In practice, adequate linear or exponential interpolation should be applied. The PAP is calculated from the eventual parity distribution at the end of the reproductive period.

$$PAP = \sum_i i\ p(\beta,i).$$

Rallu and Toulemon (1993) referred to this measure as PATFR (Parity and Age Total Fertility Rate). The TFRPPR (TFR based on Parity Progression Ratio) by Feeney (1986) is also a closely related measure.

2. Introducing Perturbation

In a stable state in which all cohorts have the exactly same fertility schedule, there is no difference between TFR and PAP. To examine the difference, two scenarios of perturbation are hereby introduced. One is a universal decline in intensity of birth. Assume that while older cohorts have the fertility schedule m(x,i), younger cohorts follows the schedule of c m(x,i), where $0<c<1$. This expresses a decline in the quantum of fertility without a tempo change. If X is the age of the transitional cohort, the age pattern of intensity changes as X moves from α to β as shown in Figure 1. The TFR and PAP can be seen as the function of X and are denoted TFR(X) and PAP(X), respectively. The change starts when the transitional cohort begins childbearing ($X=\alpha$) and ends when the cohort finishes reproduction ($X=\beta$).

Another scenario is an age-shift of intensity without any change in quantum or shape. Assume that while older cohorts have the fertility schedule $m(x,i)$, younger cohorts follows the schedule of $m(x-h,i)$, where $0<h$. This expresses a delay in the tempo of fertility without any change in quantum or shape. The age pattern of intensity changes with the aging of the transitional cohort, as shown in Figure 2. As in these figures, it is assumed that intensity of birth has a unimodal age pattern. It is also assumed that the upper limit of reproduction does not change from β. This implies that, even in the age-shift of intensity, the eventual TFR and PAP are less than the original ones because fertility around the end of reproduction is lost.

3. Poisson Distribution

Here we assume that the intensity of birth is independent from parity. Namely, the intensity is a univariate function of age and can be written as $m(x)$. If $M(x)$ is the cumulative intensity,

$$M(x) = \int_0^x m(a)\ da.$$

Under this condition, parity has the Poisson distribution with the parameter $M(x)$ (Krishnamoothy, 1979).

$$p(x,i) = \frac{M(x)^i e^{-M(x)}}{i!}.$$

Since intensity is independent from parity, it turns out that the ordinary incidence rate without considering parity is equivalent to the intensity.

$$f(x,i) = m(x)\ p(x,i),$$

$$f(x) = \sum_i f(x,i) = m(x).$$

This implies that the TFR is equivalent to the sum of intensity for all ages. The PAP is defined as the average parity at the end of the reproductive period. Thus, as far as the eventual parity has the Poisson distribution which parameter is the TFR, there is no difference between the TFR and PAP.

Figure 1. Age-Neutral Quantum Decline

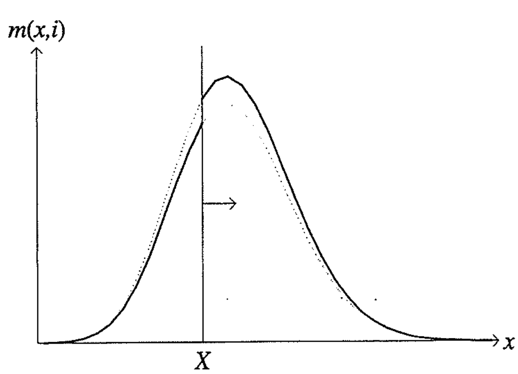
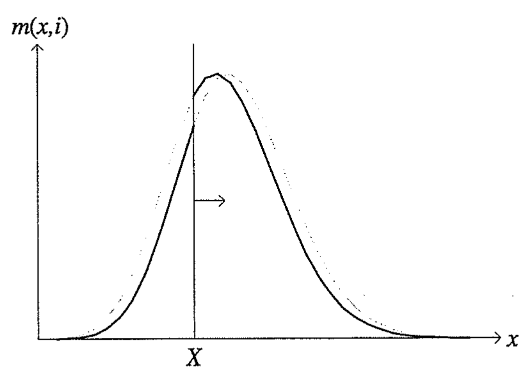


Figure 2. Delay in Intensity



Because neither scenario considered here affects the assumption of the independence of intensity with parity, the parity distribution of a hypothetical cohort always has the Poisson distribution with the parameter $M(x)$. Therefore, there is no parity distribution effect in a Poisson process.

4. Exponential Distribution

For the sake of simplicity, this section concentrates on first births. Therefore, the TFR represents the average number of first children and the PAP the proportion of women who have ever given birth. For the sake of convenience, the intensity of first birth is written as $m_0(x)$ and its cumulative as $M_0(x)$.

$$M_0(x) = \int_0^x m_0(a)\, da.$$

The proportion of women who have never given birth, $p(x,0)$, is written as $S_0(x)$.

$$S_0(x) = p(x,0) = e^{-M_0(x)}.$$

This form can be seen as an expansion of basic exponential distribution with a constant intensity, as in the case of the Poisson distribution. Since the incidence rate is the product of the intensity and parity,

$$f_0(x) = m_0(x)\, S_0(x).$$

4-1. Age-Neutral Quantum Decline

Here we assume that there was a one-time change in intensity from $m_0(x)$ to $c\, m_0(x)$, where $0<c<1$. Since the cumulative hazard is also multiplied by c, the proportion of women who have never given birth will be powered by c for cohorts younger than the transitional cohort.

$$e^{-c M_0(x)} = S_0(x)^c.$$

The TFR when the transitional cohort is at age X is the original TFR minus the change in the proportion of non-mothers at age X.

$$TFR(X) = 1 - S_0(\beta) - \{S_0(X)^c - S_0(X)\}.$$

For the PAP, the ratio of proportion of childless women, rather than the difference, is the matter of consequence.

$$PAP(X) = 1 - S_0(\beta)\frac{S_0(X)^c}{S_0(X)}.$$

It can be shown that the PAP declines monotonously as the transitional cohort ages.

$$\frac{d}{dX}PAP(X) = -(1-c)\, m_0(X)\, S_0(\beta)\frac{S_0(X)^c}{S_0(X)} < 0.$$

On the other hand, the TFR can have an extreme value within the reproductive period to produce a U-shaped trajectory.

$$\frac{d}{dX}TFR(X) = c\, m_0(X)\, S_0(X)^c - m_0(X) S_0(X).$$

The above equation implies that TFR(X) hits the bottom when the old and new incidence rates of first births are equivalent. If X^* is the age corresponds to the bottom of trajectory,

$$c\, e^{-c M_0(X^*)} = e^{-M_0(X^*)}.$$

This produces the following solution.

$$M_0(X^*) = -\frac{\ln c}{1-c}.$$

Since the right hand side is greater than one, $TFR(X)$ does not have an extreme value within the reproductive period if $M_0(\beta) \leqq 1$. In such a case, $TFR(X)$ will decline monotonously. For the TFR to produce a U-shaped trajectory, the cumulative hazard must exceed the unity before the reproduction ends. This implies that the proportion of childless women should be smaller than exp(-1) which is approximately 36.8 per cent. This is a weak requirement and the TFR will almost always produce a U-shaped trajectory except in case of very low fertility.

It is obvious that $PAP(\alpha) = TFR(\alpha)$ and $PAP(\beta) = TFR(\beta)$. If the PAP declines monotonously and the TFR follows a U-shaped trajectory with only one extreme value, it is expected that the PAP is greater or equal to the TFR throughout the change.

