A Revised Parity Progression Model and It's Application

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Background

China's birth planning policy is at its historical turning point. Fertility in China has been below-replacement fertility for more than a decade, a result of restrictive birth planning policy and unprecedented socioeconomic development. Heated debates have already emerged on when and how the Chinese government should relax its birth planning policy to maintain the balance among demographic stability, economic growth, environment sustainability and human rights. Such changes will have to take local socioeconomic factors as well as demographic conditions into considerations. For example, one proposal is to phase out the one-child policy after one generation, and allow newly married couples to have two children if one of the marriage partners is a single child her or himself. Proposals like this require not only good understandings local demographic conditions, but also need appropriate demographic tools to estimate its potential demographic effects.

Feeney (1983, 1985) extends the conventional cohort component method by formulating fertility in projection in terms of period duration-parity progression ratios, as opposed to the period age specific fertility rates, which provides an effective tool to address the stepwise nature in fertility: children are born in sequence and fertility decisions are parity dependent. The birth planning policy in China, as well as its future changes, is also parity dependent. However, the population projection applying Feeney's model is still rare, mainly because the period duration-parity progression ratios required for this model is difficult to estimate from empirical data (Feeney and Yu 1987).

In this paper, we propose a revised parity progression model based on the age pattern of birth progression and new method to calculate parity progression ratio from census data by combing the strengths of Feeney's duration-parity progression model with the age-parity progression model developed by Ma et al. (1986). We also incorporate information collected from fertility surveys and birth planning administrative database to specify local conditions for our projection. We then apply the revised model to estimate the potential effects of policy change on population in Jiangsu, China.

Methods

The essential idea of Feeney's parity progression model is to express the total $(i+1)^{th}$ birth in a close population during a short period as the sum of the $(i+1)^{th}$ births contributed by the cohorts of women who had had an i^{th} previously:

$$B_{i+1}(t) = \int B_i(t-a)\psi_i(a)da \qquad \text{(i = 0,1,2...)}$$

where $B_i(t)dt$ denotes the number births of order i between time t and time $t+dt$ and $\psi_i(a)$ denotes the proportion who have an $(i+1)^{th}$ birth between a and $a+da$ years, after their i^{th} birth among all women who had an i^{th} birth previous. Feeney calls $\psi_i(a)$ as *parity progression schedule*. The parity progression schedules incorporate both parity progression ratios and the birth interval distributions.

Alternatively, we may formulate Feeney's parity progression model in terms of women's age instead of birth interval as:

$$B_{i+1}(t) = \int W_i(t,a)\omega_i(a)da \qquad \text{(i = 0,1,2...)}$$

where $W_i(t,a)dt$ denotes the number of women at age a gives births of order i between time t and time $t+dt$ and $\omega_i(a)$ denotes the proportion who have an $(i+1)^{th}$ birth between **age** a and $a+da$, among those who had an i^{th} birth previous. It is easy to see that the integral of $W_i(a)$ in this formulation ($\int W_i(a)da$), should equal to the integral of $B_i(a)$, in Feeney's formulation ($\int B_i(a)da$).

The parity progression projection applies the life table technique to fertility analysis. The age specific progression ratios are equivalent to mortality (q_xs) in life table. The cumulative value of age specific progression ratios for each parity is the overall parity progress ratios. Because births are now separated into parities, there is no recurrence issue in traditional fertility analysis. The cumulative progression ratio is the proportion of women progress to next parity, and is necessary less than 1. One advantage of formulating parity progression in terms of age, opposite to birth-interval in projection is that makes both mortality and fertility formulated in terms of age and leaves only one clock to deal with, just like conventional cohort component methods.

Another advantage of formulating progression in terms of age is that the required data are easier to find. Chinese population census and annual population surveys include both age structures of women, birth by parity in the year before the enumeration and number of children. Period age specific progression ratios can be estimated from available data. We propose a new method to convert the period progression measures into hypothetical cohort measures by applying life table technique. We then use the proportional hazards approach suggested by Feeney (1985) to adjust fertility schedule according to underlying age progression pattern and fertility level.

In summery, population projection using age-based parity progression method can be done with the following steps:

1. Estimate age specific period parity progression ratio.
2. Covert period age specific period parity progression measures into cohort based parity progression measure using life table techniques.
3. Choose a set of parity specific fertility and age specific progression fertility rate to calculate age specific parity progression ratio for projection.
4. Incorporate age specific parity progression ratio into cohort component model and do projection.

Data and Analysis

Under Jiangsu's current birth planning policy, newly married couples are allowed to have two children if one of the marriage partners is a single child her or himself in rural areas and if both marriage partners are single children in urban areas. The projection will provide demographic assessment for unifying the birth planning policy across the rural and urban area under different assumptions of parity 2 total fertility rate, while assuming that the age patterns of parity 2 birth will stay unchanged in the next 15 years.

Female's age structure and fertility data from the 2005 one-percent Population sample survey are the main sources for estimating parity projection ratios. Information collected from a recent survey on reproductive intention and behavior services as reference for setting the fertility, parity and other parameters in projection.

An innovative approach in this analysis is to use information from birth planning administrative database maintained by Jiangsu Population and Family Planning commission to estimate the probability of marriage involving "single" child – those who are the only child of their parents, as it is the most important parameter of the policy change, and it changes over time because of the history of how the birth planning policy was implemented.

Based on the reproductive survey and people's desire of having second children, we make population projection under three sets of parity fertility levels. Other parameters include women's age, parity, residential status and marriage type (between single children or not) to assess the potential demographic effects of policy change. Our projection results indicate that a unified policy will not cause a large increase of birth, nor it will have a heap of births. It also suggests that the earlier the policy change is, the smoother the transition will be. Our projections also demonstrate that parity progression model is a powerful yet flexible tool in population projection to accommodate specific local conditions.