The End of the Fertility Transition in the Developed World

John Bongaarts

Population and Development Review, Vol. 28, No. 3 (Sep., 2002), 419-443.

The End of the
Fertility Transition
in the Developed World

JOHN BONGAARTS

OVER THE PAST quarter-century massive changes in fertility behavior have occurred in most world regions. Many developing countries have experienced large and rapid fertility declines, and a number of countries in Asia and Latin America are now approaching the end of their transitions with fertility around or in a few cases (e.g., China) even below 2 births per woman. In the "more developed" world (Europe, North America, Japan, Australia, and New Zealand) average period fertility was already low in the early 1950s and, after temporary baby booms of varying magnitude, has decreased further to 1.6 births per woman in the late 1990s (United Nations 2001).

These recent fertility declines have been more rapid and pervasive than was expected. For example, medium variant projections for the late 1990s prepared by the United Nations Population Division in the 1970s, 1980s, and early 1990s slightly overestimated the fertility levels observed in the 1990s for the world and many regions. These results are primarily attributable to the invalid assumption that all countries end their fertility transitions with fertility stabilizing at the replacement level of 2.1 births per woman. This assumption was widely accepted in the past, and it is fair to say that the UN incorporated the consensus of the demographic community on this issue. Starting with its 1998 revision the UN no longer takes 2.1 as the eventual end point of the transition, and countries with low fertility are now projected, in the most commonly cited so-called medium projections, to remain permanently below the replacement level (United Nations 1999, 2000a, 2001).

One reason for this uncertainty about future fertility trends is that conventional demographic theory has little to say about levels and trends in post-transitional societies (Caldwell 1982). In an attempt to remedy this shortcoming, demographers and social scientists are engaged in an active debate on the causes of low fertility and the prospects for further change (Chesnais 1996, 1998; Lesthaeghe 2001; Lesthaeghe and Willems 1999;

McDonald 2000). The matter is of considerable importance because further declines in fertility or even a continuation of current low fertility levels will contribute to rapid aging of populations and will lead to a decline in the size of national populations. These demographic developments in turn are likely to have significant social and economic consequences (Coale 1986; OECD 1998; World Bank 1994).

This study examines recent trends and patterns in fertility in the developed world, with particular emphasis on the effects and implications of changes in the timing of childbearing. The main objective is to demonstrate that while fertility in these countries is indeed low, women's childbearing levels are not as low as period measures such as the total fertility rate suggest. This argument has been advanced in earlier research based on theoretical analysis (Bongaarts and Feeney 1998). The present study supports this earlier work with more extensive empirical evidence. I conclude by discussing the implications for future trends in fertility.

Fertility levels and trends

To obtain a fuller understanding of the various dimensions of fertility change, several indicators need to be examined, starting with period fertility.

Period fertility

Overviews of recent fertility trends in the developed world are widely available (Calot 1999; Coleman 1996; Council of Europe 2000; Demeny 1997; Sardon 2000; United Nations 2000b); only a brief summary is provided here based on estimates from United Nations (2001). In general, fertility as measured by the total fertility rate (TFR) was well above the replacement level in the 1950s and early 1960s, averaging 2.8 births per woman. In most countries, this period was followed by one of sharp decline to below-replacement levels (to 1.91 on average) between the mid-1960s and late 1970s. Over the past two decades fertility decline has continued but at a much slower pace, and in a few countries fertility has turned upward slightly— for example, in Denmark, Finland, Norway, and the United States. In the four decades from the late 1950s to the late 1990s the TFR of the developed world dropped by 44 percent, from 2.82 to 1.57 births per woman, with more than two-thirds of this decline occurring before the late 1970s.

