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A comparison of fertility measures from censuses and a civil registration and vital statistics system: The case of the Republic of Korea

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Abstract:
Despite its simplicity in compiling and summarizing the trends and levels of fertility, the period Total Fertility Rate (TFR) can fluctuate considerably from year to year due to timing of births (postponement and advancement). Another problem with period TFR is that it counts all women aged 15-49 in the denominator, including those who have never given births. This paper estimates parity progression ratios, which decompose fertility rates by birth order, and the tempo adjusted fertility measure proposed by Bongaarts and Feeney. They are known to be insensitive to tempo distortions and robust to misreported dates of birth. In addition, parity progression ratios estimate the period TFR by relating births outcome (numerator) to only women who have given births (denominator). These fertility measures, derived from the censuses and vital registration system, are compared to assess the plausibility of the current period TFR, calculated from vital registration system. Possible explanations for differences among the fertility measures are discussed.

Keywords: total fertility rate, tempo adjusted fertility rate, parity progression ratios, vital statistics

1. Introduction:

The period total fertility rate (TFR) is defined as the number of children would be borne per woman if she experienced the current age-specific fertility rates throughout her reproductive life (aged 15-49). It is an age-standardized measure that is independent of confounding effects arising from different age structures of the populations. The period TFR is useful and convenient in making comparisons among populations with different age structures. Despite its simplicity and usefulness, the period TFR is highly variable and can change rapidly from one year to another. Bongaarts and Feeney (1998) explain in detail how the timing of births (delay and advancement) can cause such fluctuations in the period TFR. For example, if couples decide to postpone childbearing to later years, then the current period TFR will fall immediately. However, assuming fertility remains constant and the delayed births are recuperated later years, the real fertility (quantum) may not be really changing. This is just a temporary change caused by the timing of births. This problem is widely known as tempo distortions which leads to over or under estimation of the true fertility level. Bongaarts and Feeney (1998; 2010) introduce a fertility measure (BF tempo adjTFR) that corrects for the tempo distortions in the period TFR caused by the timing of births.

In addition to the risk of tempo distortions present in the period TFR, it does not take into account of the distribution of births by order in the denominator. In other words, both BF tempo adjTFR and the period TFR do not differentiate the parity of women at the risk of giving birth. Therefore, both measures are called "rates of second kind" because they include all women regardless of the exposure to the risk of event in question. In contrast, "rates of first kind" only consider women who are exposed to risk of event in question (Kohler and Ortega, 2002). As an illustration, suppose we are interested in finding the fertility estimates of first order birth. Then, the denominator of the rates of first kind includes only women at the risk of giving birth to their first child. However, the rates of the second kind include all women including those who have already given birth to their first child. Obviously, the rates of the first kind are preferred to the rates of the second kind. If possible, we should strive to produce and use rates of the first kind.

[1] The views expressed in this paper are those of the author and do not necessarily reflect the views of the United Nations Statistical Institute for Asia and the Pacific

Kohler and Ortega (2002) introduce period fertility measure based on parity progression ratios (PPRs). Since PPRs are calculated based only on the proportion of women of a given parity who go on to have another child, they are not age dependent. That is why they are insensitive to tempo distortions and robust against misreporting of dates of births. The PPRs basically provide a proportion of women progressing from parity i to i+1. A parity refers to the number of children a woman has already had. For example, a parity 2 refers to a woman who has already had 2 children. Feeney and Yu also (1987) calculate period TFR of China based on PPRs.