4-2. Age-Shift of the Intensity

Here we assume that the intensity of birth for cohorts younger than the transitional cohort has shifted, such that $m_0(x) \rightarrow m_0(x-h)$ where $h>0$. Since the cumulative hazard also shifts by h, the proportion of childless women shifts by h.

$$e^{-M_0(x-h)} = S_0(x-h).$$

The TFR and PAP have the same form as in the case of quantum decline but $S_0(X)^c$ is replaced by $S_0(X\text{-}h)$.

$$TFR(X) = 1 - S_0(\beta) - \{S_0(X\text{-}h) - S_0(X)\}.$$

$$PAP(X) = 1 - S_0(\beta)\frac{S_0(X-h)}{S_0(X)}.$$

The following result shows that $PAP(X)$ produces a U-shaped trajectory because the first parenthesis shifts from negative to positive under the assumption of the unimodal age pattern of $m_0(x)$.

$$\frac{d}{dX}PAP(X) = \{m_0(X-h) - m_0(X)\} \cdot S_0(\beta)\frac{S_0(X-h)}{S_0(X)}.$$

It turns out that the derivative of $TFR(X)$ is simply the difference between incidence rates. Thus, the TFR also produces a U-shaped trajectory.

$$\frac{d}{dX}TFR(X) = f_0(X-h) - f_0(X).$$

It can be shown that the TFR is smaller than the PAP. In the following result, the equation on the right hand side is a quadratic equation of $S_0(X)$ whose roots are $S_0(X\text{-}h)$ and $S_0(\beta)$. Because $S_0(X)$ is between $S_0(X\text{-}h)$ and $S_0(\beta)$, the right hand side should be always non-negative. This implies that $PAP(X) \geqq TFR(X)$.

S0(X) {PAP(X) - TFR(X)} = -S0(X)2
+ {S0(β)+S0(X-h)}S0(X)
- S0(β) S0(X-h).

5. Geometric Distribution

Two important results were obtained in the analysis of first births in the former section. Firstly, the TFR can produce a U-shaped trajectory even in the case of age-neutral quantum decline. Secondly, the TFR is smaller than the PAP throughout the change. These results could be sustained in a more general setting of multiple births if some assumptions were made on parity distribution. To illustrate an example, it is assumed here that parity has the geometric distribution at all ages. Although the reality of this assumption is questionable, this will produce the simplest solution.

As in the branching process (Harris, 1989, p. 9), it is assumed that the proportion of childlessness is given exogeneously. If $R(x)$ is the parity progression ratio at age x and for $i > 0$,

$$p(x,i) = \{1 - p(x,0)\}\,\{1 - R(x)\}\,R(x)^{i-1}.$$

Recall that the mean of geometric distribution is $1/\{1\text{-}R(x)\}$. To simulate low fertility in contemporary Japan, it is desirable that the conditional mean for women who ever had birth, $1/\{1\text{-}R(x)\}$, declines monotonously within the range between one and two. Here we choose the following form.

$$\frac{1}{1-R(x)} = 2 - p(x,0),$$

$$\text{or,}\quad R(x) = \frac{1-p(x,0)}{2-p(x,0)}.$$

Then, parity has the following distribution at age x.

$$p(x,i) = \left(\frac{1-p(x,0)}{2-p(x,0)}\right)^i, \quad i > 0.$$

As in the previous section, it is assumed that $S_0(x) = p(x,0)$ is determined by the intensity $m_0(x)$ and its cumulative function $M_0(x)$. The general system of parity progression is,

$$\frac{d}{dx}p(x,0) = -m(x,0)p(x,0),$$

$$\frac{d}{dx}p(x,i) = m(x,i-1)p(x,i-1) - m(x,i)p(x,i),\ i > 0.$$

Applying the assumption of geometric distribution yields the following solution.

$$f(x,i) = m(x,i)p(x,i)$$

$$= S_0(x)m_0(x)\frac{\{1-S_0(x)\}^i\{i+2-S_0(x)\}}{\{2-S_0(x)\}^{i-1}}.$$

$$f(x) = \sum_i f(x,i)$$

$$= S_0(x)\,m_0(x)\,\{3-2\,S_0(x)\}.$$

In a stable state,

TFR= PAP= {1 - S0(β)} {2 - S0(β)}
= S0(β) 2 - 3 S0(β) + 2.

5-1. Age-Neutral Quantum Decline

Here it is assumed, as in Section 4-1, that there has been change from $m_0(x)$ to $c\ m_0(x)$, where $0<c<1$. For cohorts at age X and below, the proportion of childlessness is $S_0(X)^c$. The new incidence rate for all parities is,

$$f_2(x) = c\ m_0(x)\ S_0(x)^c\ \{3 - 2\ S_0(x)^c\}.$$

The difference in $S_0(X)$ and its square causes the TFR change in an additional way. On the other hand, each argument of the original PAP is multiplied with the ratio of $S_0(X)$ and its square.

TFR(X) = S0(β) 2 - 3 S0(β) + 2
- {S0(X) 2 - S0(X) 2c}
+ 3{S0(X) - S0(X) c}.

$$PAP(X) = S_0(\beta)^2 \frac{S_0(X)^{2c}}{S_0(X)^2} - 3S_0(\beta)\frac{S_0(X)^c}{S_0(X)} + 2.$$

As in Section 4-1, the PAP declines monotonously.

$$\frac{d}{dX} PAP(X) = -(1-c)\ f_0(X) S_0(\beta) \cdot \frac{S_0(X)^c}{S_0(X)^2}\left\{3 - 2S_0(\beta)\frac{S_0(X)^c}{S_0(X)}\right\} < 0.$$

The TFR hits the bottom when the old and new incidence rates are equivalent.

$$\frac{d}{dX} TFR(X) = \frac{f_0(X)}{m_0(X) S_0(X)} \{f_2(X) - f(X)\}.$$

As in Section 4-1, the TFR declines monotonously if fertility is extremely low. The condition $f_2(X^*) = f(X^*)$ is equivalent with the following equation of $S_0(X^*)$.

$$\frac{S_0(X^*)^2 - c\, S_0(X^*)^{2c}}{S_0(X^*) - c\, S_0(X^*)^c} = \frac{3}{2}.$$

One asymptotic line is $S_0(X^*) = c^{1/(1-c)}$ which makes the denominator zero. Within the range $c^{1/(1-c)} < S_0(X^*) \leqq 1$, the maximum of the equation on the left hand side represents the unity when $S_0(X^*) = 1$. Thus, the condition $f_2(X^*) = f(X^*)$ is satisfied only when $S_0(X^*) < c^{1/(1-c)}$. If fertility is low enough so that $c^{1/(1-c)} < S_0(\beta)$, there is no such X^* that satisfies $f_2(X^*) = f(X^*)$.

The value of $c^{1/(1-c)}$ is 0.3487 when $c = 0.9$ and 0.3277 when $c = 0.8$. Except for a very drastic change or very low fertility, there exists X^* corresponding to the extreme value. Thus, we can expect that the TFR produces a U-shaped trajectory and is lower than the PAP throughout the change.

