The Second Demographic Transition in Singapore: Policy Interventions and Ethnic Differentials*

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This study examines fertility decline in Singapore for 1975-2010 to assess effects of pro-natal policy interventions. Pro-natal policy developments in Singapore are divided into several phases, and we investigate their impacts on period fertility rates during particular phases. To evaluate quantum improvements underlying increases in period fertility rates between before and after a policy implementation, we modify the Bongaarts-Feeney's tempo adjustment method (1998) to decompose the timeseries of fertility rates into quantum- and tempo- components. Results uncover ethnic differentials in fertility evolutions not only in the patterns but also in the determinants

This study examines patterns and demographic factors underlying the fertility decline in Singapore during the 2nd demographic transition. Specifically, we observe the total fertility rates by major ethnic groups from 1975 to present, with references to the timing of pro-natal policy implementations. In order to evaluate the effects of policy interventions by detecting changes in total fertility rates, well-known tempo distortion in the period fertility measures should be disentangled. This paper focuses on a period quantum measure derived from a modification of the Bongaarts-Feeney's adjustment formula (1998).

Pro-natal policy developments in Singapore were divided into several phases. In the first phase, the Singapore government introduced a set of population control programs in the mid-1960s to achieve replacement reproduction by 1980, and this anti-natal policy remained effective throughout the early 1980s (Saw 2005: 35-39). These programs were so effective that Singapore's total fertility rate reached 2.08 in 1975 and continued to decline until the mid-1980s. To respond to the prolonged decline, the Singapore government introduced policies in 1984 that aimed to raise the fertility of educated females (Phase II). These policies selectively targeting to the highly educated females did not remain, but the government's population policies shifted from anti-natal to pro-natal. From 1987, the government started to support mothers who have 3rd and higher order children by adopting a set of pro-natal policy measures (Phase III). At the

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same time, eugenics policies and old anti-natalist policies were gradually abolished. While there were no major pro-natal policy developments from 1991 to 1999 (Phase IV), the government further emphasized the pro-natalist tone and enhanced supports for 1st and 2nd childbirths after 2000 (Phase V-VII)[1].

Figure 1 shows that both Chinese and Malay's total fertility rates achieved the replacement level by 1975. After the 1980s, there are ethnic differentials. Among the Malay, consisting 13-15% of the population, the total fertility rate began to increase in 1979 while anti-natal policies remained, and their total fertility rate continued to stay above the replacement throughout the 1990s. However, Malay's total fertility rate has been declining rapidly in recent years. Among the Chinese, consisting 75-78% of the population, the total fertility rate initially declined from 1975, but the decrease halted in 1983 when selective pro-natal policies targeting the highly educated females were introduced. Between 1986 and 1988, their total fertility rate increased, but showed a steady decline from the 1990s. Chinese fertility also has fluctuations: decreases in inauspicious tiger years, 1986, 1998 and 2010, while increases in dragon years, 1988 and 2000.

<Figure 1 about here>

Overall, increases in the Chinese and Malay's total fertility rates in the late 1980s are consistent with an interpretation that relaxing anti-natal policies and introducing pro-natal policies had favorable effects on persistent fertility decline by that time. Moreover, if eugenics policies had a greater influence on the total fertility rate of the Chinese, whose education attainment levels were relatively higher than the Malay's, the fact that the Chinese total fertility rate stabilized around 1983 was as expected.

When it comes to policy evaluations, following the line of policy evaluation literature (Heckman and Vytlacil 2007) or causal inference in Statistics (Holland 1986), it might be argued that we should conduct a counterfactual comparison of the effects on cohort's fertility with the fertility of the cohort without the policy intervention. However, because of data limitations, we focus on the effects of policy interventions on a period fertility measure to discuss whether the changes in the measure appear to be consistent with the policy interventions[2].

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[1] See Saw(2005 and 2007), Wong and Yeoh(2003), Yap(2009), Straughan et al.(2009) and documents by Singapore National Population Secretariat among others for detailed pro-natal policy developments in Singapore.

[2] See Anderson, Chen and Fook-Kee(1977) for a similar approach regarding the fertility transition in Singapore.

Apparently, for policy assessment, we need to compare fertilities before and after the intervention, so changes in the fertility measure matter. Moreover, there are at least three reasons to focus on a period measure rather than a cohort measure. First of all, compared to a cohort fertility measure for which we have to wait for 15-30 years to complete the reproductive ages, period measures allow immediate policy assessments. Second, policy intervention affects all cohorts currently at reproductive ages. We usually do not intend to install a policy targeting a specific cohort. Moreover, we may regard a specific policy as characterized by a period; i.e. a policy is said to be effective from a specific month and year. Finally, demographic data for age-specific rates are commonly publicized in an age-period format, not in a cohort-period nor a cohort-age format. Thus, statistical tables required for period age-specific rates are readily available for computation[3].

