On the Quantum and Tempo of Fertility: Reply

JOHN BONGAARTS
GRIFFITH FEENEY

BEFORE EXPLAINING why we disagree with the views expressed in the two preceding comments, we summarize briefly the purpose and main features of the method described in Bongaarts and Feeney (1998).

Our study set out to address a well-known flaw in the total fertility rate, the most widely used measure of period fertility. The TFR is affected by changes in the timing of childbearing. In years when women's ages at childbearing rise, the TFR is depressed, and in years when timing of childbearing is advanced, the TFR is inflated relative to the level that would have been observed without such timing changes. To remove the distortions in the TFR caused by these tempo effects, we proposed a simple equation for calculating an "adjusted" total fertility rate (TFR′). Details are provided in our original 1998 article and in Bongaarts (1999), but we briefly reiterate a few key points.

First, TFR′ should be interpreted as a variant of the conventional TFR. The TFR is defined as the number of births women would have by the end of their childbearing years (i.e., completed fertility) if the age-specific fertility rates observed in a given year applied throughout the childbearing years. This is a hypothetical rate because no actual cohort will experience these observed period fertility rates. Our TFR′ is a similar hypothetical measure, but one that corrects for distortions caused by year-to-year tempo changes. Neither the TFR nor the TFR′ attempts to estimate the completed fertility of any actual birth cohort, nor do they attempt any prediction of future fertility. Our goal is simply to provide a period measure of fertility that removes tempo distortions in conventionally calculated total fertility rates.

Second, our study was inspired by the work of Norman Ryder, and we gratefully acknowledge his fundamental contribution to this line of research. However, our conceptualization of quantum and tempo is different from Ryder's. In his work, quantum refers to the completed fertility of cohorts,

and tempo to the timing or mean ages of births within these cohorts. In our study, quantum and tempo are defined as components of the TFR observed during any given year. The quantum component is what the TFR would have been without tempo effects. The tempo component is the difference between the quantum component and the observed TFR. In Ryder's cohort-based formulation, quantum and tempo are observable quantities, but only after the cohorts in question have completed their childbearing years. In our formulation the terms quantum and tempo have meaning with reference to the period in question and can be calculated on the basis of a conceptualization that introduces a new indicator, namely, the TFR that would have been observed in a given year had there been no changes in the timing of childbearing over the course of the year.

Third, the derivation of our simple adjustment formula required us to make some assumptions about possible patterns of change in childbearing. Our central assumption is that the shape of the age schedule of fertility at each birth order does not change during the period for which the TFR is measured. That is, variations in these schedules are limited to multiplication by a constant factor to change the level of period age-specific fertility rates up or down and movement to lower or higher ages to change the timing of childbearing. This implies an absence of cohort effects because the postponement or advancement of births occurs uniformly over all ages within a period. Interestingly, Kim and Schoen (1999) consider this assumption to be "not unreasonable." More on this below.

We also note that our adjustment formula has been independently derived by Kohler and Philipov (2000). They advance a more general equation, which incorporates variance effects, but their formula reduces to ours when the shape of the fertility schedule is invariant.

Reply to Kim and Schoen

Kim and Schoen have misread our study. Their conclusions are based on the erroneous assumption that our adjustment formula attempts to estimate the completed fertility of actual cohorts. They demonstrate that our adjusted TFR indicator "mischaracterizes the course of completed fertility." This criticism is not relevant because we did not attempt to estimate the fertility of actual cohorts. Their analysis sheds no light on the accuracy of our method and there is consequently no need to comment further on it.

Reply to van Imhoff and Keilman

The first objection these authors raise is that our adjustment procedure is based on "improper" fertility measures. It is of course true that we did not rely on occurrence-exposure rates, but this not a problem for our method.

We never claimed that we relied on such rates, and they are not required for our method to be valid.[1]

The second objection is that our "constant shape" assumption is "clearly violated." The authors present no significant evidence to support this claim, but we comment briefly on this issue because it is central.

