected total fertility by raising the proportion never married.

With these observation and findings, we proceed to construct the fertility outlook in Japan. This is necessary to have precise prospects on future population as demographic projection for the society whose fertility is among the lowest low together with the world longest longevity. In the latter half of the presentation, I explain the outlook of fertility and population in the official population projection based on analyses such as those described above. The fertility assumptions underlying the projection were made on the basis of the cohort-fertility method, or the life course approach. That is a statistical projection of the level of completed fertility and the birth timing of each female birth cohort including those who have not yet completed their reproductive processes. Therefore, detailed results from close examination on the changing process of fertility components are required. On the other way around, since the future age-specific fertility rates of cohorts were estimated or assumed separately by birth order, the future life courses concerning reproductive process are constructed via the multi-state life table approach. Together with the traits of the population such as rapidly declining size and the world oldest age structure, the latest official population for Japan provides woman's life time probabilities of having birth, family size distributions, and the average life time length spent in specific family status. The micro type information on the future look of individual life may be useful than being provided macro indices, as is the case so far.

Data: the National Fertility Survey

Beside the vital statistics and censuses in obtaining age specific fertility rates, the dataset that I use in the analysis of marital fertility is built from six surveys among the National Fertility Survey (NFS), which has been conducted every five year by National Institute of Social Security and Population Research (NIPSSR 2003). Individual information on conception and birth histories of first-marriage couples of wife's cohorts born in 1928 through 1975 are extracted from the results of the Seventh (1977) through Twelfth (2002) NFS, and converted into statistical birth process of cohort life course. The result from the Thirteenth (2005) survey is also tentatively used (see Appendix).

Models and methods

The common overview of the fertility rate, or equivalently the average number of children and probability of having birth of certain order to analysis and projection is as follows. The cohort fertility is here constituted by a number of sub-models broken down by probabilities. Specifically, if the average number of birth and the birth probability of having the *n*-th birth at certain age is respectively denoted CTFR and CTFR*n*, then;

$CTFR_n = (1-\gamma) \cdot CEB_n \cdot \delta_n$, and;

$CTFR = \sum_{n=1}^{4+} CTFR_n$

where γ is the proportion of never-married (the complement of the cumulative first marriage rate), CEB_n is the probability giving birth by married women, and δ represents the effects of divorce, bereavement, remarriage and childbearing out of wedlock on fertility and expresses the ratio between fertility of first-married couples and the fertility of all married women including the former group. Though suffix for age does not appear in the equation for simplicity, all these quantities are defined at each age as well as lifetime value as evaluated at certain age such as 50.

The completed number of births from married couples, *CEB*, is the product of the expected completed number of births from married couples, $CEB^*(afm)$, which is a function of age at first marriage, *afm*, and a fertility variation coefficient of married couples, κ, as (omitting the suffix *n* for birth order);

$$CTFR = (1-\gamma) \cdot \left(CEB^*(afm) \cdot \kappa\right) \cdot \delta .$$

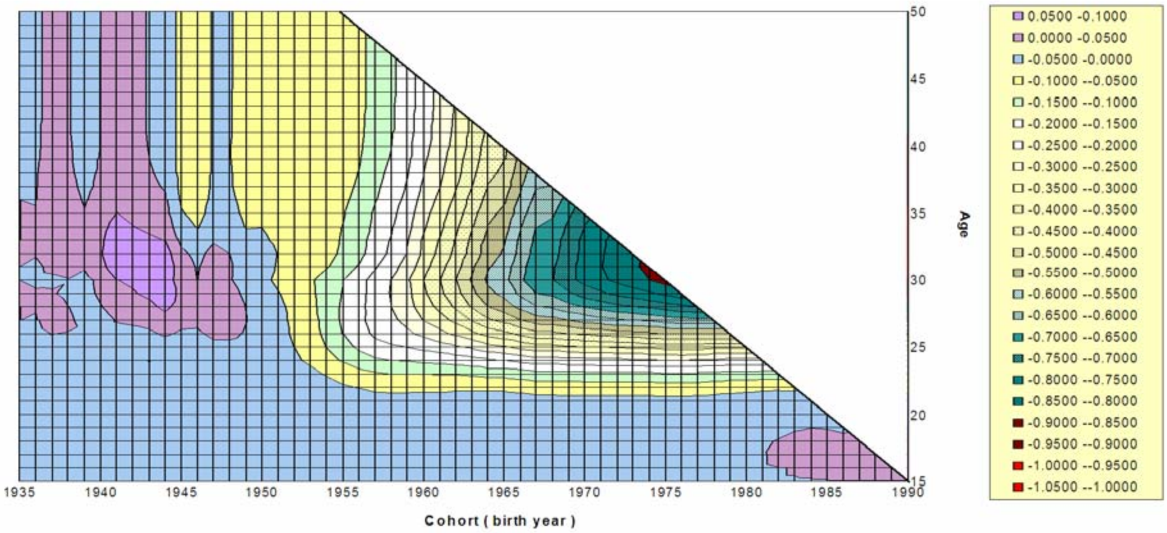
$CEB^*(afm)$ is a common function to all cohorts, while the fertility variation coefficient of married couples, κ, is an indicator expressing changes in reproductive behaviors of married couples. It is observed that the *CEB* is quite stable when *afm* is controlled at least for early cohorts. This is the rationale to fix the relationships between *CEB* and *afm* as $CEB^*(afm)$, which is conformed by cohorts born during 1935-54. Therefore marital fertility (the average number of children ever born *CEB* or the probability of having birth of *n*-th order CEB_n) varies according to *afm* (the mean age at first birth) and κ (relative intensity of marital fertility) of a specific cohort. Furthermore, the *afm* could depend on cohort characteristics. In this presentation, the effects of compositional change of educational attainment for cohorts are examined as a driving force of fertility reduction through delaying marriages.