One drawback to the period measure is tempo distortion: period fertility measure can increase due to tempo distortion even when the underlying cohort's fertility decline. In order to assess fertility policies, we are compelled to resolve a problem caused by tempo effects. This paper focuses on changes in period quantum measures for policy assessment and proposes an extension of Bongaarts-Feeney's adjustment (1998) to decompose the tempo- and quantum- effects on changes in period fertility measures. The next section discusses the decomposition method and data used for the Singapore case. Results highlight ethnic differentials in fertility changes not only in regards to time trends but also in the tempo effects on fertility rates of different birth orders.

Methodology and Data

The basic idea to decompose changes in period measures into a quantum component and a tempo component comes in twofold. The first one is related to a dynamic relationship between period measures of consecutive year t and t-1. For any period measure, the value in year 1 can be written as the sum of the value in year 0 and the difference of the values between year 0 and 1. The relationship can be generalized to the value in year t comprised of the value in the initial period (year 0) and the sum of the change from year 0 to T.

[3] Note that two consecutive birth cohorts pass through the same age during one year on the Lexis surface. Strictly speaking, a cohort analysis requires cohort-period formatted data, which is available from annual statistical reports only under exceptional circumstances.

The second idea is to apply Kitagawa's decomposition method (1955) to the difference of two rates, each of which is composed of products of components. Bongaarts-Feeney's formula for total fertility rates is consisted of a product of two factors, thus we can apply Kitagawa's standard decomposition method to changes in total fertility rates.

Let $X_j(t)$ and $X_j^*(t)$ denote the total fertility rate and the tempo adjusted total fertility rate in year t of the j[th] order birth, respectively. Bongaarts-Feeney's tempo adjusted total fertility rate (1998) is defined by Eq. (1).

$$X^*{}_j(t) = \frac{X_j(t)}{1 - r_j(t)} \quad \cdots(1)$$

In Eq. (1), $r_j(t)$ stands for a change in the mean age at the j[th] childbirth from the beginning to the end of year t, measured in years-old. It is commonly referred as an adjustment factor that manages tempo distortions induced by horizontal shifts (direction along ages) in period age schedules of fertility on a Lexis surface. Specifically, we estimate the factor with Eq. (2).

$$r_j(t) = \frac{1}{2}\left[\frac{\sum_x (x+2.5)FR_j(t+1,x)}{X_j(t+1)} - \frac{\sum_x (x+2.5)FR_j(t-1,x)}{X_j(t-1)}\right] \quad \cdots(2)$$

where $FR_j(t,x)$ denotes an age-specific fertility rate of the j[th] order birth of women of age x-x+4 in year t. When $r_j(t)$ is strictly positive so that the period age schedule on the Lexis surface shifts towards older age, the delayed childbearing causes a tempo effect which lowers the period fertility. In this case, the adjustment factor, $R_j(t) \equiv 1 - r_j(t) < 1$, counteracts to recover a level as if no change in the age schedule has occurred.

To decompose changes in observed total fertility rates of the j[th] order from year t-1 to t, we employ the Kitagawa's method as in Eq. (3).

$$\begin{aligned} X_j(t) - X_j(t-1) &= R_j(t)X_j^*(t) - R_j(t-1)X_j^*(t-1) \\ &= \tfrac{1}{2}\left[X_j^*(t) - X_j^*(t-1)\right]\left[R_j(t) + R_j(t-1)\right] + \tfrac{1}{2}\left[X_j^*(t) + X_j^*(t-1)\right]\left[R_j(t) - R_j(t-1)\right] \quad \cdots(3) \\ &\equiv \alpha_j(t) + \beta_j(t) \end{aligned}$$

In Eq. (3), $\alpha_j(t)$ represents a contribution of the change in the adjusted total fertility rates for the period spanning from year t-1 to t. Zeng and Land (2001, 2002) clarify that, like conventional period total fertility rates, Bongaarts-Feeney's adjusted period total fertility rates can be interpreted as the average total number of births that a woman in a hypothetical cohort would have throughout the reproductive period if this hypothetical cohort experienced the observed period age-specific fertility rates with changing period tempo but a constant quantum and an invariant shape of the age schedule. Following their interpretation, $\alpha_j(t)$ can be regarded as measuring a contribution of the change in the period quantum with no change in tempo, and we call this "quantum effect", hereafter. Similarly, $\beta_j(t)$ corresponds to the contribution of the change in the period tempo to the observed fertility differential between year t-1 and t with no change in the quantum. It is the size of the tempo distortion effect and is referred to as "tempo effect". Note that when the speed of deferring fertility diminishes ($0 < r_j(t) < r_j(t-1) < 1$), this tempo effect is positive and raises the period total fertility rates from year t-1 to t.

