Age-specific Fertility Rates Projected by the Extended Lee-Carter Model

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Accurate projections of age-specific fertility rates are essential for population projections using the cohort-component method, as they form the basis for the population aged zero in the following year. This study proposes a semiparametric modeling framework for projecting cohort age-specific fertility hazards. The model comprises a nonparametric baseline component, derived directly from the observed data, and a parametric component that captures systematic deviations from this baseline. When projecting future parameters, statistical extrapolation was implemented by considering the actual trends of the parameters and imposing several constraints.

To accurately reproduce age schedules while controlling for cohort completed fertility, we employ an extended Lee–Carter model that utilizes the first through third singular values and corresponding singular vectors obtained from singular value decomposition. The model estimates parity- and age-specific fertility hazards, allowing for forward projections of age-specific fertility rates by cohort.

Completed fertility is decomposed into the following components for projection: (1) the proportion of never-married women at age 50, (2) the expected number of children ever born to married couples, (3) the coefficient of variation in marital fertility, and (4) the coefficient of the effects of divorce, widowhood, and remarriage. These elements are projected under three scenarios: high, medium, and low, to capture uncertainty in future trends. The projected cohort fertility rates are then converted into period age-specific fertility rates.

The methodology presented in this study was employed in setting the fertility assumptions for Japanese women in the “Population Projections for Japan (2023 revision)”, which is based on the 2020 Population Census.

Keywords: population projections, fertility assumptions, age schedule, extended Lee-Carter model