In the decomposition analysis on marital fertility, the logistic regression technique is used to identify the amount of reduction in the birth probability of each birth order at each age caused by educational upgrading and marriage delay induced and not induced by educational upgrading. Detailed method of the decomposition technique used in this presentation is described in Appendix.

Results of the decomposition analysis on fertility reduction

In this section, the parity and factor strata of fertility decline in Japan are visualized by the layers of component effects in the reproductive life course. The most basic is the contour map of Japanese fertility decline over successive cohorts in form of reduction in the average number of children per woman at each age in reproductive process as compared to those of the cohort born in 1935 as Baseline (Figure 1).

Figure 1 Reduction in the Cumulative Fertility Rate of Japanese Female Cohorts from Cohort born in 1935 as Baseline



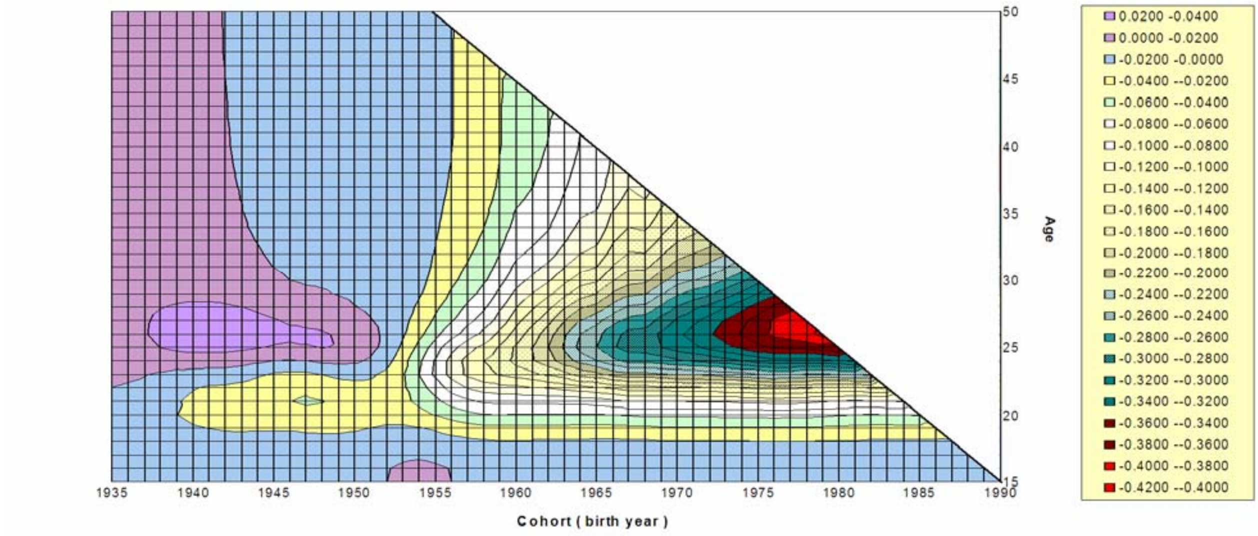
Note: Reduction in the cumulative age-specific fertility rate ($\approx$ the average number of children ever born) at each age from the female cohort born in 1935 is mapped on the age-cohort coordinates plane (the Lexis surface). The larger the reduction observed, the darker the pattern painted. The blank area in upper portion for cohorts born in 1954 and after is unattained age for them at the time of data collection (the Vital Statistics).

This is a type of the Lexis map in which the horizontal axis represents procession of cohorts indicated by birth year, and the vertical axis is age development from age 15 at bottom to 50 at the top. Therefore the life course of each cohort corresponds to vertical section of the chart. The larger the reduction observed, the darker the pattern painted. In this particular picture, blue area indicates parts in which no or little reduction is observed. The blank area in upper portion for cohorts born in 1956 and after is unattained age for the cohorts at the time of data collection (the Vital Statistics).

The chart indicates that there is successive fertility reduction that is concentrated around ate 30 cohorts born in later 1950's and later. It is seen that a part of reduction in some cohorts is recuperated along with life course (vertical line). The pattern epitomizes delay in childbearing since the fertility reduces only temporally in the life course of cohorts. With this type of the Lexis mapping, it is easy to see in which part of the life course of which cohort the fertility changes take place. In the following, we visually examine the life course transformations concerning reproductive process of Japanese women in detail.

