Ethnic differentials in effects of 1st marriage and marital fertility on below-replacement fertility in Singapore, 1980-2015: A multistate lifetable analysis

Keita Suga
National Institute of Population and Social Security Research
Tokyo, Japan

Singapore has drawn demographers' attentions for intensive population control policies and their effects on fertility (Saw 2005; Wong and Yeoh 2003; Yap 2009; Straughan et al. 2009). Around ten years after the fertility rates attained the replacement level, Singapore government started relaxing and abolishing anti-natalist policies, and then introducing restrictive pro-natalist policies. In the late 1980s, total fertility rates recovered about the replacement reproduction; especially Malay's TFR recorded 2.69 in 1990. However, fertility rates resumed to decline from the early 1990s. As a reaction to the prolonged fertility declines, the government strengthened and enhanced the pro-natalist policies under three rounds of "Marriage and Parenthood Package" since 2000. One of the most frequently mentioned policy interventions in Singapore is a promotion of marriage and its distinct effects by education attainment. Ethnic differentials of fertility are also argued from this perspective as an extent that Chinese females are relatively better educated. Nevertheless, there are few studies directly analyzing either an effect of nuptiality on fertility changes or its ethnic differentials, partly because of limited data availability. With utilizing publicized statistical tables by Singapore government, this paper estimates multistate lifetables regarding 1st marriage and parity specific childbirths by ethnic group each year for 1980-2015 and decomposes fertility changes into contributions of the 1st marriage and the childbirths. Results reveal ethnic differentials and similarities: for overall changes of fertility changes from 1980 to 2015, nuptiality accounted completely for Malay's fertility changes, while both nuptiality and marital fertility affected Chinese fertility; negative nuptiality effects have increasingly impacts both on Malay's and Chinese fertilities after 2000.

Data and Methodology

In general, a multistate lifetable requires for construction (1) a distribution of the states (i.e. population at risk) and (2) intensity rates (i.e. hazard rates of the events that risk population experiences). For the case of Singapore, the state distributions (distribution of the nevermarried and parity specific evermarried females) by ethnic

group are computable by population census (only in census years after 1980). The number of marriages and live births (numerators for the hazard rates) can be obtained from vital statistics each year. Thus, with the state distributions between census years at hand, we are able to calculate the hazard rates with the number of marriages and childbirths divided by the state distributions scaled to mid-year population estimates. Then the multistate lifetable is constructed via a standard procedure (e.g. Pollani 2001).

Figure 1 shows overview of an estimation procedure for the state distribution between census years. First, notice that hazard rates correspond with probabilities for age x population moving from state i to other states j until age x+1. For instance, the 1st marriage hazard of age x is a probability of being evermarried by age x+1 conditional on being nevermarried at age x. We take advantage of this nature of hazard rates to estimate the state distribution of age x in year t+1 with the state distribution of age x in year t multiplied by the transition probability and a transformation of age x+1 to x of newly calculated state distribution for year t+1. Furthermore, with a state distribution from year-t census taken as an initial value and forward recursive estimations of state distributions, we have an estimate for the next census in year T, when another state distribution is observed. We improve state distribution estimates from year t+1 to T-1 with an additive adjustment term by age and state, which is identified by means of minimizing mean squared errors of the state distribution estimate for year T from the census distribution. As a result of the adjustment, we diminish a potential inaccuracy in the estimates of the state transitions. Moreover, smooth connections between the transitions in two consecutive periods before and after a census are guaranteed.

As a measure of completed period fertilities which summaries multistate lifetables, we calculate total period average parity (TPAP), which is a weighted sum of a lifetable function, lx(state,age), of age 50 with their parity as the weight. It is evident from the construction of the lifetables that TPAP is a function of hazard rates of the 1st marriage and order-specific births given by married women. We employ a generalized Kitagawa's decomposition method to a difference of the function (Das Gupta 1993). It can be shown that a difference of TPAP in year T from a year of reference (t=0) is decomposed into two components as in Eq. [1], from which Eq.[2] follows.