5-2. Age-Shift of the Intensity

If there were an age-shift of the sort wherein $m_0(x) \rightarrow m_0(x-h)$, the proportion of childlessness would also shift from $S_0(x)$ to $S_0(x-h)$. Thus, the incidence rate would also shift in the same way.

$$f_2(x) = f(x-h)$$

The TFR and PAP would have the same form as in the quantum decline but $S_0(X)_c$ would be replaced by $S_0(X-h)$.

$TFR(X) = S_0(\beta)^2 - 3\ S_0(\beta) + 2$
$- \{S_0(X)\ 2 - S_0(X-h)^2\}$
$+ 3\{S_0(X) - S_0(X-h)\}.$

$$PAP(X) = S_0(\beta)^2 \frac{S_0(X-h)^2}{S_0(X)^2} - 3S_0(\beta)\frac{S_0(X-h)}{S_0(X)} + 2.$$

The PAP will produce a U-shaped trajectory in accordance with the difference between $m_0(X)$ and $m_0(X-h)$. Assume that $S_0(\beta) < 1/2$. In the following equation, the last parenthesis is positive only if $S_0(x-h)$ is more than three times as large as $S_0(x)$. Such a drastic delay is not assumed here and the PAP does not produce a reversed U-shaped curve.

$$\frac{d}{dX} PAP(X) = S_0(\beta)\frac{S_0(X-h)}{S_0(X)^2} \cdot \{m_0(X) - m_0(X-h)\} \cdot \{2S_0(\beta)S_0(X-h) - 3S_0(X)\}.$$

As in Section 4-2, the derivative of $TFR(X)$ is simply the difference between the old and new incidence rates at age X. This implies that the TFR also shows a U-shaped trajectory.

$$\frac{d}{dX} TFR(X) = f_0(X-h) - f_0(X).$$

Here we assume that $S_0(X) / S_0(X-h) < 2$ and $S_0(\beta) < 1/2$. In the last big parenthesis of the following equation, $1 + S_0(X) / S_0(X-h)$ is less than 3 and $S_0(X) + S_0(\beta)$ is less than 3/2. Thus, the PAP is larger than the TFR except for a lengthy delay or extremely low fertility.

$$PAP(X)-TFR(X)$$

$$=\left\{1-\frac{S_0(X-h)}{S_0(X)}\right\}\{S_0(X)-S_0(\beta)\}$$

$$\cdot\left[\left\{1+\frac{S_0(X-h)}{S_0(X)}\right\}\{S_0(X)+S_0(\beta)\}-3\right].$$

6. Numerical Example

The analytical results so far illustrate that the TFR tends to produce a U-shaped trajectory even in a case of age-neutral quantum decline. This implies that the TFR tends to exaggerate the fertility decline. Unfortunately, both TFR and PAP produce U-shaped curves in a case of delay in childbearing. However, the PAP is more robust and the degree of exaggeration thereof is smaller than that of the TFR.

Table 1 compares the TFR and PAP in Japan and the Republic Korea in 2000. The parity distribution in Korea was obtained from the 2000 census. Because the Japanese census lacks information on fertility, the cohort specific parity distribution in the year 2000 was estimated based on a series of incidence rates of each cohort. As expected, the PAP in Korea showed higher value than the TFR. In Japan, however, the PAP was slightly lower than the TFR.

Table 1. PAP and TFR in Japan and Korea

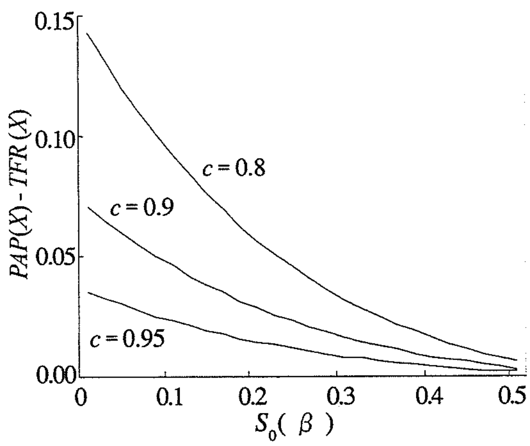
Eventual Parity Distribution	Japan (2000)	Korea (2000)
0	0.2958	0.1555
1	0.2077	0.2460
2	0.3685	0.5055
3	0.1073	0.0851
4+	0.0208	0.0078
PAP	1.35	1.54
TFR	1.36	1.47

If there were any measurement errors, the result on Japan would be more problematic because the parity distribution was estimated indirectly. However, there are some reasons to believe that the difference between the TFR and PAP should be smaller in Japan than in Korea.

One reason is Japan's slow delay in childbearing. The average age at childbearing rose from 29.0 in 1990 to 29.7 in 2000. In the same period, however, the average age rose from 27.2 to 28.9 in Korea. In fact, the tempo change in Japan is among the slowest in countries suffering from very low fertility. Many European countries with low fertility experienced a delay of one year over a period of six years or less (Suzuki, 2003, p. 4). It is apparent that the slower the delay, the smaller the parity distribution effect.

Another reason is the high proportion of eventual childlessness, $S_0(\beta)$, in Japan. As Table 1 reveals, the proportion was 29.6% in Japan in 2000. This is not the extremely low level of fertility that can cause a monotonous decline of the TFR in the case of quantum decline, a reversed U-shaped trajectory of the PAP in postponement of childbearing, or a higher value of the PAP than the TFR. However, it can be shown that the higher the proportion of childless women, the smaller the parity distribution effect. Figure 3 shows an example when $S_0(X)$ is at the midpoint of its change in the scenario of age-neutral quantum decline.

Figure 3. The Difference between TFR and PAP by $S_0(\beta)$ and c in Quantum Decline



Conclusion

This paper has compared the TFR and PAP in terms of their responses to one time quantum or tempo change. It has been shown here that the TFR tends to exaggerate fertility decline and to show lower value than the PAP. It is also shown herein that the slow change in tempo and high proportion of childlessness could explain the small difference between the TFR and PAP in Japan. The numerical example employed was for the year 2000, preceding a drastic fertility decline in Korea. It will be interesting to see if the difference in Korea in 2005 decreased, as would be expected from the results of this paper.

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Causes of Lowest-Low Fertility and Ineffectiveness of Governmental Interventions in Japan and Korea

Toru Suzuki

Introduction

There was an emergence of "lowest-low fertility" defined as having TFR (Total Fertility Rate) of 1.3 or less in Europe in the 1990s (Kohler et al., 2002). After the turn of century, lowest-low fertility started spreading in Eastern Asia. The TFR in the Republic of Korea (simply "Korea" henceforth) showed a drastic decline since 2001 and arrived at an incredibly low level of 1.08 in 2005. Japan's TFR of 1.25 in 2005 is also lower than most European countries.

The emergence of lowest-low fertility was accompanied by various reversals in the relation with socioeconomic determinants at the aggregate level. Unlike in the 1970s, low fertility countries of today are characterized by low female labor force participation, robust marriage institution, and strong family ties. Thus, it is not the change in family values toward individualization and secularization as emphasized in the second demographic transition theory (van de Kaa, 1984) that is responsible for lowest-low fertility. Rather, we should focus on the disharmony between the changing socioeconomic determinants of fertility and unchanging family values in lowest-low fertility countries.

To develop the theory of lowest-low fertility, this paper attempts a detailed comparison between Japan and Korea. Efforts will be made to explain the difference in fertility between two countries, as well as to explain recent changes in each country. After considering the effect of tempo distortion, a decomposition of fertility decline to nuptiality and marital fertility will be attempted. It will be shown that demands for spouse and children are not declining rapidly and are not at lowest-low level. Thus, recent fertility decline should be explained not from changing family values but from obstacles to fulfill the demand. Such obstacles as direct cost of children, difficulty for occupational achievement for youth and opportunity cost accompanied by female labor force participation are examined.