Notice that $X_j(t) = X_j(t-1) + \Delta X_j(t)$ for any t where $\Delta X_j(t) \equiv X_j(t) - X_j(t-1)$. By applying Eq. (3)'s relationship into $\Delta X_j(t)$ and the recursive substitution of $X_j(t)$ on the right hand side of this relationship for $X_j(t+1)$:

$$\begin{aligned} X_j(t+1) &= X_j(t-1) + \alpha_j(t+1) + \beta_j(t+1) + \alpha_j(t) + \beta_j(t) \\ &= X_j(t-1) + \sum_{\tau=t}^{t+1} \left(\alpha_j(\tau) + \beta_j(\tau)\right) \end{aligned} \quad \cdots(5)$$

By the forward recursive substitution of Eq. (5) from the year of reference($t = 0$; the year of a policy intervention) to year T, the change in the period total fertility rate is decomposed into the level of the period fertility in the year of the reference and the cumulative contributions of the quantum and the tempo[4].

[4] Alternatively, because we are interested in the difference of the year T value from the year 0 value, set t+1 (in the left hand side X_j and the upper limit of the summation)

$$X_j(T) = X_j(0) + \sum_{\tau=1}^{T} \alpha_j(\tau) + \sum_{\tau=1}^{T} \beta_j(\tau) \quad \cdots(6)$$

Eq. (6) clearly shows how tempo distortion affects changes in period measures: not the difference of effects between year T and 0 but the accumulative effects of each single years over the interval must be considered in order to evaluate an annual average change of the period fertility over the duration, $\frac{1}{T}\left(X_j(T) - X_j(0)\right)$. Notice from Eq. (1) that Bongaarts-Feeney's adjustment factor, $r_j(t)$, equals a relative difference of the adjusted total fertility rate from the observed total fertility rate, $\left[X_j^*(t) - X_j(t)\right] / X_j^*(t)$. Hence, in contrast to Eq. (6), Bongaarts-Feeney's tempo adjustment intends to eliminate the tempo effect from the period measure in a particular year to recover a level without the tempo distortion. It is informative to see the dynamics of period fertility rates which would have been those if there is no change in the quantum or the tempo.

$$X_j^{\alpha}(t) = X_j(0) + \sum_{\tau=1}^{t} \alpha_j(\tau) \text{ for any t} \quad \cdots(7)$$

$$X_j^{\beta}(t) = X_j(0) + \sum_{\tau=1}^{t} \beta_j(\tau) \text{ for any t} \quad \cdots(8)$$

We call $X_j^{\alpha}(t)$ as "the cumulated quantum total fertility rate" and $X_j^{\beta}(t)$ as "the cumulated tempo total fertility rate". Interpretations for these period measures stem from the quantum effect and the tempo effect demonstrated in Eq. (3). The cumulated quantum total fertility rate increases or decreases only in response to the quantum component. It corresponds with timeseries of period total fertility rates of hypothetical cohorts which would have been observed if there were no change in the tempo and the shape of the age schedule of childbearing from year 0 to year t. Similarly, the cumulated tempo total fertility rate reveals timeseries of period total fertility rates with a fixed quantum. It reflects a cumulative effect of tempo distortions from year 0 to year t, interpreted as the average total number of births given by women of hypothetical cohorts under a constant quantum at the level of year 0 with an invariant shape of the age specific fertility.

There are at least two advantages in defining the cumulated quantum- and

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equals to T and t (in the right hand side X_j and the lower limit of the summation) equals to 1.

tempo- total fertility rates. First, notice from the equations (6), (7) and (8) that the difference between the cumulated quantum (tempo) total fertility rate and the observed total fertility rates in year t equals to the total tempo (quantum) effects on the observed total fertility rate cumulated from year 0 up to year t. Figure 2 depicts Eq. (6), (7) and (8) for Singapore, and illustrates that the area between the dotted line and the solid line corresponds to the total decline of the observed total fertility rate due to the decrease in the quantum from 1975 to each year. The second advantage is that, with these definitions, it is straightforward to decompose an annual average change of the period fertility for year 0-T as in Eq. (9).