In Figure 2, development of the proportion ever married by age measured by the cumulative first marriage rate for the female cohorts is painted. Basically the same pattern is observed in marriage change as the fertility seen in Figure 1. In addition, an interesting pattern, which indicates slight delay in youth and acceleration immediately after, is observed in cohorts born late 1930's through 40's.

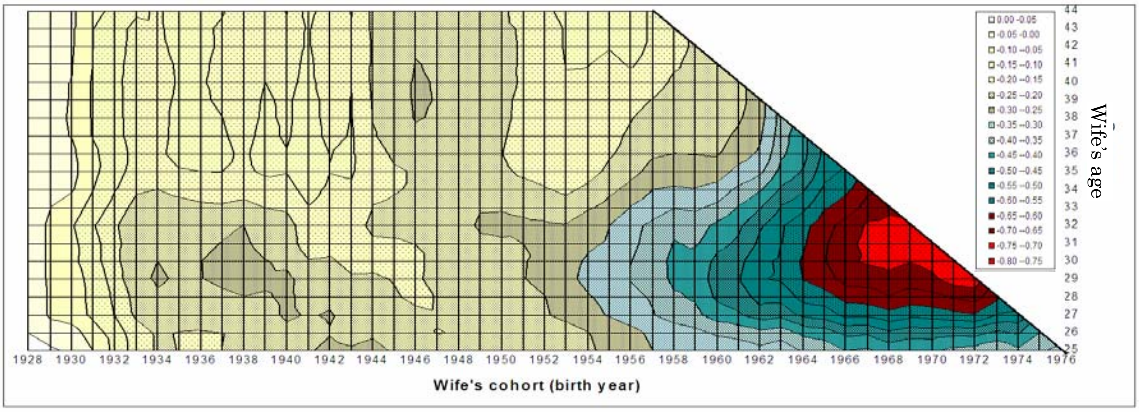
Figure 2 Reduction in the Proportion Ever Married of Female Cohorts from Cohort born in 1935 as Baseline



Note: This is a chart with same framework as Figure 1 for the cumulative first marriage rate (≈the proportion ever married) of the female cohorts.

Reduction in the average number of children ever born among the first-married couples at each wife’s age (ranged 25 to 44) from that of wife’s cohort born in 1928 is mapped on the age-cohort coordinates plane in Figure 3. The larger the reduction turn out to be, the darker the paint pattern appears. The only visual representations of the results are presented below in this section. The implications are presented and discussed collectively in the next section.

Figure 3 Reduction in the Average Number of Children Ever Born for Married Couples Classified by Wife's Age and Cohort from Cohort born in 1928 as Baseline

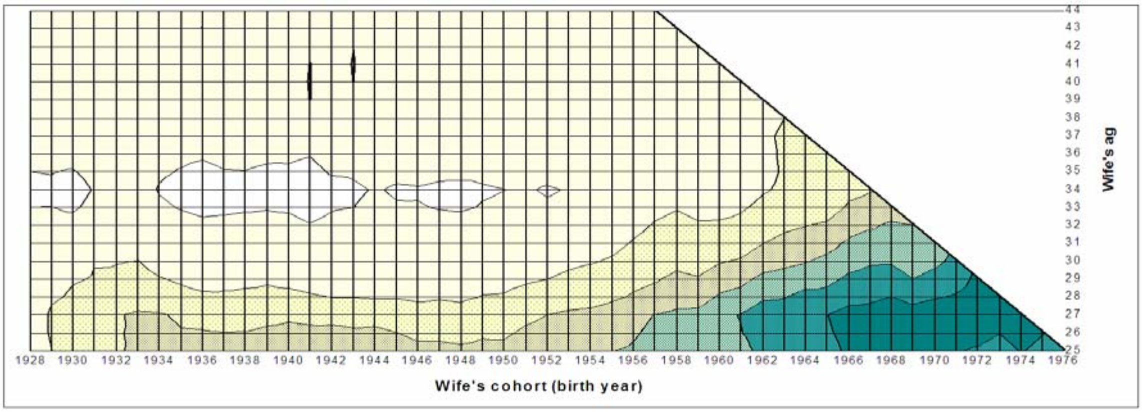


Note: Reduction in the average number of children ever born among the first-marriage couples at each age of wives (ranging from 25 to 44) from those of wife's cohort born in 1928 is mapped on the age-cohort coordinates plane (the Lexis surface). The larger the reduction observed, the darker the pattern painted. The blank area in upper portion for cohorts born in 1958 and after is unattained age for them at time of .the survey (the Twelve's National Fertility Survey)