As we noted, our method is based on the simplifying assumption that fertility schedules are invariant over time at each birth order. This assumption is supported by empirical analyses by numerous researchers in recent decades (see Bongaarts and Feeney 1998 for details). As is customary in analyses of this kind, we do not imagine our simplifying assumption to hold absolutely, but only to be a good approximation of reality. As we noted, "It is likely that our assumption is in practice violated during certain years (e.g., in wars, famines, etc.) when fertility changes rapidly and suddenly from one year to the next...." The question then is not whether our assumption is violated but whether any violations are small enough to be inconsequential in most applications.

A full analysis of this issue is beyond the scope of this response, but we present some new data in support of our position. Specifically, we calculated the standard deviation of past fertility schedules in the United States for each year from 1917 to 1991. Table 1 presents the results for birth orders one through four in 1917 and 1991, the beginning and end points of our data series. The standard deviation increased slightly at each birth order (and there were fluctuations during this 74-year interval), but overall these increases were modest. For our simplifying assumption to be reasonable, year-to-year changes in the standard deviation should be small. Table 1 also presents the average absolute annual change (in percent) in the standard deviation of the fertility schedule for orders one through four from 1917 to 1991, a period that covers the depression of the 1930s, World War II, and the baby boom of the 1950s and early 1960s. These averages range from a high of 1.2 percent for birth order one to a low of 0.5 percent for birth order four. These annual changes are typically very small, and our

TABLE 1 Estimates of standard deviation of fertility schedules by birth order one through four for the United States, 1917 and 1991, and average absolute annual change in standard deviation 1917–91

Birth order	Standard deviation (years) 1917	Standard deviation (years) 1991	Average absolute annual change (percent) in standard deviation 1917–91
1	4.9	5.7	1.2
2	5.1	5.6	0.7
3	5.2	5.5	0.6
4	5.2	5.5	0.5

SOURCE: Bongaarts and Feeney 1998.

assumption of no change is generally a good approximation of reality. Of course, in some years the changes were well above average (e.g., between 1945 and 1946 the standard deviation at birth order one jumped by 4 percent). It would be desirable to extend our formula to accommodate changes in the fertility schedules, and we applaud the work of Kohler and Philipov (2000) on this issue.

Whether these small year-to-year changes in the shape of the birth-order-specific fertility schedules result in significant errors in our estimates of TFR′ is a question that can be answered by undertaking a sensitivity analysis. Zeng and Land (2000) have undertaken such an analysis by implementing extensive computer simulations. They conclude: "the Bongaarts–Feeney formula usually is not sensitive to its assumptions on invariant shape of the fertility schedules and equal changes in timing across ages. That is, as compared to the classic TFR(t), the B–F method is generally robust for producing reasonable estimates of adjusted period TFR′(t) to reduce the distortion caused by the tempo changes, except in abnormal conditions (i.e., extremely large changes in the tempo and shape of the schedule)."

In sum, neither of these comments has changed in any way our view that the proposed new method is sound and useful for interpreting levels and trends in fertility. Definitive results must of course await more widespread application, but we anticipate that in most cases deviations from our assumptions will introduce only minor errors in estimates of the quantum and tempo components of period fertility.

Note

1 We do not comment on the two figures presented by Van Imhoff and Keilman because the occurrence-exposure rates they use contain tempo distortions that are not removed, and the adjusted total fertility rates they present appear to be calculated inaccurately. In our adjustment formula, r_o equals the change in the mean age of the fertility schedule at order *o* between the beginning and end of the year for which the TFR′ is to be estimated. In practice, estimates of r_o cannot be obtained directly from the annual data that are usually available. We recommended that r_o for year *t* be estimated as $(MAC_o(t+1)-MAC_o(t-1))/2$, where $MAC_o(t)$ is the mean age of the childbearing schedule at order *o* in year *t*. Van Imhoff and Keilman instead use the formula $MAC_o(t)-MAC_o(t-1)$, which is inaccurate and contributes to the fluctuations in the adjusted total fertility rates presented in their figures.

References

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