$$\frac{1}{T}\left(X_j(T)-X_j(0)\right)=\frac{1}{T}\left(X_j^{\alpha}(T)-X_j(0)\right)+\frac{1}{T}\left(X_j^{\beta}(T)-X_j(0)\right) \quad \cdots(9)$$

<Figure 2 about here>

Data for the analysis are obtained from the statistical tables published by Immigration and Checkpoints Authority and Department of Statistics of the Singapore government. We need to compute the age-specific fertility rates by birth order. The numerator, live births by mother's age, mother's ethnic group and birth order, is available from the vital statistics, *Registration of Births and Deaths Statistics*, from 1967 onward. The denominator, female population by five-year age group and ethnic group, is taken from *Singapore Census of Population* every 10 years from 1980 to 2010 and from *General Household Survey* for years, 1995 and 2005. For intermediate years, official population estimates are reported in *Yearbook of Statistics Singapore* from 1968[5].

After 1990, age-specific female population and its estimate are available only for Singapore residents. Singapore residents are comprised of Singapore citizens and permanent residents that include Singapore residents living outside of Singapore for less than six months but exclude foreigners[6]. However, registration statistics report all

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5 The intermediate population estimates are revised upon the results of the population census. Moreover, the method of the estimation has modified on and after 2008. In the calculation of the age-specific fertility rates, smoothed series of age-specific female population is utilized for intermediate years. Note that female population by single-year of age reported in the population census shows a discontinuity in the cohort size born before and after 1946: the cohort size born before 1946 is smaller than the size born after 1947. Hence, for the age of 25-29, the natural cubic spline is applied separately for each of three periods, 1968-1971, 1971-2005 and 2005-2010, and similarly for other age groups.

6 The mid-year population estimates reported after 1990 exhibit the resident population even for 1980-1989 (see e.g. Singapore Department of Statistics 2011). After

live births including those given by non-residents. Hence, age-specific fertility rates (i.e. the denominator) are available only for Singapore residents. However, we cannot obtain births given by the residents for the numerator.

In recent years, the proportion of non-resident population among the total population has increased rapidly and has reached a considerable fraction: 5.5%(1980), 10.2%(1990), 18.7%(2000), and 25.7%(2010). International immigration may cause an upward bias in the calculation of age-specific fertility rates. To assess this potential discrepancy, the total fertility rates calculated by the author are compared with official figures, which take Singapore residents' births as the numerator but are available only after 1980. The difference range from -0.06(1980) to 0.13(2009), and the timeseries correlation coefficient is 0.976. Therefore, the total fertility rates calculated in this study should capture enough information on change in fertility[7]. Finally, because age-specific fertility rates by ethnic groups are available only by five-year age categories in Singapore, random and minor fluctuations in the mean ages at childbirths given by Eq. (2) are removed by natural cubic spline smoothing for each of birth orders and ethnic groups[8].

Tempo- and Quantum- Effects on the Changes of the Period Fertility Rates in Singapore: 1975-2010

The decomposition results each year from 1975 are shown in Figure 3 for Chinese and Figure 4 for Malay. In Figure 3, the area between the tempo-cumulated total fertility rate and the observed total fertility rate is shaded for Chinese. This area

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2000, even the population census of Singapore is conducted as register-based (Singapore Department of Statistics 2003), and foreigners are excluded from most of statistical tables.

[7] The official total fertility rates by ethnic group are available after 2000(Singapore Dept. of Stat., *Population Trends*, 2005-2011). The timeseries correlation coefficients of both Chinese and Malays exceed 0.996 for 2000-2010.

[8] Because the age-specific fertility rates are calculated with the data in the age-period format, the cohort size differentials induce artificial period fluctuations even when the cohort's fertility rates change smoothly. The induced fluctuations are the severer, the smaller the population size of the groups is. Our preparatory investigation shows that the smoothed mean ages capture the long-run tendency of the delayed childbirth. Although smoothing the mean age would impose an elimination of unstable tempo effects, it seems inevitable as long as working with period measures. Decomposition results should be viewed as tempo effects not caused by year-by-year fluctuations but induced by the shift of the fertility age schedule under the smoothed long-term trend. See Kohler and Philipov (2001) for a worked example with smoothed fertility schedules.

corresponds to the contribution of the quantum to the change in the observed total fertility rates. Figure 3 demonstrates that the quantum drives the Chinese period fertility for most of the period from 1975 to present. For Malays, the area between the quantum-cumulated total fertility rate and the observed total fertility rate is shaded. This area exhibits the contribution of the tempo distortion to the change in the period total fertility rates. Hence, compared to the Chinese case, the tempo has a sizeable effect on the changes in Malay's period fertilities. In fact, the cumulated quantum total fertility rates in 1990 and 2000 reached the same level as in 1975, implying that there were no cumulated quantum effects from 1975 to 1990 and to 2000. This fact again confirms that the tempo plays a role in maintaining the total fertility rates above 2.5 throughout the 1990s, though there were also conceivable increases in the quantum components from 1986 to 1990.