After describing the history of governmental intervention to promote fertility in Japan and Korea, the effects of policy measures such as child allowance, childcare leave, and daycare service will be examined. Analyses in Japanese literatures imply that those measures are not as effective as expected. Then, it will be shown that most of the differences between moderately low and lowest-low fertility are attributed to direct effects of cultural features, not to governmental efforts. A cultural deterministic view on fertility points out the cultural features in moderately low fertility countries that prevented fertility from declining to the lowest-low level. It will be shown that these cultural differences are beyond the family policy, and that a governmental intervention cannot induce continuous fertility recovery to the moderately low level.

1. Quantum and Tempo

Figure 1. TFR in Japan and Korea

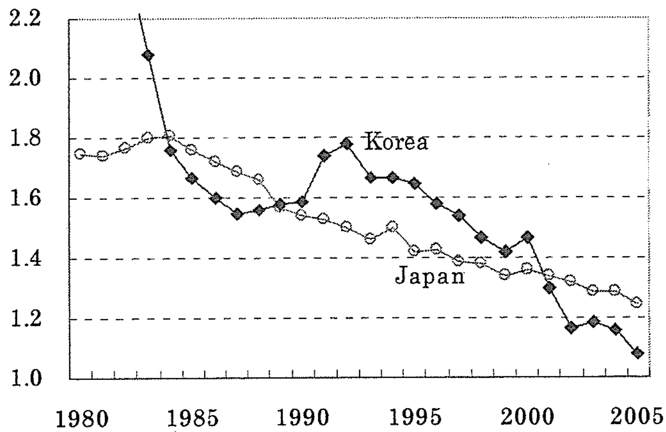


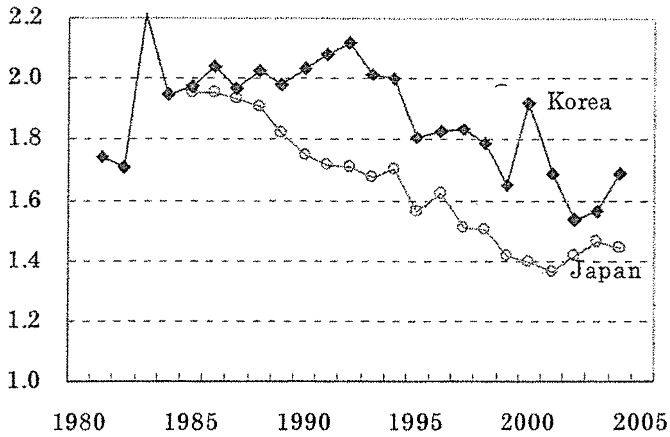
Figure 1 compares TFR in Japan and Korea. Although TFR in Korea was lower than in Japan between 1984 and 1988, Korea sustained higher fertility throughout the 1990s. After a small millennium baby boom in 2000, TFR in Korea dropped sharply to a much lower level than in Japan.

Bongaarts and Feeney (1998) proposed a measure to remove tempo distortion from TFR. Their ATFR (Adjusted Total Fertility Rate) is a hypothetical TFR that would materialize if there were no delay in childbearing. In the following, $f_i(x)$ is age-specific fertility rate of birth order i, and r_i is annual rate of change in the mean age at childbearing. The overall ATFR is simply the sum of order-specific $ATFR_i$.

$$TFR_i = \sum_x f_i(x), \quad ATFR_i = \frac{TFR_i}{1-r_i}.$$

Although they declared afterward that their ATFR is neither an estimate nor a prediction of cohort fertility (Bongaarts and Feeney, 2000, p. 560), their first illustration was based on the concept of completed fertility of a birth cohort. Thus, many problems were pointed out when the ATFR is seen to be a measure of cohort fertility (van Imhoff and Keilman, 2000; Kim and Schoen, 2000; Inaba, 2003). However, Kohler and Philipov (2001) proved that an adjustment of TFR can be defined without referring to cohort fertility at all, and Zeng and Land (2001) demonstrated the robustness of the ATFR. As far as it is not misunderstood to be a measure of cohort fertility, the ATFR should be a valid measure of period fertility being removed the effect of delay in childbearing.

Figure 2. Adjusted TFR in Japan and Korea



As shown in Figure 2, ATFR in Korea is still higher than in Japan. If the delay in childbearing were stopped in 2004, TFR in Korea would rise to 1.69, while that in Japan would recover only to 1.45. Thus, one way to answer to "Why fertility in Korea is lower than in Japan?" is "Because the delay in childbearing is more prominent than in Japan." However, it is unlikely that the delay actually stops soon either in Korea or in Japan. The delay in marriage and childbearing is a long term trend lasting more than two decades in both countries (Suzuki, 2003a, pp. 3-5). Furthermore, this decomposition into tempo distortion and net quantum is not helpful because most determinants of fertility promote both delay and decline at the same time. More useful insight can be obtained from decomposition into nuptiality and marital fertility.

2. Nuptiality and Marital Fertility

Extramarital births are very seldom in Japan and such births accounted for only 1.99% of all births in 2004. Although there is no statistics, extramarital births are thought to be very small also in Korea (Eun KS, 2003, p.557; Cho BY, et al., p. 31). Thus, we can assume that practically all the births in Japan and Korea come from married couples.

Decompositions into nuptiality and marital fertility used to be conducted on AMFRs (Age-specific Marital Fertility Rates) by the mid 1990s in Japan (Atoh, 1992, p. 51; Kono, 1995, pp. 67-71; Tsuya and Mason, 1995, pp. 147-148; NIPSSR, 1997, p.10). If $f(x)$ is the ordinary age-specific fertility rate and $\Phi(x)$ is the proportion of currently married women, AMFR is defined as follows;

$$AMFR(x) = \frac{f(x)}{\Phi(x)}.$$

Decomposition analysis using AMFRs is especially dangerous when there is a secular trend of marriage postponement. Because marital fertility is dependent on

Figure 3. Total First Marriage Rate

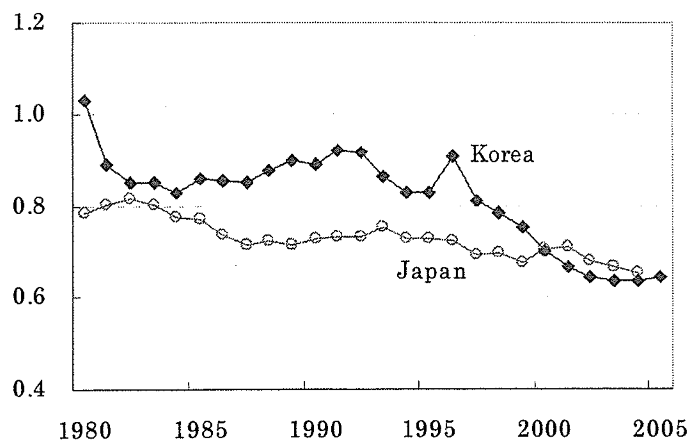
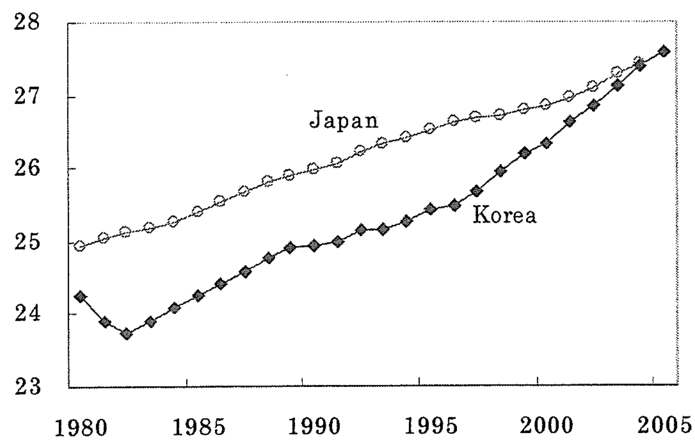