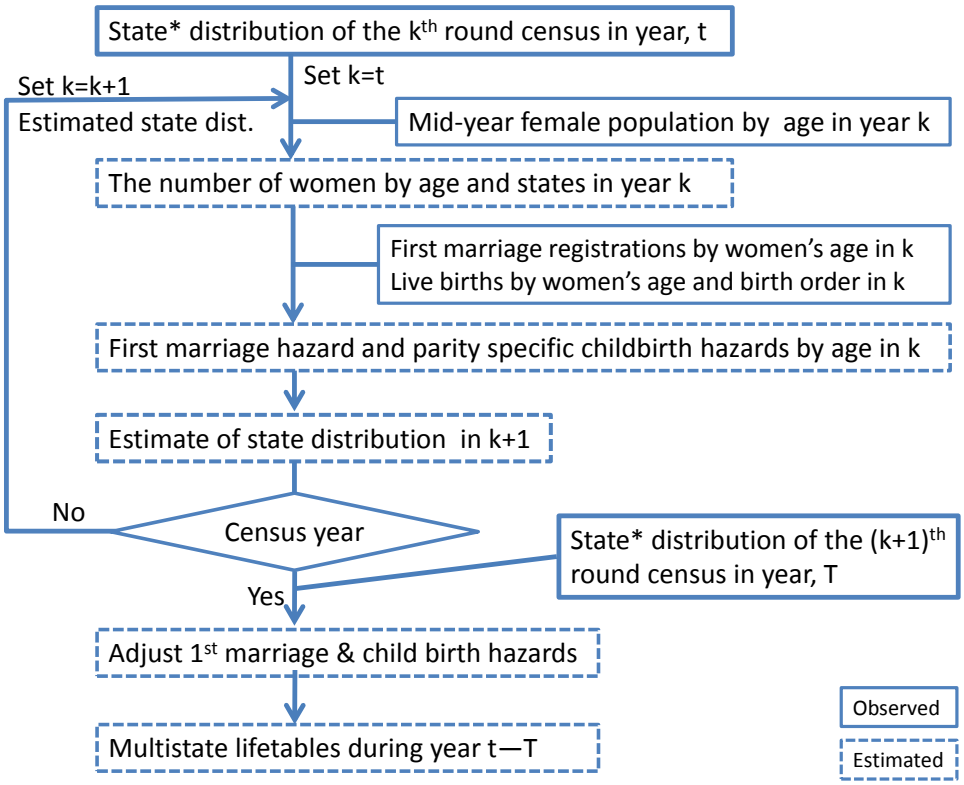
$$TPAP_t - TPAP_{t-1} = \mathrm{A}_t + \mathrm{B}_t \qquad \text{Eq.[1]}$$

$$\frac{1}{T}\left(TPAP_T - TPAP_0\right) = \frac{1}{T}\left(TPAP_T^{\alpha} - TPAP_0\right) + \frac{1}{T}\left(TPAP_T^{\beta} - TPAP_0\right). \qquad \text{Eq.[2]}$$

where $TPAP_T^{\alpha} = TPAP_0 + \sum_{\tau=1}^{T} \mathrm{A}_\tau$ Eq.[3] and $TPAP_T^{\beta} = TPAP_0 + \sum_{\tau=1}^{T} \mathrm{B}_\tau$ Eq.[4].

In Eq. [1], A_t measures an effect of a change in the 1st marriage hazard on the difference of TPAP, and B_t quantifies a contribution of a change in birth hazards. We

call $TPAP_T^{\alpha}$ as "cumulated nuptiality effect". It corresponds with time series of PTAP which would have been observed if no change in the childbirth hazards from year 0 to T. Similarly, $TPAP_T^{\beta}$, "cumulated marital birth effects", reflects a cumulative effect of changes in child birth hazards of the evermarried females from year 0 to year T with a fixed marriage hazard at the level of year 0. Eq.[2] decomposes an annual average change of TPAP from year 0 to T into contributions of the cumulated nuptiality and marital fertilities.