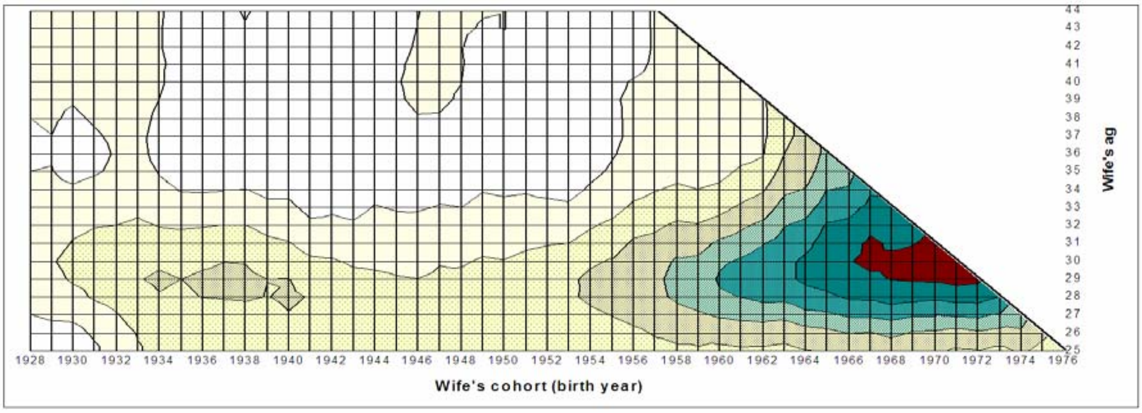
Since reduction of marital fertility can be attributed to reduction of birth probability by birth order, separate observation is given in Figure 4. The largest part is notable attributed to the reduction of second birth. Most of early reduction in first birth probability in life stage is recuperated. So dose the second birth probability until cohort born in early 1960's, but the recovery weakens in cohorts afterwards.

Figure 4 Reduction in the Probability Having the First to Third Birth for Married Couples Classified by Wife's Age and Cohort from Cohort born in 1928 as Baseline

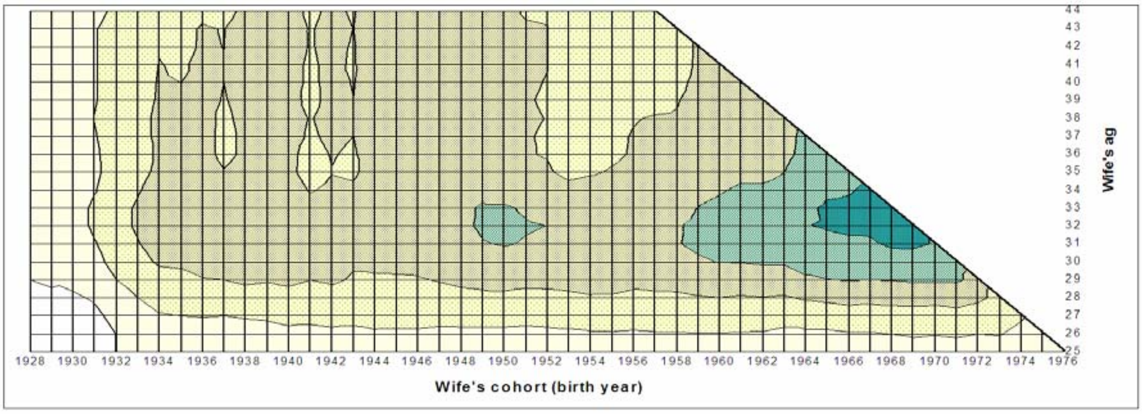
a. The First Birth



b. The Second Birth



c. The Third Birth

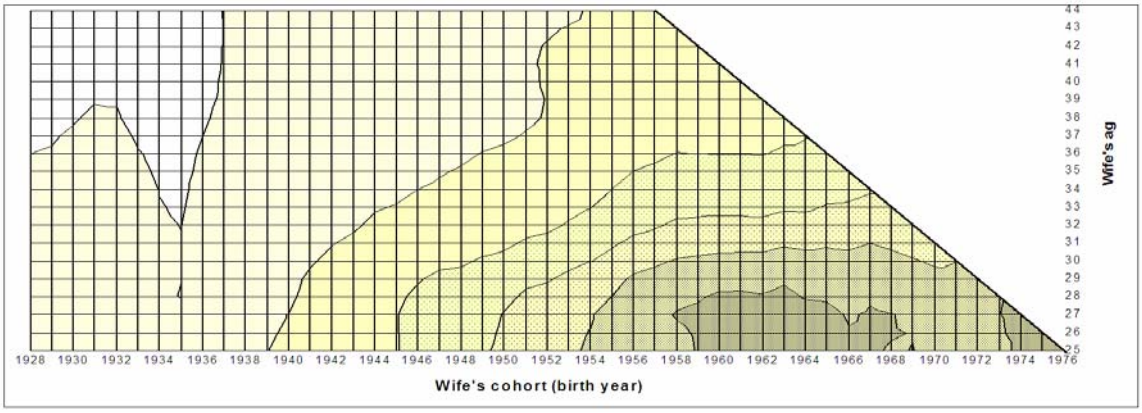


Note: These are charts with same framework as Figure 3 for the probability having live birth of the first to third order to the female cohorts. Three planes sum up to the one in Figure 3 together with those for higher order births.