Figure 4. Mean Age at First Marriage



marriage duration as well as on age, decomposition using AMFRs is severely squeezed by compositional changes in marriage duration within an age interval. While Japanese demographers have recently recognized this problem (Hirosima 2001; 2003; Kaneko, 2004a; 2004b), Korean demographers still rely on AMFRs (Jun KH, 2002, pp. 90-94; Eun KS, 2003, p. 582; Kim SK, 2004, p. 7).

Japanese demographers have been devoting to methodological development on this issue. Hirosima (1999) used the proportion of eventually married women and the complete average number of children among married women to decompose the effect of nuptiality decline and that of marital fertility decline. Kaneko (2004a) shifted age-specific fertility rates $f(x)$ in accordance to the delay in marriage and calculated new AMFRs. Kaneko (2004b) carried out decompositions using logistic regression analysis with parities by age as dependent variables.

While these studies continue relying on age-specific fertility rates, Iwasawa (2002) introduced the eventual average number of children by age at marriage. Assume that there is no divorce or death of spouse by age β, the end of reproduction. Assume also that a woman who married at age a is expected to have $N(a)$ children by age β. If ?(a) is density function of marriage, EAC (Eventual Average number of Children) among eventually married women is;

$$EAC = \int_0^{\beta} \rho(a)\, N(a)\, da.$$

If one applies ?(*a*) of different cohorts while keeping *N*(*a*) constant, one obtains hypothetical EACs given that marital fertility did not change. CFR (Complete Fertility Rate) is the average number of children of a cohort that finished reproduction and is EAC times the proportion of married women at age β. By comparing a hypothetical EAC times the proportion married with an actual CFR, one can infer the effect of nuptiality decline on CFR.

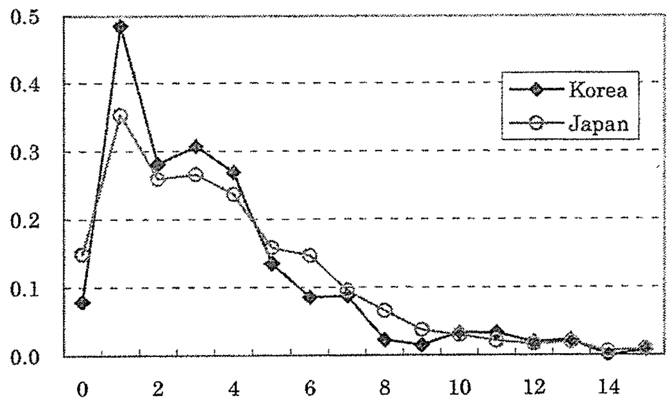
This method cannot be applied directly to period fertility because *N*(*a*) cannot be defined for a hypothetical cohort. Here, a simplification of Iwasawa's method is attempted by assuming that marital fertility is not dependent on age at marriage but solely on marriage duration. The distribution of marriage duration in year t at age x is estimated from female first marriage rate by year and age f (t,x).

$$p(t,x,y) = \varphi(t-y, x-y).$$

If $m(y)$ is the standard fertility by marriage duration, hypothetical age-specific fertility rate can be estimated as follows;

$$f^*(t,x) = \sum_y p(t,x,y)\, m(y).$$

Figure 5. Duration-Specific Marital Fertility Rate



Summing up $f^*(t,x)$ gives a hypothetical TFR given that there were no change in marital fertility. By comparing with the actual TFR, the effect of nuptiality decline can be estimated. Age-specific first marriage rates and fertility rates were calculated from vital statistics and current population estimates in Japan and Korea. Figure 3 compares TFMR (Total First Marriage Rate) and Figure 4 compares the MAFM (Mean Age at First Marriage) of women in Japan and Korea. These graphs show that, although nuptiality in Korea rapidly declined and has caught up Japan, it is not low enough to make fertility in Korea much lower than Japan. Then, we can expect that it is not nuptilality but marital fertility that produced the recent fertility difference between two countries.

To show this quantitatively, hypothetical TFRs were calculated using the method described above. Figure 5 shows the standard marriage duration specific fertility rates that are required in this method. These rates were obtained from national sample surveys in two countries; The Twelfth Japanese National Fertility Survey in 2002 conducted by the National Institute of Population and Social Security Research, and The 2000 National Fertility and Family Health Survey by the Korea Institute for Health and Social Affairs. The fertility in the year of marriage is higher in Japan, suggesting that there are more shotgun marriages than in Korea. Korean couples tend to concentrate childbirth between one and four year after marriage.

Assumptions made to estimate hypothetical TFRs are;.

(1) Marital fertility does not depend on age but solely on marriage duration.
(2) There is no divorce or death during reproductive ages.
(3) There is no delay in marriage registration.
(4) Couples married for more than ten years do not have childbirths.

Figure 6. Actual and Hypothetical TFR: Japan

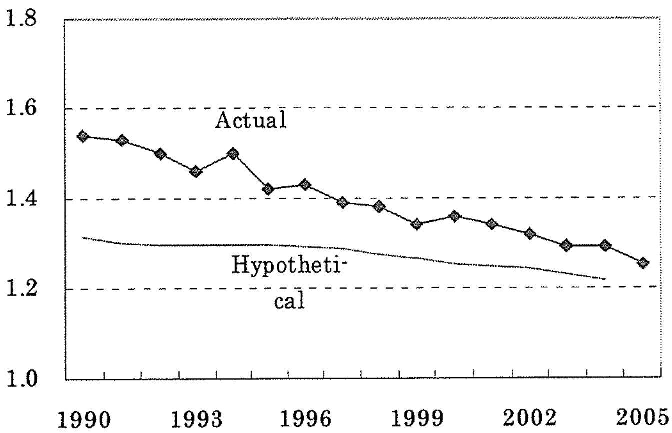
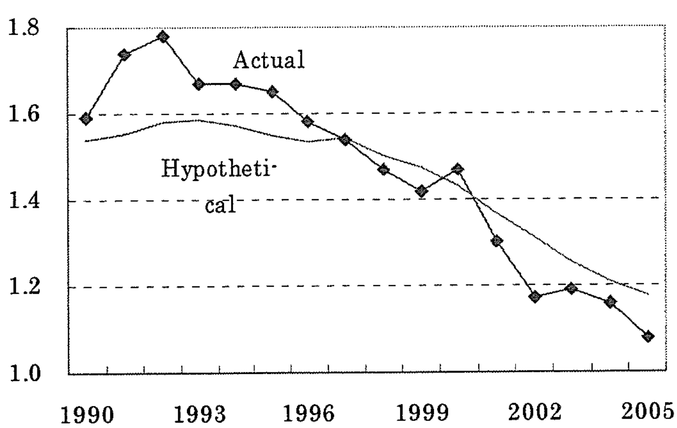


Figure 7. Actual and Hypothetical TFR: Korea



While the former two assumptions will result in overestimation of fertility rates, the latter two will cause underestimation. If overall estimation errors were relatively stable during the period, we would be able to obtain useful insights from the comparison between the hypothetical and actual TFRs. Figures 6 and 7 give such comparisons in Japan and Korea. Note that the trajectory of hypothetical TFRs indicates a TFR decline given that there was no change in marital fertility, while actual TFRs are the results of both nuptiality and marital fertility declines. Apparently, both factors contributed to the fertility declines in both countries.