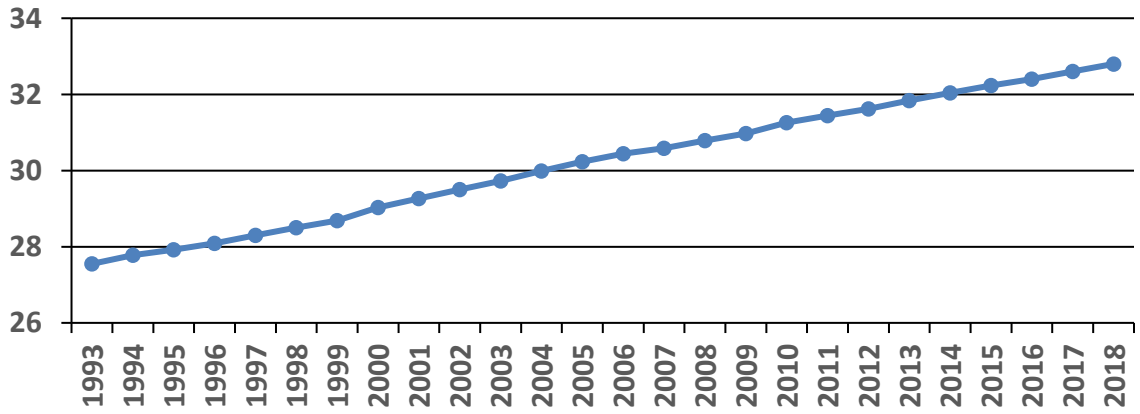
In general, the period TFR and PPRs are based on vital statistics compiled by national statistics offices. However, many countries do not have well-functioning civil registration and vital statistics systems (CRVS), which are essential in producing high-quality vital statistics. For these countries, the period TFR and PPRs can be derived from censuses. Cho, Retherford, and Choe (1986) developed an indirect estimation method known as the "own-children method" that estimates the period TFR from censuses by reconstructing a complete birth history from the census data.

As mentioned above, there are various methods and sources of data (vital statistics from CRVS and census data) to estimate the level of fertility. The purpose of this paper is to compare wide range of fertility measures from different data sources (vital statistics and censuses) so that we can assess the plausibility of the current period TFR and shed some light on advantages and limitations of each fertility measures. For this analysis, I use vital statistics and recent 20% and 10% sample of Republic of Korea's 2015 and 2010 censuses.

2. Methodology:

I attempt to derive five TFRs from different data sources and methods: the period TFR (TFR(vital)), Bongarrts and Feeney's tempo adjusted TFR (BF tempo adjTFR), TFR from 2010 census by applying the own-children method (TFR(owch)), TFRs from 2010 (TFRpppr2010) and 2015 (TFRpppr2015) censuses based on PPRs. The standard TFR(vital) and BF tempo adjTFR are calculated by using the vital statistics compiled by Statistics Korea. TFR(owch), TFRpppr2010 and TFRpppr2015 are estimated from censuses.

Figure 1: Mean age at childbearing, Republic of Korea (1993-2018)



Source: Statistics Korea, 2020

The methodology used in calculating the TFR(vital) is straightforward. It is simply the sum of age specific fertility rates of women aged from 15 to 49. The age specific fertility rates are computed by dividing the age specific number of births by number of women. The BF tempo adjTFR is calculated by adjusting the TFR(vital) by the amount of increase or decrease in the mean age at childbearing (see (1) below). The increase in the mean age at childbearing is an evidence of postponement of childbearing. Figure 1 shows the trend of mean age at childbearing from 1993 to 2018. The figure show that the mean

age at childbearing increased linearly at an annual increase of 0.2 years. This also suggests that TFR(vital) might suffer from tempo distortions as discussed above.

$$\text{BF tempo adjTFR} = \sum_i \frac{\text{TFR}_i}{1-m_i} \text{ ; i=birth order i to n; m=mean age at childbearing} \quad (1)$$

TFR(owch) is estimated by matching the children and mother in the census by using the information on age, sex, children ever born and relationship to the head of household. The accuracy of the TFR(owch) is heavily dependent on the quality of the responses on this key information in the census. By matching the potential children to mothers in the same household, a complete birth history is reconstructed and the TFR(owch) is obtained from this reconstructed birth history. Since the own-children method assumes that children usually stay with their mother in the same household up to age of 15, the own-children method provides its estimates 15 years prior to the census being used.