<Figure 3 about here>

<Figure 4 about here>

Table 1 shows details of the fertility change accountable to various demographic factors. First three rows of panel A and B in Table 1 show the annual average change in period measures: total fertility rates, cumulated quantum- and tempo- total fertility rates for Chinese and Malays, respectively. They were first annualized, and then normalized for thirty-five years to compare different lengths of time periods. Thirty-five years is the length of reproductive years and it happens to coincide with the length of the time span of the analysis. The table also shows the percentage contribution of the quantum- and tempo- effects decomposed based on Eq. (9) and contributions of specific birth orders.

<Table 1 about here>

From 1975 to 2010 overall, we verify that most of the fertility decline comes from the quantum component for Chinese: the period total fertility rate decreases by 1.04, while the quantum component decreases by 1.09 and the tempo component increases by 0.05. For Malays, the 0.42 decrease in the total fertility rate from 1975 to 2000 is attributable to 0.66 decrease in the quantum and 0.24 increase in the tempo. The tables also show that most of the decline in the Malay's quantum component is a consequence of the decline in parity four and above, while the Chinese quantum components of parity two and three also affect their fertility decline.

Compared to the overall change from 1975 to present, however, diversified phenomena can be seen when we focus on specific phases for population policies. Between 1984 and 1987, when discriminative population policies were implemented, Chinese period quantum fertilities of the 2nd and the 3rd order increased. While Malay's period total fertility rates exhibited more rapid rise, the decomposition result demonstrated that it was a spurious increase induced by the tempo distortion.

Between 1987 and 1991, when pro-natal policies for 3rd and higher order births were introduced, Chinese period total fertility rates increased. However, the quantum increased only for 1st order births. In fact, the quantum fertilities decreased for 2nd and 3rd childbirths and the tempo effects for these orders significantly contribute to the increase in Chinese period fertility for this period. On the other hand, Malay's period fertility rates reveal a considerable increase, and the quantum for 1st to 3rd order childbirth mainly account for the upsurge.

However, both Chinese and Malay's period fertilities followed prevailing tendencies of declines, when relatively enhanced pro-natal policies were implemented after 2000. Only Chinese period quantum fertility of the 1st child for 2004-2008 showed a small increase. Negative quantum effects have increasing impacts on Malay's fertility after 2000.

Concluding remarks

This paper discusses the intrinsic nature of period fertility measures and focuses on the change in the period quantum for policy assessment, and then proposes a method, by which we decompose timeseries of the period fertility rates into contributions of tempo- and quantum- components. Like the conventional total fertility rate and the Bongaarts-Feeney's adjustment formula, the derived measures inherit interpretations familiar to demographers. The method is easy to apply even with limited but widely obtainable demographic data in comparison with other approaches: micro datasets (e.g. Singapore Census of Population) would be needed for causal inference; parity distributions are required for Kohler-Ortega(2002)'s approach; births by mother's age of single-years are essentials in Kohler-Philipov(2001)'s adjustment for the variance change in the age schedule of fertility. In addition, the decomposition result can be graphically summarized and demonstrated in one single figure attractive to presentation.

From the decomposition results, we find ethnic differentials in period fertility not only in time trends but also in the determinants. For overall changes until 2010 after Singapore's total fertility rates attained the replacement level in 1975, the quantum change drives the Chinese fertility. At the same time, the tempo had a considerable effect on Malay's fertility, especially for the 1990s. Even for the periods right after policy interventions, components underlying the changes in total fertility rates are different between ethnic groups. We find that the quantum components help to increase the Chinese total fertility rates of 2^{nd} and 3^{rd} order births for 1984-1987 and the Malay's total fertility rates of 1^{st} to the 3^{rd} order births for 1987-1991. These results may be argued that the population policies implemented in the 1980s were effective in Singapore. However, the rapid quantum declines after 2000 may suggest that more enhanced pro-natal policy interventions in recent years might have lost such effectiveness.