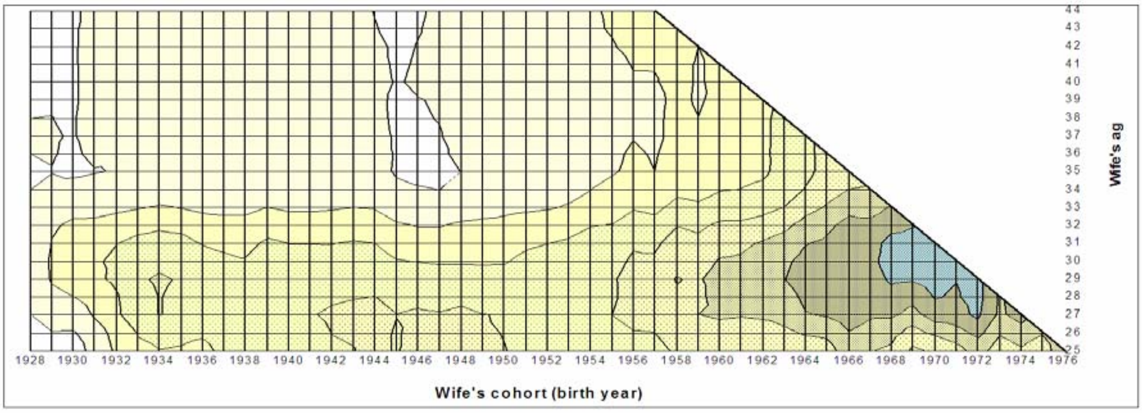
Reduction of marital fertility in total shown in Figure 3 can be decomposed into reduction caused by educational upgrading (increase in proportion with high educational grade), marriage delay (including or excluding effect from educational upgrading), and other behavioral changes of couples (residual). The results are shown in Figure 5.

Figure 5 Reduction in the Average Number of Children Ever Born for Married Couples Classified by Wife's Age and Cohort from Cohort born in 1928 as Baseline

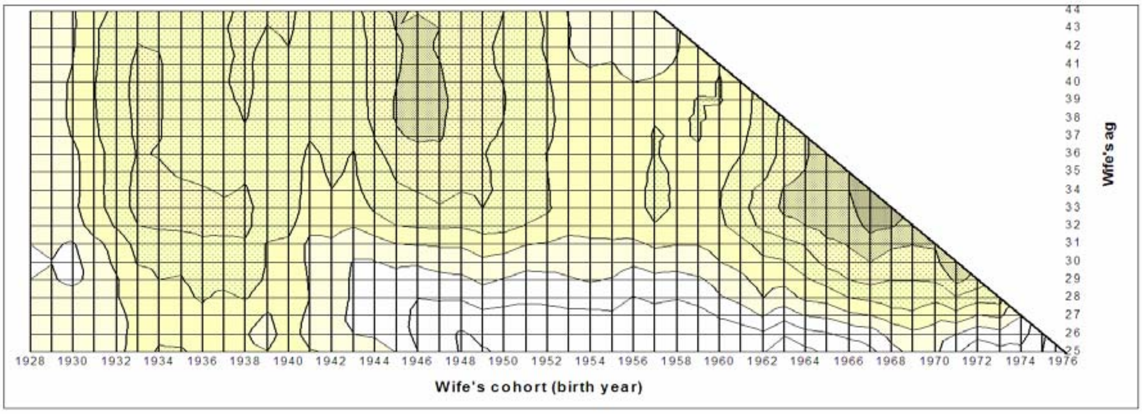
a. Caused by Wife's Educational Upgrading (Total Effect)



b. Caused by Marriage Delay (Excluding Effect of Educational Upgrading)



c. Caused by Couples' Behavioral Changes (Residual Effect)

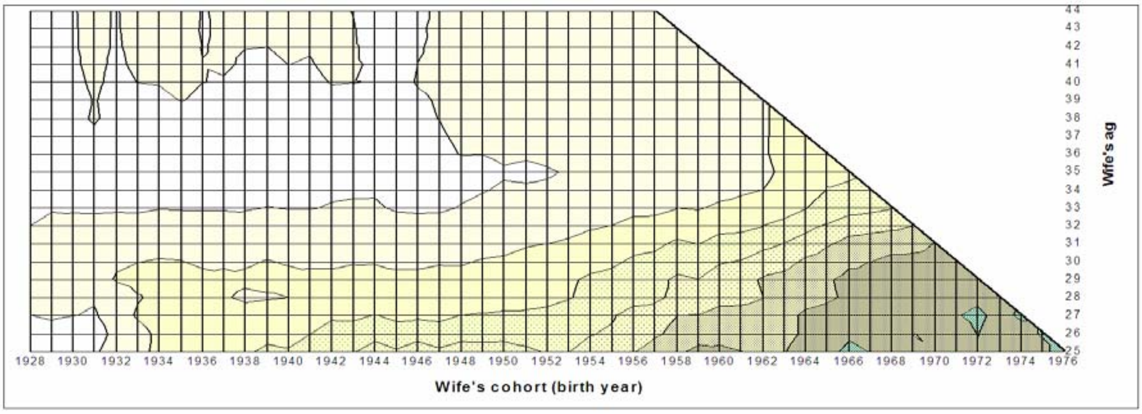


Note: These are charts with same framework as Figure 3 for the reduction in the average number of children ever born caused by three major factors for fertility reduction. Three planes sum up to the one in Figure 3.