The process of estimating the TFRpppr2010 and TFRpppr2015 are very similar to the own-children method in the sense that children are matched to their mothers using the same logic used in the own-children method. The own-children method estimates TFR based on conventional age specific fertility rates (rates of second kind) whereas the reconstructed birth history method yields PPRs (rates of first kind). TFRpppr2010 and TFRpppr2015 are estimated by multiplying the PPRs conditioned on parity (see (2) below)

$$\text{TFRpppr} = p_0 + p_0p_1 + p_0p_1p_2 + \cdots; \quad (2)$$

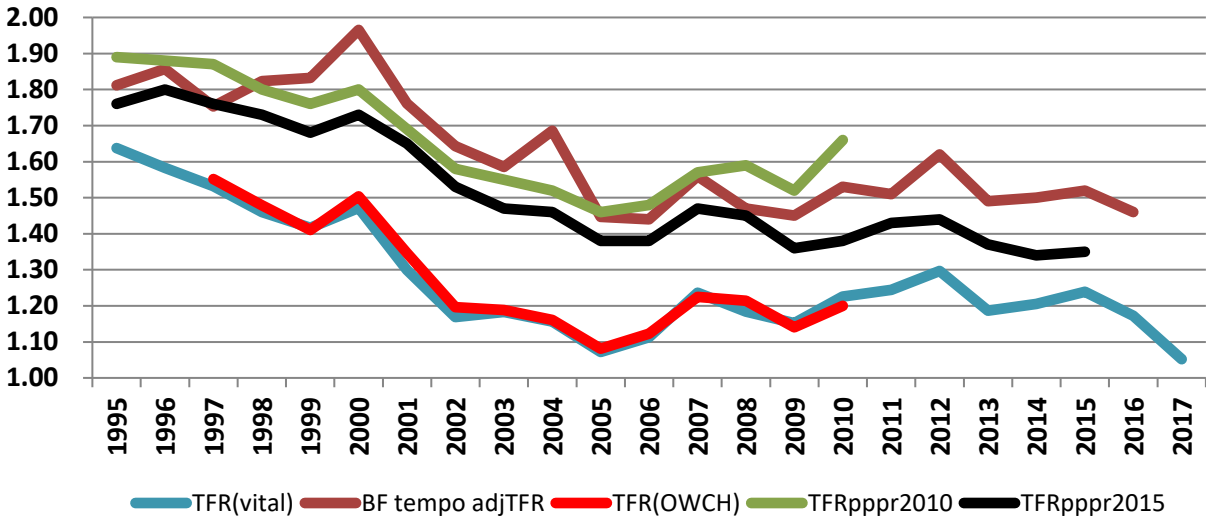
p_i=proportion of women progressing from ith to (i+1)th birth

I use the fertility estimation computer programs provided by East-West Center (1992) to estimate the TFR (owch), TFRpppr2010 and TFRpppr2015.

3. Result:

Figure 2 compares the TFR(owch), TFRpppr2010, TFRpppr2015 and BF tempo adjTFR to the conventional vital statistics based TFR (TFR(vital)). BF tempo adjTFR, TFRpppr2010 and TFRpppr2015 show similar trends and levels of fertility patterns. These measures are similar in the sense that they are all tempo adjusted TFRs. The level of BF tempo adjTFR is slightly higher than PPRs. PPRs are smoother than BF tempo adjTFR due to its multiplicative nature as shown in equation (2).