Table 1 shows the

rate of TFR decline by three year period. In Japan, the actual TFR declined by 16.2% between 1990 and 2004 (from 1.54 to 1.29). A little less than a half (7.3% decline) of this can be attributed to nuptiality decline. However, the contribution of nuptiality decline tends to be larger recently. Korea witnessed 27.0% decline of TFR between 1990 and 2004 (from 1.59 to 1.16). About four fifth (21.5%) was due to nuptiality decline. It should be noted that the relative importance of nuptiality is sensitive to the choice of period, because neither fertility nor nuptiality declines monotoneously. However, it is very unlikely that the rapid fertility decline in Korea between 2000 and 2004 (21.1%) was caused solely by nuptiality decline, considering that the TFMR declined only by 9.7% in the same period.

Table 1. TFR Decline by Period (%)

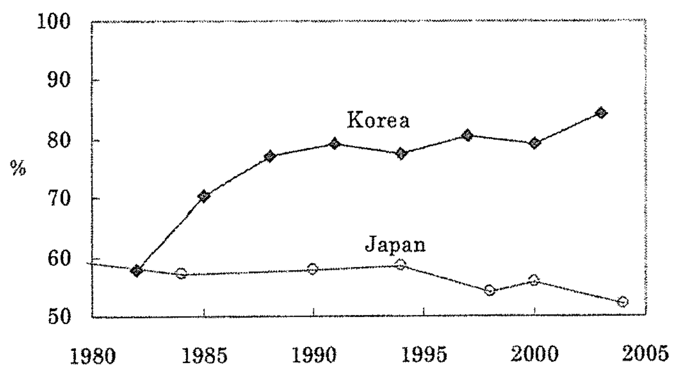
Period	Japan		Korea	
	Actual	Hypothetical	Actual	Hypothetical
1990~1995	-7.8	-1.3	3.8	0.5
1995~2000	-4.2	-3.4	-10.9	-7.6
2000~2004	-5.1	-2.7	-21.1	-15.5
1990~2004	-16.2	-7.3	-27.0	-21.5

3. Determinants of Fertility

3-1. Proximate Determinants

Since marriage does not explain whole part of the fertility decline, there should be proximate determinants (Bongaarts, 1978) that caused a significant fall in marital fertility. Time series data are only partially available for those determinants. Figure 8 shows the proportion of wives using contraception taken from the family planning survey by Mainichi Newspaper Company (Japan) and from the national fertility survey by KIHASA (Korea). The proportion rose sharply in the 1980s in Korea and has been much higher than Japan. It seemed that contraceptive prevalence in Korea reached the saturation level and there was little room for further change. Surprisingly, however, there was a further increase between 2000 and 2003. Thus, it is thought that contraception played a significant role for the recent fertility decline in Korea, this is not the case in Japan.

Figure 8. Practice of Contraception



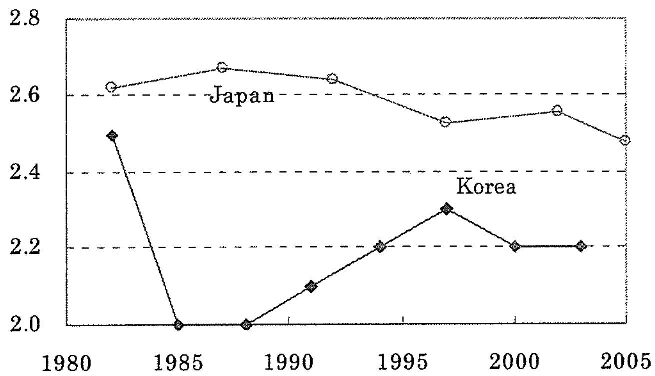
Source: NIPSSR, Kim et al. (2004b)

In Japan, the incidence of abortion and that of stillbirth have been declining. It is said that many mothers in Japan stop breastfeeding by 1.5 years after the birth. Then, induced abortion, intrauterine mortality, or postpartum amenorrhea does not explain the recent fertility decline. The remaining proximate determinants are frequency of intercourse and sterility. It might be possible to assert that sexless couples are in increase due to the long working hours or strengthened mother-child ties. It might also be possible to hypothesize an increase in infecundity due to the rising age at marriage, environmental hormone, and sexually transmitted diseases (Semba, 2002). However, quantitative evaluations of such hypotheses will be difficult due to the lack of necessary data.

3-2. Demand for Children

Figure 9 compares the ideal number of children asked in national fertility surveys in two countries. This measure could be seen as the demand without considering one's income constraint. Although Korean wives consistently wish the smaller number of children than Japanese wives, a part of this difference could be attributed to the questionnaires; Korean wives are asked her individual desire while Japanese wives are asked the consensus of couple[1].

Figure 9. Ideal Number of Children



Source: NIPSSR, Kim SK, et al.(2004b)

The decline in demand for children among Korean wives during the first demographic transition was very impressive. The ideal number of children dropped from 5.0 in 1960 to 2.0 in 1984 (Jun KH, 2002, p. 105). This drastic change was promoted by the strong governmental campaign of family planning and the demand recovered to some extent after the Korean government retreated from the very powerful anti-natal policy (Yamaji, 2003, p. 65). Since 1997, however, the Japan-Korea difference has been small and it is difficult to say whether the difference is real or due to the questionnaires. According to Kim SK, et al. (2004, p. 316) on which Figure 9 based, the ideal number of children among Korean wives was 2.2 and did not change between 2000 and 2003. Thus, the cause of recent drastic decline in marital fertility should be explored not in the demand itself but in obstacles to fulfill the demand.

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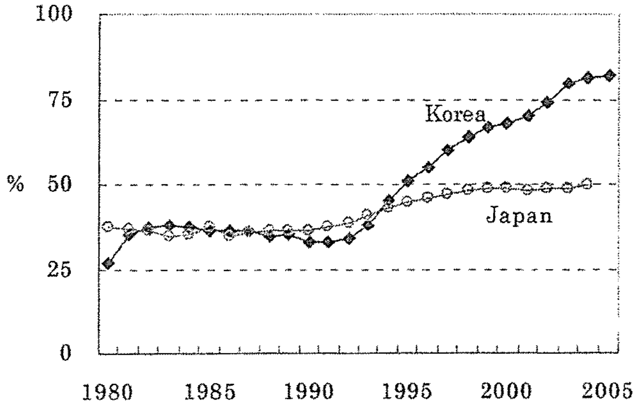
1 The sentences in questionnaires are; "부인께서는 몇 명의 자녀를 두는 것이 가장 적당하다고 생각하십니까?" (Korea), and "あなた方ご夫婦にとって理想的な子どもの数は何人ですか。" (Japan).