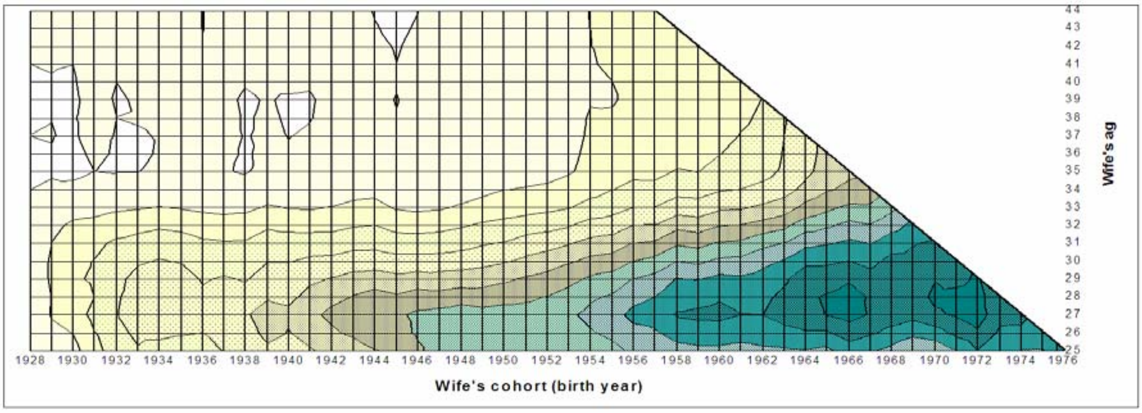
The decomposition of fertility reduction by factors can be applied to the probability of having birth of each order. The reductions attributed to marriage delay as a whole for the first and second birth are indicated in Figure 6.

Figure 6 Reduction in the Probability having First and Second Birth for Married Couples Caused by Marriage Delay (Total Effect) Classified by Wife's Age and Cohort from Cohort born in 1928 as Baseline

a. Caused by Marriage Delay (Total Effect) of the First Birth



a. Caused by Marriage Delay (Total Effect) of the Second Birth



On the process of fertility decline in Japan

In the previous section, the history of Japanese marital fertility along with 48 years of wife's birth cohort since cohort born in 1928 is reconstructed by means of six national representative surveys extended over 25 years. As a result, detailed process of onset of the recent marital fertility reduction is revealed. An outline is as follows. (1) Until cohort (born in) 1950, there has been almost no change found in marital fertility, though educational upgrading started to have slight effect on marital fertility during cohorts born in 1940s. (2) Marriage delay started by cohort 1952/53 (Kaneko 2003) having influences on the timing of having first and second child, however, without changing the completed fertility for cohort born in 1950s. They caught up to the previous level by age 40. Effect of educational upgrading expanded until cohort 1957 having little change thereafter. The probability having third child showed an slight upward tendency during cohorts 1952-58 followed by recession to the previous level. (3) After cohort 1960 the pace down seen before age 35 becomes conspicuous and it gradually remained until late 30s. For cohorts 1960-64 the catch up to the level of the previous cohorts is not enough at age 37. The effect from couples behavioral change become large (36% at wife's age 32, 25% at age 37), though the effect of marriage delay is still substantial (58% at age 32, 70% at age 37%). (4) For cohorts born after 1965, the pace down before age 35 becomes even outstanding (-0.4 children from the previous 5-year cohort at age 32). The effect from couple's behavioral change expanded to 44% at age 32. Effect on second child is greater than other birth order implying diffusion of only child family in these young cohorts. Similar but not extending traits are found in succeeding cohorts born in early 1970s.

Related materials and selected references

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Appendix: The Logistic Regression Model for Removal of Exogenous Effects of the Age-specific (Marital) Fertility Rate

The probability of having a child of each birth order and (as the sum of them) the average number of children for couples are expressed in terms of the logistic regression model with exogenous factors. The probability having *n*-th order child by some age of wife (say age 35) for wife *i* is given by;

$$\ln p_{i,n} / (1 - p_{i,n}) = \beta_{n,0} + \sum_{j=1}^{k} \beta_{n,j} X_{i,j} + \sum_{m=1}^{k_m} \gamma_{n,m} a_i^m + \sum_{c=1}^{k_c} \delta_{n,c} Y_{i,c} + e_{i,n}$$

where a_i, $X_{i,j}$, $Y_{i,c}$ are age at marriage, dummy for covariates, and cohort dummy for *i*, $\beta_{n,j}\ (j = 1 \cdots k), \gamma_{n,m}\ (m = 1 \cdots k_m), \delta_{n,c}\ (c = 1 \cdots k_c)$ are regression coefficients for those regression variables(k, k_{m}, k_c are number of categories of each variable, regression coefficients for reference categories are zero), and $e_{i,n}$ is regression error. Then

The probability of having the n-th child (observed): $p_n = 1 \Big/ \left[1 + \exp\left\{-(\beta_0 + \delta_c)\right\}\right]$

The probability without effect of marriage delay: $p_{n|M^-} = 1 \Big/ \left[1 + \exp\left\{-(\beta_0 + \delta_{c|M^-})\right\}\right]$

