

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 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.

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

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

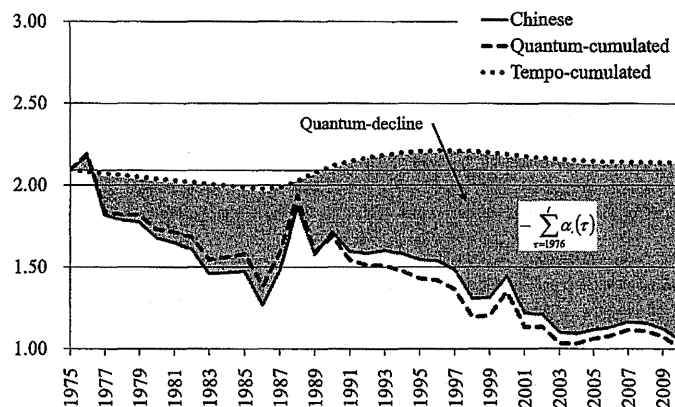
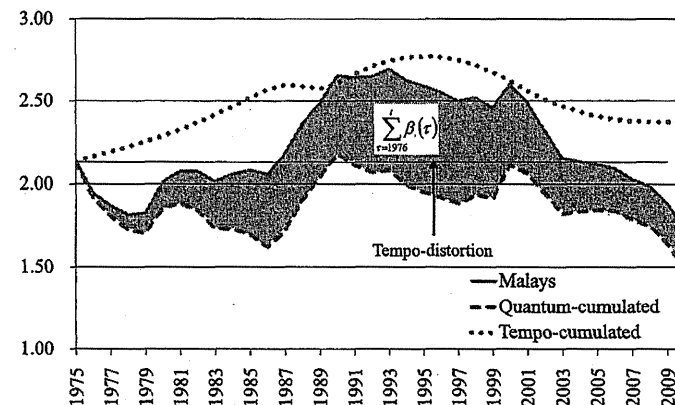


Figure 4. Quantum- and Tempo- Cumulated Total Fertility Rates in Singapore: Malay, 1975-2010



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.

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.

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

		Periods							
		1975-2010	1975-1984	1984-1987	1987-1991	1991-2000	2000-2004	2004-2008	2008-2010
A. Chinese									
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 ²⁾		-1.09	-2.07	0.27	-0.36	-0.76	-2.76	0.67	-1.80
Cum. tempo-TFR ³⁾		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 (%) ³⁾									
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									
		Periods							
		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 ²⁾		-0.66	-1.57	-0.09	3.43	0.00	-2.44	-0.79	-4.69
Cum. tempo-TFR ³⁾		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 (%) ³⁾									
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 $[TFR_i(T) - TFR_i(0)]/[TFR(T) - TFR(0)]$.
 3) % ratio of $[X_i^q(T) - X_i^q(0)]/[TFR(T) - TFR(0)]$ where $X_i^q(t)$ denotes the cumulated quantum TFR, defined in Eq. (7).
 4) % ratio of $[X_i^t(T) - X_i^t(0)]/[TFR(T) - TFR(0)]$ where $X_i^t(t)$ denotes the cumulated tempo TFR, defined in Eq. (8).

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 changes in the period quantum for policy assessment, and then proposes a method, by which we decompose time series 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 the 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 2nd and 3rd order births for 1984-1987 and the Malay's total fertility rates of 1st to 3rd 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.

Reference

- Anderson, John E., Mark C. E. Cheng and Wan Fook-Kee (1977) "A Component Analysis of Recent Fertility Decline in Singapore." *Studies in Family Planning*, 8(11): 282-287.
 Bongaarts, John and Griffith Feeney (1998) "On the Quantum and Tempo of Fertility." *Population and Development Review*, Vol.24(2): 271-291.
 Heckman, James J. and Edward J. Vytalil (2007) "Econometric Evaluation of Social Programs, Part I: Causal Models, Structural Models and Econometric Policy Evaluation", James J. Heckman and Edward E. Leamer eds., *Handbook of Econometrics*, Vol. 6B, pp.4779-4874, North-Holland: Amsterdam.