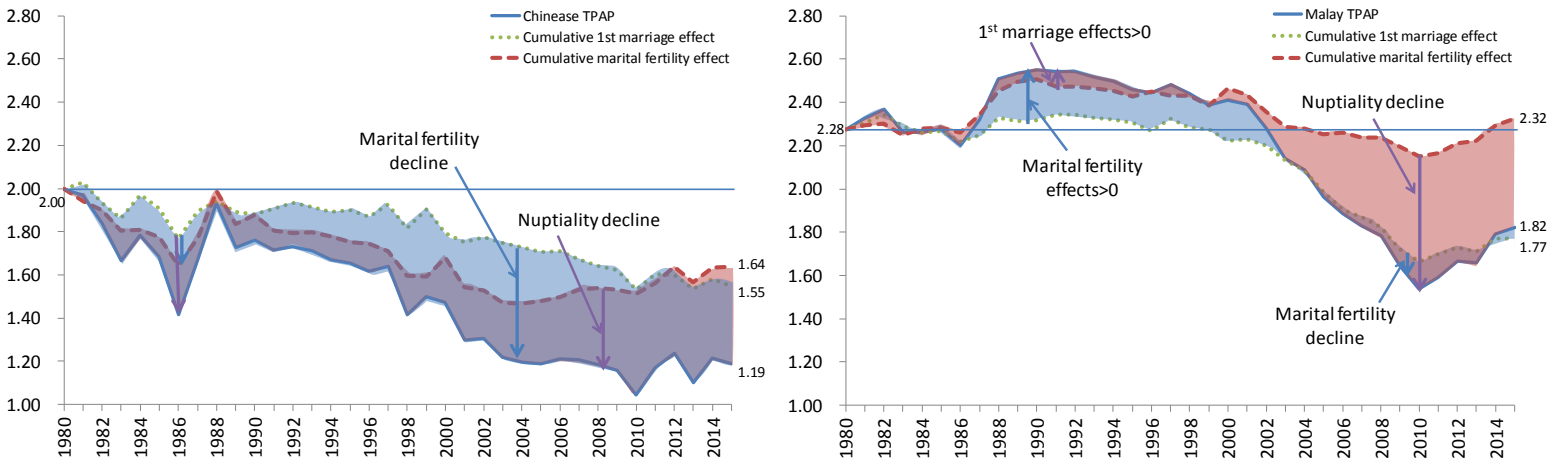
*States={Nevermarried, Married&[No child, parity 1, parity2 , parity 3, parity 4+]}

Figure 1. Multistate lifetable construction with a limited data

Results

Figure 2 depicts decomposition results for Chinese and Malay's TPAP from 1980 to 2015. Notice that the difference of TPAP from the cumulated nuptiality effect corresponds with fertility decline attributable to changes in childbirth hazards (See area shaded in panel I of figure 2, which equals to $-\sum_{\tau=1}^{T} B_\tau$). Panel I of figure 2 demonstrates for Chinese that changes in marital fertility affected TPAP severer than effects of changes in the 1st marriage until the late 1990s, while the marriage effects on TPAP were boosted rapidly after 2000; overall for 1980-2015, naptiality is responsible for one half of Chinese fertility decline (Table 1). Panel II of figure 2 exhibits a sizeable

nuptiality effect on Malay's TPAP. Throughout 1990s, Malay's cumulated marital childbirth effect stayed almost unchanged. After it decreased from 2000 to 2005, the cumulated marital childbirth effect was again stabilized. Prolonged decline in TPAP since the 1990s with the stability of the cumulated marital childbirth effect imply a role of nuptiality as a primary determinant of Malay's fertility decline after 1990; overall for 1980-2015, nuptiality completely accounts for Malay's fertility decline; indeed, the marital child birth effect lifts up TPAP (Table 1).



I. Chinese II. Malay

Figure 2. Decomposition of TPAP into Effects of Nuptiality and Marital Childbirth in Singapore: 1980-2015

Table 1. Decomposition of TPAP into Effects of Nuptiality and Marital Childbirth: Chinese and Malay in Singapore: 1980-2015

	Years		Δ(2015 1980)
	1980	2015	
I. Chinese			
Change of period measures			
Total period average parity[1]	1.998	1.188	-0.810
Cum. 1st marriage effect[1)]	1.998	1.548	-0.450
Cum. marital fertility effect	1.998	1.638	-0.360
Percent distribution of effects			
1st marriage effect[2)]			-55.6
Marital fertility effect[3)]			-44.4
II. Malay			
Change of period measures			
Total period average parity[1)]	2.275	1.820	-0.455
Cum. 1st marriage effect[1)]	2.275	1.771	-0.504
Cum. marital fertitlity effect[1)]	2.275	2.324	0.049
Percent distribution of effects			
1st marriage effect[2)]			-110.7
Marital fertility effect[3)]			10.7

1) $[TPAP_{2015}\text{-}TPAP_{1980}]*B/T$ where B stands for the length of the reproductive years(i.e. age 20-49) and T stands for the length of the period. TPAP should be read as X^a for cumulative 1st marriage effect and X^b for cumulative marital fertility effect, defined in Eq.[6] and Eq.[7], respectively. 2) % ratio of $[X^a_{2015}\text{-}X^a_{1980}] / [TPAP_{2015}\text{-}TPAP_{1980}]$ where X^a denotes cumulative 1st marriage effect defined in Eq.[6]. 3) % ratio of $[X^b_{2015}\text{-}X^b_{1980}] / [TPAP_{2015}\text{-}TPAP_{1980}]$ where X^b denotes cumulative marital fertility effect defined in Eq.[7].