The probability without effect of educational upgrading: $p_{n|E^-} = 1 \Big/ \left[1 + \exp\left\{-(\beta_0 + \delta_{c|E^-})\right\}\right]$

The probability without both effects: $p_{n|EM^-} = 1 \Big/ \left[1 + \exp\left\{-(\beta_0 + \delta_{c|EM^-})\right\}\right]$

Total effect of marriage delay: $\nabla \hat{p}_{n|M} = \hat{p}_n - \hat{p}_{n|M^-}$,

Pure effects of marriage delay: $\nabla \hat{p}_{n|M^*} = \hat{p}_{n|E^-} - \hat{p}_{n|EM^-}$,

Total effect of educational upgrading: $\nabla \hat{p}_{n|E} = \hat{p}_n - \hat{p}_{n|E^-}$,

Pure effects of educational upgrading: $\nabla \hat{p}_{n|E^*} = \hat{p}_{n|M^-} - \hat{p}_{n|EM^-}$,

Common effect: $\nabla \hat{p}_{n|EM^*} = \hat{p}_n - \hat{p}_{n|M^-} - \hat{p}_{n|E^-} + \hat{p}_{n|EM^-}$,

Effect of marital behavioral change: $\nabla \hat{p}_{n|B^*} = \hat{p}_{n|EM^-} - \hat{p}_n[0]$,

($\hat{p}_n[0]$ is the probability of reference cohort).

Then, reduction of probability having *n*-th child is decomposed as follows,

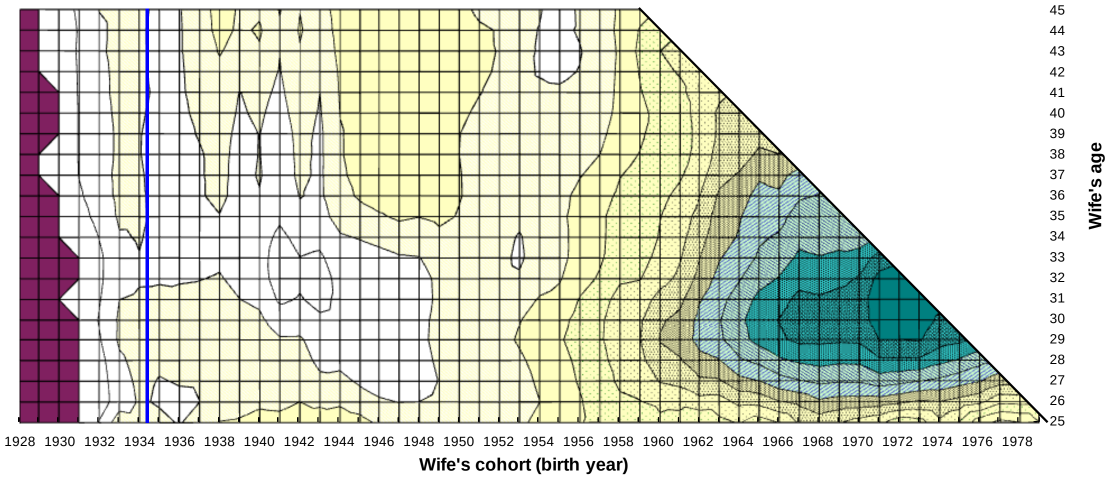
$$\Delta p_n = \nabla p_{n|E^*} + \nabla p_{n|EM^*} + \nabla p_{n|M^*} + \nabla p_{n|B^*}$$

Change in the average number of children is sum of those effects by birth order. All variables and relationships above apply at each single age of woman.

Appendix: Tentative Results from the Data Set with the Latest Survey

The following Lexis maps are result from the data set including data from the latest, Thirteenth National Fertility Survey conducted in 2005.

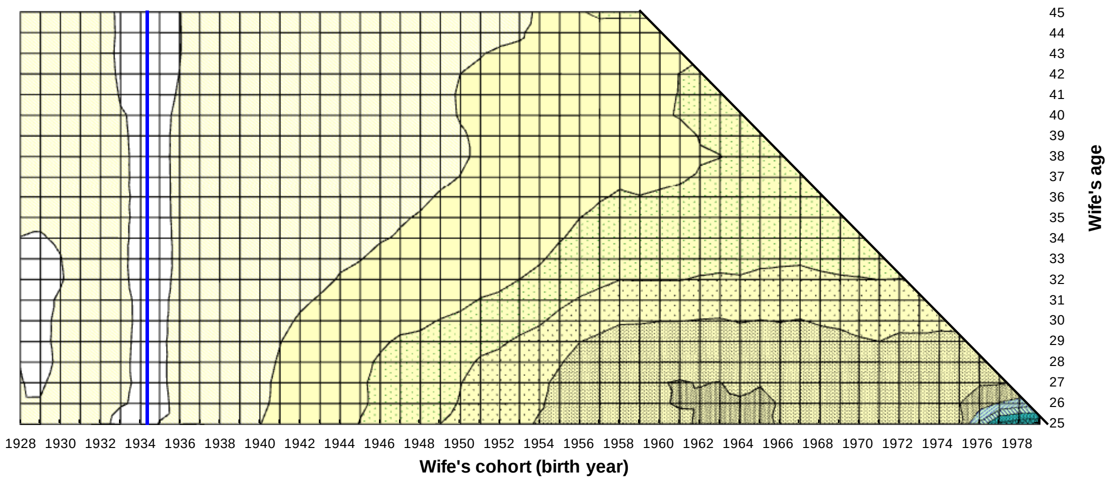
Figure A3 Reduction in the Average Number of Children Ever Born for Married Couples Classified by Wife's Age and Cohort from Cohort born in 1935 as Baseline