Figure 2: Comparison of TFRs derived from censuses and vital statistics

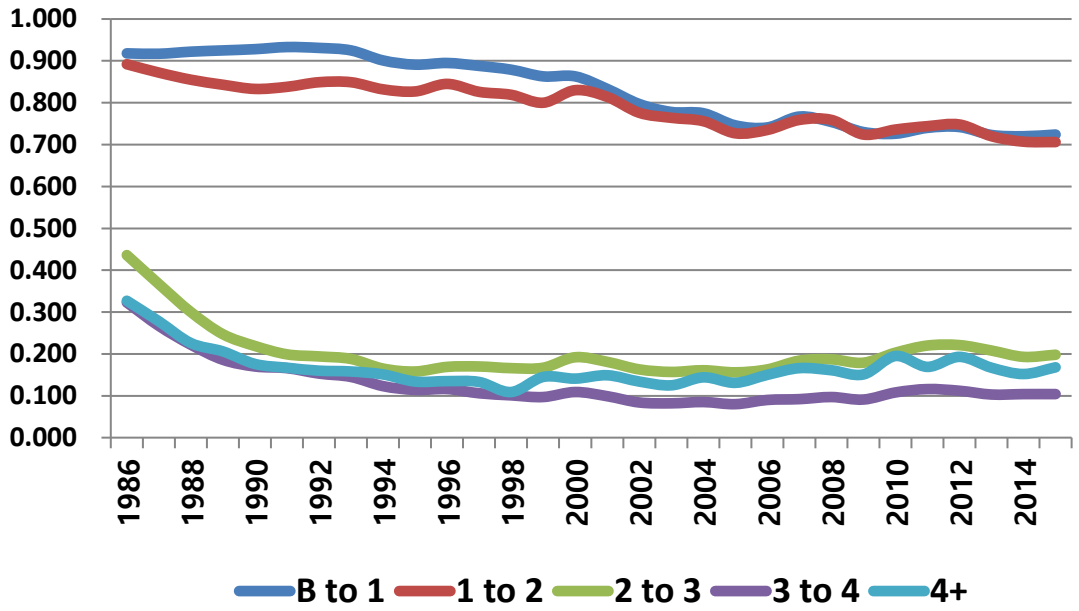


Note: Author's own calculations
Source:2010 (10%), 2015 (20%) Korean census samples and vital statistics (Statistics Korea)

Despite the difference in level among these fertility curves, they exhibit similar trends of fertility patterns. Despite of differences in methodology and sources of data, the TFR(owch) is almost identical to the standard period TFR (TFR (vital)) which confirms the high quality of vital statistics and information used in the 2015 census.

Another benefit of PPRs is that we are able to disaggregate the fertility level by birth orders. Figure 3 shows the PPRs estimated from 2015 census. As mentioned before, this is a proportion of women at parity i progressing to parity i+1. The proportions of having a first and a second child have been steadily decreasing. It is interesting to note that higher parity births (2 to 3, 4+) have been slightly on the rise.

Figure 3: Parity progression ratios estimated from 2015 census



Note: Author's own calculations
Source: 2015 (20%) Korean census samples (Statistics Korea)

4. Discussion:

As suggested in the Figure 1, the increasing mean age at childbearing indicates possible presence of tempo distortions in the period TFR. This suspicion is confirmed in Figure 2. Both BF tempo adjTFR and PPRs based TFR, which are insensitive to tempo distortions, are higher than tempo sensitive TFR(vital) and TFR(owch). The current period TFR seems to be underestimated due to tempo distortions. In the absence of tempo distortions, I argue the period TFR would be best estimated to somewhere between TFRpppr2010 and TFRpppr2015.

Although the trend is very similar between TFRpppr2010 and TFRpppr2015, the level of TFRpppr2015 is slightly lower than that of TFRpppr2010. One possible explanation is that the Republic of Korea has switched from a traditional census to registered based census for 2015 census. TFRpppr2015 draws information from the 2015 census where it is based on population register rather than traditional field enumeration. Does this suggest a possible under-registration of the population in the population register? This is beyond the scope of this study but this warrants further investigations.

I also argue that rates of first kind should be used over the rates of second kind on the basis of logical soundness. It might be difficult, time consuming or impossible to estimate the rates of first kind (e.g. PPRs based TFR) due to data limitations, lack of computing resources or other technical restrictions.

However, when possible, we should try to estimate and use them since they are better measures than rates of second kind.

Both own-children method and birth history reconstruction methods require accurate information in the data sources in order to yield accurate fertility estimates. Figure 2 supports high quality of information in the census and vital statistics. This triangulation, using other sources of independent data and methods, process is found to be useful in validating the fertility estimates, estimation methods, and the quality of data sources.

BF tempo adjTFR, TFRpppr2010 and TFRpppr2015 show that there is a potential increase of TFR from the current lowest-low fertility level if the postponement of birth wanes. Figure 3 shows steady decline of first and second births accounts for the rapid fertility decline in the Republic of Korea, but we also see a slight increase in births at higher parities in recent years.

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