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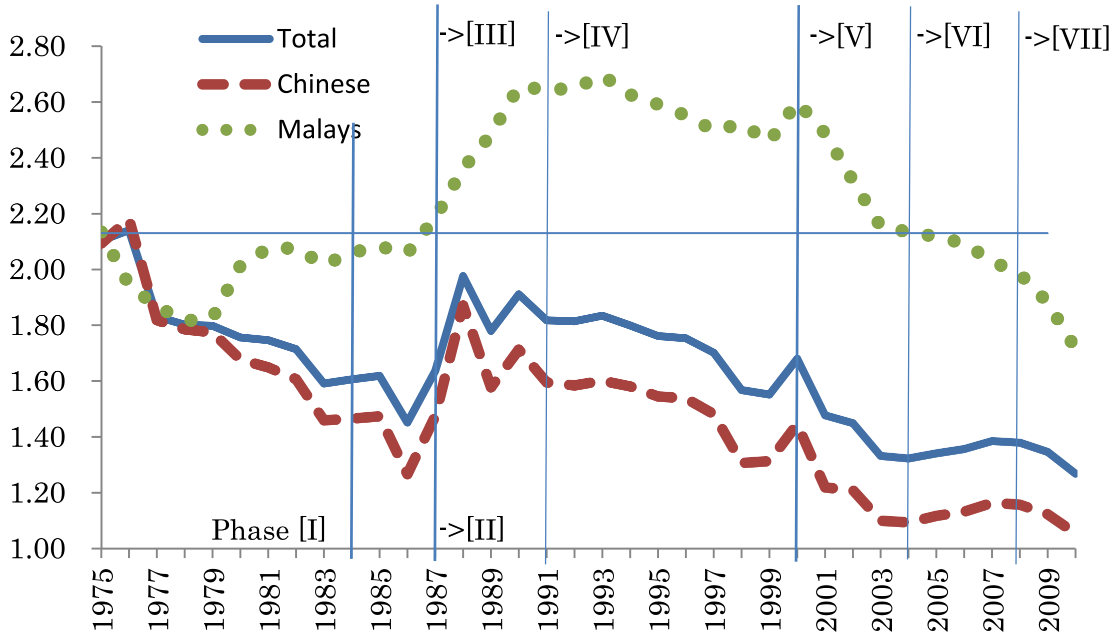
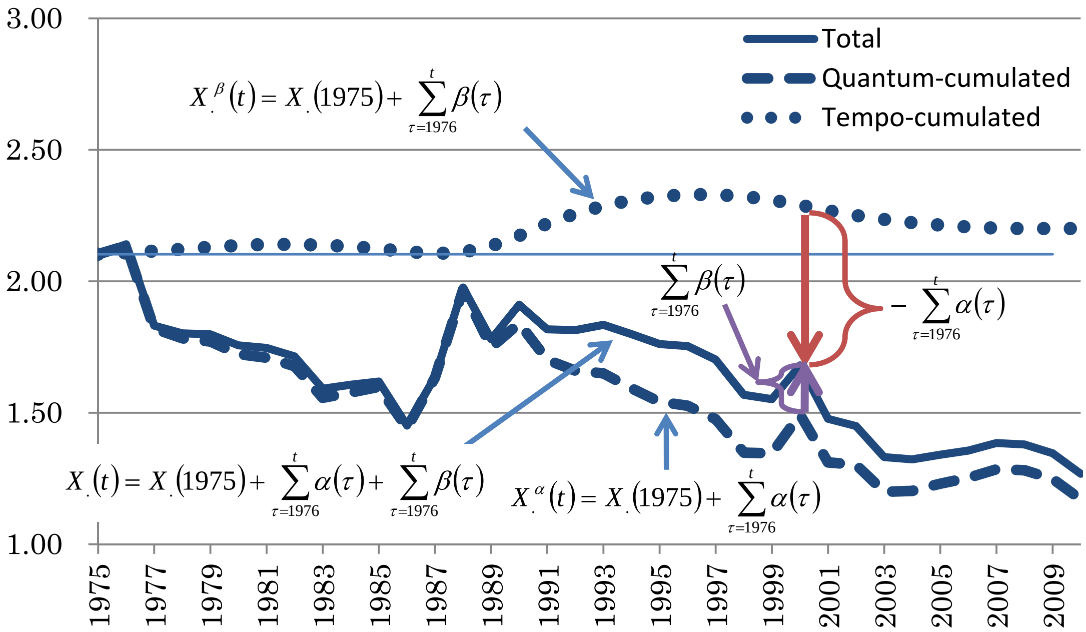


Figure 1. Period Total Fertility Rates by Ethnic Group in Singapore: 1975-2010.



Note: $X_{\cdot}(t)$ stands for the sum of $X_j(t)$ over the birth order, $X_{\cdot}(t) = \sum_{j=1}^{4+} X_j(t)$.