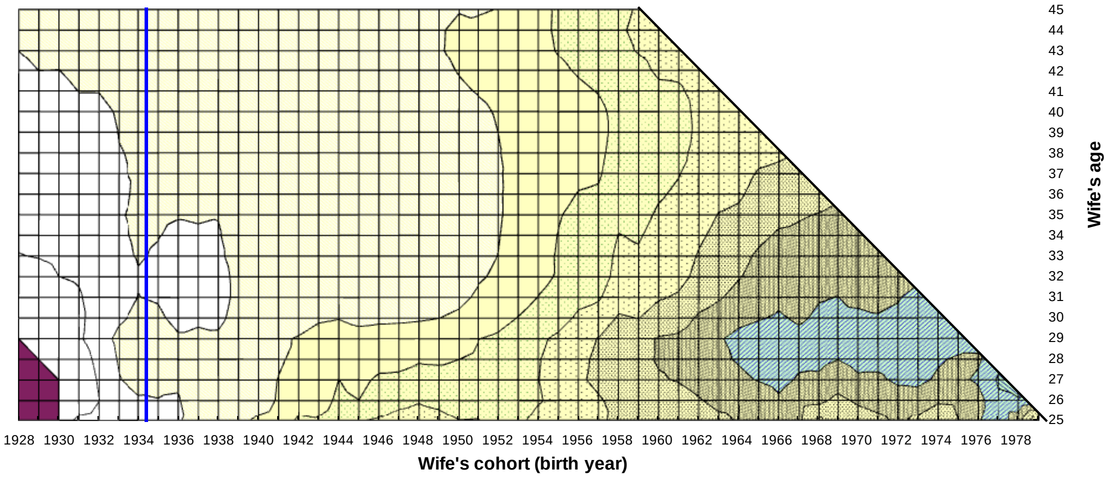
Note: Reduction in the average number of children ever born among the first-marriage couples at each age of wives (ranging from 25 to 44) from those of wife's cohort born in 1935 is mapped on the age-cohort coordinates plane (the Lexis surface). The larger the reduction observed, the darker the pattern painted. The blank area in upper portion for cohorts born in 1960 and after is unattained age for them at time of .the survey (the Twelve's National Fertility Survey)

Figure A5 Reduction in the Average Number of Children Ever Born for Married Couples Classified by Wife's Age and Cohort from Cohort born in 1928 as Baseline

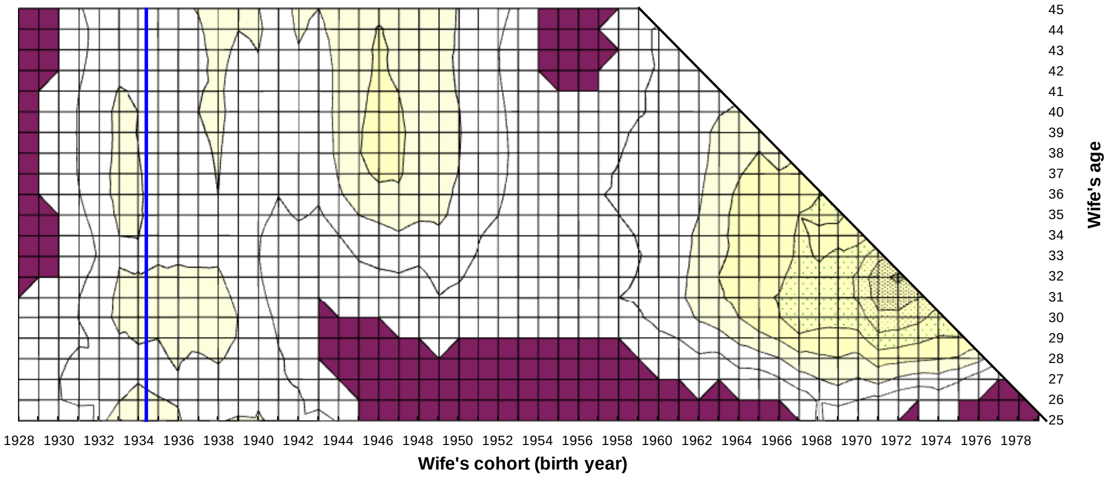
a. Caused by Wife's Educational Upgrading (Total Effect)



b. Caused by Marriage Delay (Including Effect of Educational Upgrading)



c. Caused by Couples' Behavioral Changes (Residual Effect)



Note: These are charts with same framework as Figure A3 for the reduction in the average number of children ever born caused by three major factors for fertility reduction. Three planes sum up to the one in Figure A3.