3-3. Direct Costs of Children

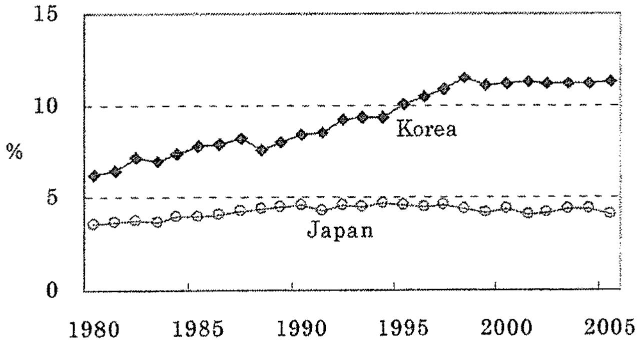
The most important obstacle in Korea seems to be the rising costs of children. According to the OECD statistics, Korea's expenditure on educational institutions accounted for 8.2% of GDP in 2001 and was highest among countries for which data were available. The figure for Japan was as low as 4.6% and was 21st among 27 countries. The heavy burden of human investments is strongly felt by Korean women. According to Chang HK (2004, p. 130), the most frequent answers to the causes of fertility decline (multiple choice) were "Educational cost is too high" (51.6%) and "Childrearing costs other than education are too high" (52.8%). In the 2003 national fertility survey, "childcare and (public) educational cost" and "private educational cost" were listed as the most serious difficulties in household expenditure (Kim SK, 2004, p. 16; Kim SK, et al., 2004, p. 159).

Figure 10. College Enrollment Rate



Source: NIPSSR, NSO

Figure 11. Educational Expenditure in Household Consumption



Source: MIC, NSO

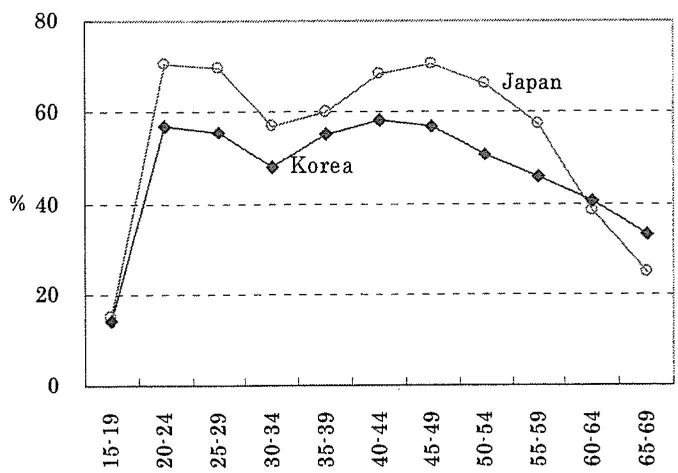
Figure 10 demonstrates how "educational inflation" in recent Korea has been drastic. It is said that the oversupply of college graduates has narrowed the income difference by education and hindered high school graduates from finding jobs (Lee CY, 2002, p.285). Figure 11 compares educational costs as a percentage of household consumption. The share is higher in Korea already in 1980 and the gap has been widening. Although the growth rate is not as impressive as college enrollment, it is possible that substantively perceived costs rose sharply and contributed to the recent fertility decline.

3-4. Female Labor Force Participation

According to Becker (1991, pp. 350-354), the main cause of family changes since the latter half of 20th century was the rising economic power of women. The expanding occupational opportunity for women increased the time spent on market activities and raised the opportunity cost of children. The declining return from gender-based division of labor reduced the merit of marriage and promoted the rise in divorce rate. These changes resulted in the increase in female-headed households, cohabitations, and extramarital births.

The theory predicts the negative impact of female labor force participation on fertility. Actually, there are numerous empirical evidences of such a negative effect of wife's work on fertility at the micro level in Japan (Asami et al., 2000; Oi, 2004; Oyama, 2004; Sasai, 1998; Shichijo and Nishimoto, 2003; Tsuya, 1999; Fukuda, 2004; Fujino 2002; Yashiro, 2000; Yamagami, 1999; Yamaguchi, 2005). At the macro level, however, the correlation between female labor and fertility among developed countries turned from negative to positive in the 1980s (Engelhardt and Prskawetz, 2005, pp. 2-3; Billari and Kohler, 2002, pp. 20-21; Atoh, 2000, p. 202). The positive correlation at the aggregate level can be seen as the result of the heterogeneity in compatibility between work and family. In a country with high compatibility, both fertility and female labor force participation can be held at a relatively high level. In a country with low compatibility, however, the increase in female labor force participation can induce fertility decline to the lowest-low level.

Figure 12. Female Labor Force Participation in the 2000 Census



In Japan and Korea, the low compatibility between work and family is expressed in M-shaped curve of age-specific participation rates (Figure 13). Although M-shaped curve can be seen also in New Zealand, the drop between age 25-29 and age 30-34 is steepest in Japan (Furugori, 2003, p. 48). Thus, many Japanese women have ability and opportunity to work but they have to give up their career at childbearing. Such incompatibility is attributed to remaining gender role attitude, low participation of husband in housework, characteristics of labor market, and underdevelopment of family friendly policy (Atoh and Akachi, 2003, p. 35; Meguro and Nishioka, 2000). In Korea, there was a debate on if the recent change in M-shaped curve implies improvement in the compatibility (Park KS and Kim YH, 2003, p. 67).

As far as the gender equity is concerned, Japan and Korea are among the lowest in the developed world. The Human Development Report published by the

United Nations Development Programme (UNDP) includes Gender Empowerment Measure (GEM), which indicates female representation in the legislature, occupation and income. Japan's score was 0.534 in 2005 and was 25th among 28 OECD member countries. Japanese husbands spend considerably shorter time in housework than the US husbands (Tsuya and Bumpass, 2004) or Scandinavian husbands (Tsuya, 2003, p. 63). The Survey on Time Use and Leisure Activities by the Statistics Bureau shows that there was little change in husband's participation in housework between 1981 and 1996 (Atoh, 2000, p. 205). Considering the Korea's GEM score (0.479, 27th) that is even lower than Japan, there seems to remain the critical incompatibility.

3-5. Labor Market Condition and Economic Uncertainty

Young people that grew up in a period of rapid economic growth tend to have high aspiration for their future lives. When the economy slows down, however, the labor market condition for the young workers becomes tight. Those who conceive the difficulty to achieve the expected standard of living will hesitate to step into marriage and childbearing (Easterlin, 1978; Yamada, 1999).

In the case of Japan, economy was bad throughout the 1990s. Unemployment rate rose sharply from 2% in 1990 to 5% in 2003. The tight labor market condition seriously discouraged the career achievement of the youth. While those who obtained a stable job decreased from 77.8% in 1988 to 55.8% in 2004, those who obtained no job or a temporary job increased from 9.4% to 24.6% during the same period. The proportion proceeding to higher education increased from 6.5% to 11.8%.

According to Nagase (2002, pp. 27-28), part time work significantly reduces the hazard of first marriage of both men and women. While the hazard rapidly rises between age 24 and 27 for women working on fulltime basis, such acceleration cannot be observed for women with part time jobs. Takayama and his coauthors (2000, pp. 9-10) showed that the low income of young men relative to their fathers discouraged marriage. In the past, the income of men in age 30s overcame that of fathers and motivated women to marry them. Recently, however, the relative income of young men to old men has declined considerably and young men are less attractive as marriage partners than before.