Figure 2. Decomposition of Period Total Fertility Rates into the Tempo- and Quantum- Components

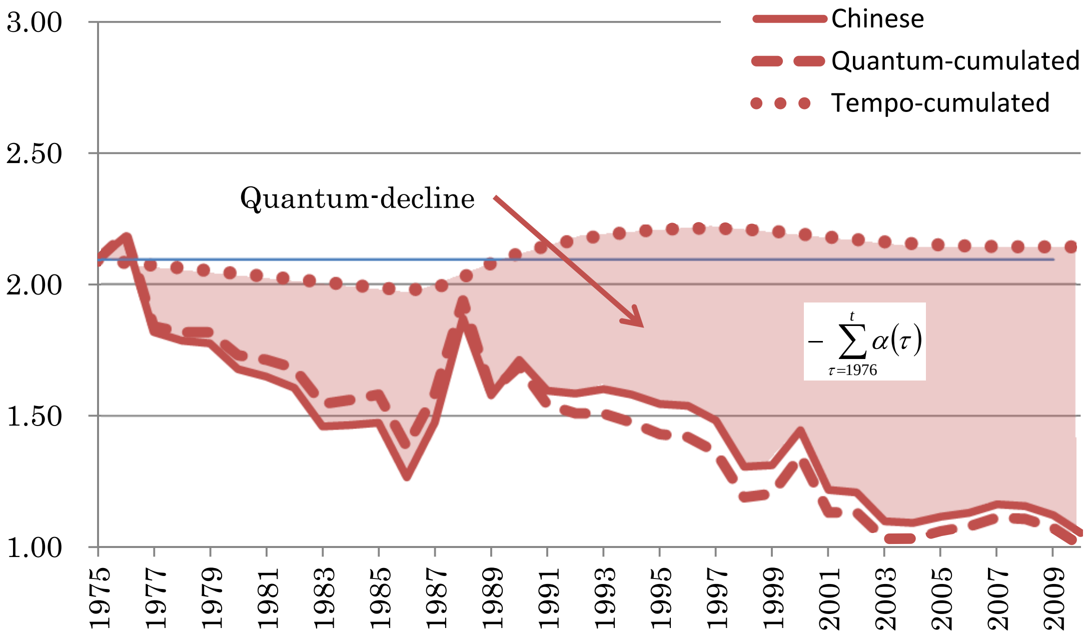


Figure 3. Quantum- and Tempo- Cumulated Total Fertility Rates in Singapore: Chinese, 1975-2010.

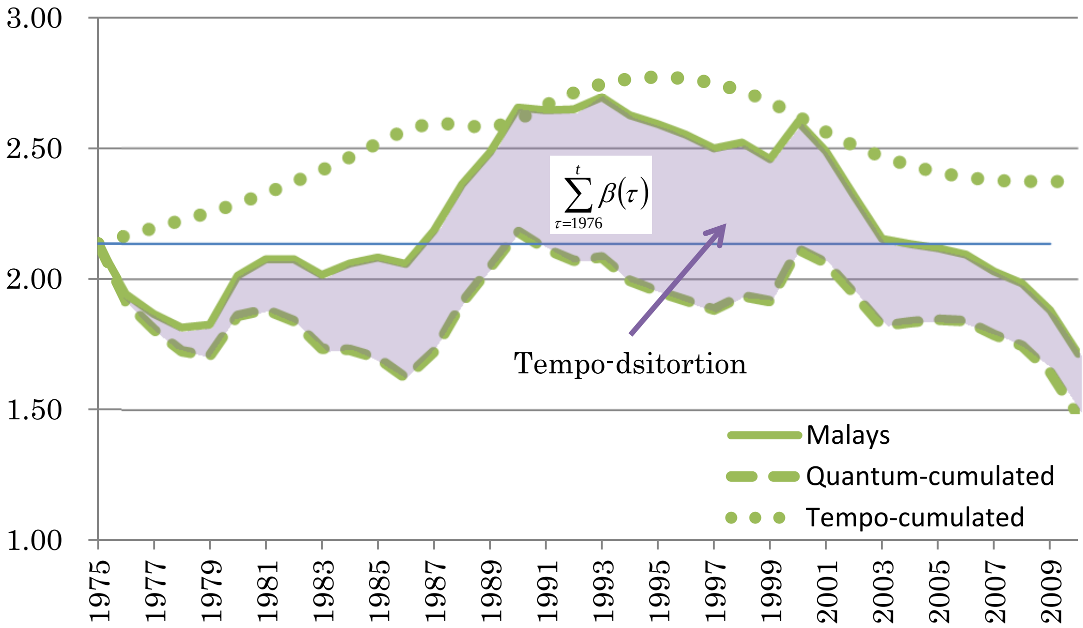


Figure 4. Quantum- and Tempo- Cumulated Total Fertility Rates in Singapore: Malay, 1975-2010.