- Holland Paul W. (1986) "Statistics and Causal Inference." *Journal of American Statistical Association*, 81(396): 945-960.
- Kitagawa, Evelyn M. (1955) "Components of a Difference Between Two Rates." *Journal of American Statistical Association* 50(272): 1168-1194.
- Kohler, Hans-Peter and Jose Antonio Ortega (2002) "Tempo-adjusted Period Parity Progression Measures, Fertility Postponement and Completed Cohort Fertility." *Demographic Research*, 6: 92-144.
- Kohler, Hans-Peter and Dimiter Philipov (2001) "Variance Effects in the Bongaarts-Feeney Formula." *Demography*, 38: 1-16.
- Saw, Swee-Hock (2005) *Population Policies and Programmes in Singapore*, Institute of Southeast Asian Studies Publications: Singapore.
- Saw, Swee-Hock (2007) *The Population of Singapore, 2nd Edition*, Institute of Southeast Asia Studies Publishing: Singapore.
- Straughan, Paulin-Tay, Gavin Jones and Angelique Chan (2009) "From Population Control to Fertility Promotion - A Case Study of Family Policies and Fertility Trends in Singapore", Gavin Jones, Paulin-Tay Straughan and Angelique Chan eds., *Ultra-low Fertility in Pacific Asia: Trends, Causes and Policy Issues*, pp.181-203, Routledge : London.
- Singapore Department of Statistics (2003) "Singapore Register-based Census - Lessons Learnt and Challenges Ahead", Paper presented at the 21th Population Census Conference, Analysis of the 2000 Round of Censuses, Kyoto, Japan, 19 - 21 November 2003.
- Singapore Department of Statistics (2011) *Population Trends 2011*, Singapore.
- Wong, Theresa and Brenda S. A. Yeoh (2003) "Fertility and the Family: An Overview of Pro-natalist Population Policies in Singapore", *Asian MetaCentre Research Paper Series*, No. 12, Asian Research Institute: Singapore.
- Yap, Mui-Ten (2009) "Ultra-low Fertility in Singapore: Some Observations", Gavin Jones, Paulin-Tay Straughan and Angelique Chan eds., *Ultra-low Fertility in Pacific Asia: Trends, Causes and Policy Issues*, pp.160-180, Routledge : London.
- Zeng, Yi and Kenneth C. Land (2001) "A Sensitivity Analysis of the Bongaarts-Feeney Method for Adjusting Bias in Observed Period Total Fertility Rates." *Demography* 38(1): 17-28.
- Zeng, Yi and Kenneth C. Land (2002) "Adjusting Period Tempo Changes with an Extension of Ryder's Basic Translation Equation." *Demography* 38(1): 17-28.

Data Source

- Department of Statistics, *Yearbook of Statistics Singapore*, Singapore, 1968-2010.
- Khoo, Chian Kim (1981) *Singapore: Census of Population 1980, Release No.2 Demographic Characteristics*, Singapore Department of Statistics.
- Lau, Kak En (1992) *Singapore: Census of Population 1990, Release No.2 Demographic Characteristics*, Singapore Department of Statistics.
- Leow, Bee Geok (2001) *Singapore: Census of Population 2000, Release No.1 Demographic Characteristics*, Singapore Department of Statistics.
- Registry of Births and Deaths, Immigration and Checkpoints Authority Singapore, *Report on Registration of Births and Deaths, 1980-2009*.
- Register-General of Births and Deaths, Syariah Court and Registrar of Marriages, *Report on Registration of Births, Deaths and Marriages*, Singapore, 1968-1979.
- Singapore Department of Statistics (1996) *General Household Survey, Release No.1 Socio-Demographic and Economic Characteristics*, Singapore.
- Singapore Department of Statistics (2006) *General Household Survey, Release No.1 Socio-Demographic and Economic Characteristics*, Singapore.
- Singapore Department of Statistics (2011) *Census of Population 2010, Statistical Release 1, Demographic Characteristics, Education, Language and Religion*, Singapore.

シンガポールにおける第2の出生力転換期の期間出生力変動： 政策介入と民族格差

菅 桂 太

シンガポールにおいて合計出生率が置換水準を達成した1975年から2010年までの期間出生力の変動パターンと要因を探り、政策導入タイミングとの関連を民族別に検討する。

シンガポールでは1980年代から出生抑制政策の段階的な撤廃と出生促進政策の導入が進められた。政策介入の時期と出生力変動及びその要因が符号するか否かを検討する際には、期間出生力の政策介入前後の変化からテンポ効果の影響を除去する必要がある。

本研究では、おもに3点に着目し、テンポの影響を除去したカンタムの寄与とみることができるとして合計出生率の変化を評価した。すなわち、(1)Bongaarts-Feeney (1998)の修正合計出生率がカンタムを定量化すると解釈できる、(2)合計出生率は修正合計出生率と補正項の積であらわれるので2時点の合計出生率の差にはKitagawa (1955)の要因分解の手法が適用できる、(3)0年とt年の期間指標の差はこの間の1年毎の差の合計に等しいという3点に着目して、政策導入前後の期間カンタム指標の変化を検討した。

分析の結果、1975年から2010年を通じた全期間では中国系の合計出生率変動のほとんどはカンタムの寄与によるのに対し、マレー系ではテンポ効果にも一定の寄与があった。また、1980年代の出生促進政策導入期では中国系・マレー系ともにカンタムの増加があったが、期間出生力の変化に及ぼすカンタムの寄与は出生順位・民族によって異なっていた。2000年以後のより積極的な出生促進政策実施期では、中国系・マレー系ともにカンタムの減少の寄与が大きく、出生力変動の要因における民族間の格差は急速に縮小していることが示唆された。