The poor economic performance in recent Japan has depressed not only nuptiality but also marital fertility. The positive effect of husband's income on marital fertility has been identified repeatedly (Yamagami, 1999; Fujino, 2002; Oyama, 2004; Morita, 2006). In this connection, the wage index in The Monthly Labor Statistics Survey dropped by 6.7% points between 1997 and 2003. The economic recession is thought to have affected not only through income level itself but also through the expected income in the future. A series of opinion survey conducted by the Cabinet Office shows a significant increase in pessimistic expectation on one's won life (Suzuki, 2005, pp. 32-33). In June, 2005, the proportion answering that "my life will go worse" surpassed the optimistic answer that "my life will go better" by 18% points. It is thought that such uncertainty toward the future is one of the major sources of lowest-low fertility in recent Japan.

While Japan suffered from the economic recession throughout the 1990s, an acute economic crisis hit Korea in 1997. Eun KS (2003) asserted that the reconstruction of labor market after the crisis made it difficult for the youths to find jobs and raised the uncertainty of workers' future lives. This labor market change is thought to have caused the fertility decline mainly through the nuptiality decline. Lee SS and coauthors (2004, p. 86) also suggested the effect of economic crisis and uncertainty toward future on the recent low propensity to marry. Though there is no fine time series data, there might be an increase in pessimistic attitude toward future as in Japan that affected the recent decline in nuptiality and marital fertility.

4. Ineffectiveness of Governmental Interventions

4-1. Governmental Actions in Japan and Korea

The Japanese government was surprised by the historically low TFR of 1.57 in 1989 and started an inter-ministry meeting to invent measures to cope with the declining fertility in 1990. The amount of child allowance was raised in 1991, while the period of payment was shortened to keep the budget. The Childcare Leave Law (formally "Law Concerning the Welfare of Workers Who Take Care of Children or Other Family Members Including Child Care and Family Care Leave") was established in May 1991 and enforced in April 1992. In December 1994, the government publicized the Angel Plan for the period between 1994 and 1999. The program emphasized the compatibility between work and childcare and public support of childrearing. As a part of this program, amendments to the Childcare Leave Law were made to support income and exempt from payment of social security premium in 1994. In 1997, a major reformation was made to the Child Welfare Law to provide with satisfactory daycare services for working mothers.

In December 1999, the Japanese government announced the New Angel Plan for the period between 1999 and 2004. This document asserted the need to improve the gender equity and working condition. In May 2000, amendments to the Childcare Leave Law and the Child Allowance Law determined that 40% of wage should be paid during the leave. Child allowance was expanded from less than three years old defined in the 1991 revision to preschoolers. The Next Generation Law, enacted in July 2003, required local governments and large companies to submit their own programs to foster new generations. At the same time, the Law for Measures to Cope with Decreasing Children Society ordered the Cabinet Office to prepare new measures to prevent the rapid fertility decline. An expansion of child allowance to the third grade of primary school was enforced in April 2004.

In December 2004, the Japanese government declared the New-New Angel Plan for the period between 2004 and 2009. The document emphasized the role of local government and companies in providing with childcare supports and improving gender equity. In addition, the document pointed out the importance of economic independence of the youth. From the fiscal year of 2006, the child allowance was expanded until the sixth grade of the primary school. In addition, the Support Plan for Mothers' Reentry to Labor Market started. The plan includes such measures as starting a course for reentering mothers at vocational schools, helping a mother who attempts to start business, and running "Mothers' Hello Works" nationwide. In June, 2006, the government announced the New Policy to Cope with Low Fertility, including raising child allowance amount for the first three years after birth, improving payment procedure of one time cash benefit at birth, supporting the cost of medical check during pregnancy, establishing "Family Day" and "Family Week," etc.

The Korean government was slow in turning from antinatal to pronatal policy probably because the high fertility lasted for a long period (Kojima, 2005, p. 4). Being shocked with the TFR of 1.17 in 2002, the Korean government started developing policy interventions to raise fertility. In January, 2004, the Task Force Team of the President's House published "The Nation's Strategy to Cope with a Low Fertility and Aging Society". The document covered a wide range of issues including labor market, welfare of the elderly people, and pronatal policy. Governmental actions such as raising salary during maternity leave, supporting employment of substitute workers during parental leave, subsidizing medical treatment of infecundity, and helping domestic work of households with children to raise fertility. However, the team was skeptical for the effectiveness of child allowance and was negative to its introduction. On the other hand, the government declared a numerical goal that increasing the proportion of national daycare center from 5.3% in 2004 to 10% in 2008 (Seo MH, 2004, p. 8).

In June, 2004, the Ministry of Gender Equity and the Committee on Aging and Future Society announced "The Childcare Support Policies to Foster Future's Manpower and to Expand Women's Participation in Economic Activities". Such proposals were made as activating maternity leave, sending baby sitters to households with infants, expanding the target of childcare support, running after school classes in primary schools, and creating specific courses to suppress the rising cost of private educations.

In August, 2005, the government declared a numerical goal to raise the TFR to 1.6 in 2010. To meet this goal, the Committee for Low Fertility and Aging Society compiled various policy measures for childbearing and elderly care, and announced the basic plan under the name of "Hopeful Korea 21" in January, 2006. The basic plan was discussed by representatives of various interest groups and finally approved in July, 2006. The document was published under the name of "Saeromaji Plan," implying the governmental program for babies (saero) and for the elderly (maji). The pronatal policy includes such measures as expanding the governmental support for daycare cost, starting a variety of public after-school program, giving advantages for young couples in housing, subsidizing medical treatment of infecundity, fostering the culture of family-friendliness and gender equity, etc.

4-2. Child Allowance

The child allowance of Japan started in 1971. Since 1992, 5,000 yen per month for the first and second children and 10,000 yen for the third and subsequent children have been paid. Until May 2000, only children less than three years were eligible. Between June 2000 and March 2004, the target was widened to include all preschoolers. In April 2004, the age limit was raised to the third year of primary school. In April 2006, the limit was raised further to include all primary school students aged 12 years and less. Japan's child allowance is means tested. In February 2003, 6,880,786 children were receiving child allowance (NIPSSR, 2005, p. 170). This was about 85% of the preschooler population. Thus, about 15% of children were eliminated because of high income of their parents.

The Saeromaji Plan in Korea stated that "the introduction of child allowance system should be discussed." Though the Uri Party proposed a child allowance of 100 thousand won per month for the second and succeeding children, it is suspicious if the government can start the system within the term of President Roh Mu-Hyeong. The chair of the committee, Kim Yong-Hyeong, suggested that some members were skeptical on the effectiveness while the child allowance requires huge budget (E-Daily, 7th, June, 2006).

Table 2. Effectiveness of Child Allowance in Japan

Literature	Yamagami (1999)	Oyama (2004)	Morita (2006)
Definition of husband's income	10 thousand yen/ year	10 thousand yen/ month	(standardized)
Partial regression coefficient	0.00244	0.01	0.043
Child allowance required to raise the number of children by 0.1 (thousand yen / month)	34	100	946

The effect of child allowance is evaluated by regarding it to be additional income of husband. Since the income of wife has both income effect and opportunity effect, the child allowance should not be seen a part of it. Table 2 shows results of three papers. The effect of husband's income was statistically significant at 10% level