Table 1. Decomposition of the Period Total Fertility Rates into Contributions of Tempo and Quantum Effects in Singapore: 1975-2010.

A. Chinese

	Priods							
	1975-2010	1975-1984	1984-1987	1987-1991	1991-2000	2000-2004	2004-2008	2008-2010
Birth order total								
Change of period measures								
Total fertility rate[1]	-1.04	-2.44	0.12	1.05	-0.58	-3.08	0.56	-1.81
Cum. quantum-TFR[1]	-1.09	-2.07	0.27	-0.36	-0.76	-2.76	0.67	-1.80
Cum. tempo-TFR[1]	0.05	-0.37	-0.16	1.42	0.17	-0.32	-0.11	0.00
Share of quantum and tempo effects in the change of period TFR (%)								
Quantum effect	-105	-85	233	-35	-130	-90	119	-100
Tempo effect	5	-15	-133	135	30	-10	-19	0
Contribution of birth order(%)[2]								
Parity 1	-12	-7	-86	56	-9	-36	83	-56
Parity 2	-29	-19	-86	12	-32	-41	13	-31
Parity 3	-27	-29	162	28	-47	-20	7	-12
Parity 4+	-31	-45	-117	4	-11	-4	-2	-1
Contribution of tempo and quantum effects on the change of TFR by birth order(%)								
Cum. quantum-TFR[3] Parity 1	-12	-2	-23	29	-35	-27	99	-56
Parity 2	-33	-15	153	-46	-35	-38	17	-31
Parity 3	-31	-28	251	-19	-49	-20	7	-12
Parity 4+	-28	-39	-148	2	-11	-4	-3	-1
Cum. tempo-TFR[4] Parity 1	-1	-5	-64	27	26	-8	-16	0
Parity 2	4	-3	-12	58	2	-2	-4	0
Parity 3	4	-1	-88	48	2	0	0	0
Parity 4+	-3	-6	31	2	0	0	0	0

B. Malay

	Priods							
	1975-2010	1975-1984	1984-1987	1987-1991	1991-2000	2000-2004	2004-2008	2008-2010
Birth order total								
Change of period measures								
Total fertility rate[1]	-0.42	-0.29	1.46	4.02	-0.17	-4.08	-1.32	-4.70
Cum. quantum-TFR[1]	-0.66	-1.57	-0.09	3.43	0.00	-2.44	-0.79	-4.69
Cum. tempo-TFR[1]	0.24	1.28	1.55	0.58	-0.17	-1.64	-0.53	-0.01
Share of quantum and tempo effects in the change of period TFR (%)								
Quantum effect	-157	-543	-6	85	-1	-60	-60	-100
Tempo effect	57	443	106	15	-99	-40	-40	0
Contribution of birth order(%)[2]								
Parity 1	-7	136	-15	34	26	-37	-22	-28
Parity 2	4	171	-15	13	-36	-29	-36	-26
Parity 3	14	134	56	33	-178	-16	-41	-19
Parity 4+	-110	-541	-24	20	88	-18	0	-27
Contribution of tempo and quantum effects on the change of TFR by birth order(%)								
Cum. quantum-TFR[3] Parity 1	-2	20	-26	30	84	-19	-4	-28
Parity 2	-8	34	13	22	-21	-14	-21	-26
Parity 3	-16	60	6	21	-176	-8	-34	-19
Parity 4+	-130	-657	0	12	112	-18	0	-27
Cum. tempo-TFR[4] Parity 1	-5	115	10	4	-58	-18	-18	0
Parity 2	12	138	70	-9	-15	-15	-15	0
Parity 3	30	74	50	12	-2	-8	-7	0
Parity 4+	20	116	-23	8	-24	0	0	0

Notes 1) $[TFR(T) - TFR(0)] \cdot 35/T$ where T denotes the duration of corresponding period.

2) % ratio of $\lfloor TFR_j(T) - TFR_j(0) \rfloor / [TFR(T) - TFR(0)]$.

3) % ratio of $\left[X_j^{\alpha}(T) - X_j^{\alpha}(0)\right] / [TFR(T) - TFR(0)]$ where $X_j^{\alpha}(t)$ denotes the cumulated quantum TFR_j defined in Eq. (7).

4) % ratio of $\left[X_j^{\beta}(T) - X_j^{\beta}(0)\right] / [TFR(T) - TFR(0)]$ where $X_j^{\beta}(t)$ denotes the cumulated tempo TFR_j defined in Eq. (8).