These average trends conceal much variation among regions and countries. In the late 1990s the highest total fertility rates were observed in North America (2.00), Australia/New Zealand (1.80), and Northern Europe (1.67) and the lowest in Japan (1.41), Southern Europe (1.32), and Eastern Europe (1.28). The TFRs of particular developed countries are as low as 1.2 in Italy, Russia, and Spain while TFRs of 2.0 births per woman are found in

the United States and New Zealand. Although our focus here is on the "more developed" world (as defined by the UN), it is worth noting that period fertility has also dropped below replacement level in several Asian populations where socioeconomic development has been rapid (e.g., in Hong Kong, Singapore, and South Korea).[1]

Cohort fertility

The fertility of a cohort of women born in the same year is usually measured by the completed fertility rate (CFR), which equals the average number of births per woman at the end of the childbearing years. Trends in the CFR of successive cohorts have generally followed the downward trend in period fertility (Frejka and Calot 2001). A substantive drawback of cohort measures such as the CFR is that they are primarily affected by childbearing levels in the past. Peak childbearing years occur typically two or three decades before the end of the reproductive years when the women whose completed fertility is being measured were in their 20s and early 30s. As a result, the CFR does not provide useful information on recent trends in fertility, which is the main reason why cohort measures are not widely used. However, the CFR does have the considerable advantage of being an unambiguous and real measure of fertility, while the more up-to-date period TFR is a hypothetical measure that is subject to bias and hence potential misinterpretation, as will be demonstrated below.

    Comparisons of period and cohort fertility are complicated by the fact that childbearing of a cohort is spread out over a range of ages and years. Nevertheless, one can make useful comparisons of completed cohort fertility with the average TFR prevailing during the years in which the cohort was in its prime childbearing years. Table 1 presents the completed fertility rate for the 1960 cohort and the average total fertility rate for 1980–94 when this cohort was between the ages of 20 and 35. The 1960 cohort was chosen for this exercise because it had reached age 40 by the year 2000. Although this cohort has not yet completed its childbearing, its additional fertility is likely to be modest and can be projected with considerable confidence (Council of Europe 2000). Table 1 includes the developed countries for which the relevant data were available from the sources indicated (with the CFR projected to age 50). In this group of countries the average TFR for 1980–94 ranged from a low of 1.38 in Italy to a high of 2.40 in Ireland, and the CFR ranged from 1.65 to 2.41 in the same two countries. There is a strong correlation between the CFR and TFR (r = 0.94). A key finding from this comparison of cohort and period fertility is that in all but one of these countries (Russia) the CFR of the 1960 cohort exceeds (or in one case equals) the average TFR for the period 1980–94. This difference averages 0.2 births per woman for the set of 32 countries in Table 1.

TABLE 1   Completed fertility rate (1960 cohort) and estimates of the total fertility rate (average for 1980–94) for developed countries

Country	Completed fertility of 1960 cohort	Total fertility rate, 1980–94	Difference
Australia	2.12	1.89	0.23
Austria	1.69	1.51	0.18
Belgium	1.84	1.59	0.25
Bulgaria	1.95	1.85	0.10
Czech Republic	2.02	1.89	0.13
Denmark	1.89	1.57	0.32
Estonia	1.99	1.99	0.00
Finland	1.95	1.72	0.23
France	2.10	1.80	0.30
Germany	1.65	1.41	0.24
Greece	1.93	1.64	0.29
Hungary	2.02	1.81	0.21
Iceland	2.49	2.18	0.31
Ireland	2.41	2.40	0.01
Italy	1.65	1.38	0.27
Japan	1.84	1.65	0.19
Luxembourg	1.75	1.53	0.22
Macedonia	2.29	2.25	0.04
Netherlands	1.85	1.55	0.30
New Zealand	2.34	2.02	0.32
Norway	2.09	1.78	0.31
Poland	2.18	2.15	0.03
Portugal	1.90	1.75	0.15
Romania	2.16	2.05	0.11
Russia	1.83	1.89	–0.06
Slovakia	2.17	2.12	0.05
Slovenia	1.87	1.64	0.23
Spain	1.75	1.58	0.17
Sweden	2.04	1.85	0.19
Switzerland	1.77	1.54	0.23
United Kingdom	1.96	1.80	0.16
United States	2.02	1.88	0.14

NOTE: CFR includes estimated remaining fertility to age 50. TFR estimates for Australia and New Zealand are from United Nations 2001 and refer to the period from mid-1980 to mid-1995.
SOURCES: Council of Europe 2000; Sardon 2000; Sato 2001; United Nations 2001.

Some analysts have argued that if period fertility remains significantly below the replacement level of 2.1 births for a long time, then the fertility of the cohorts who did their childbearing during these years cannot reach replacement fertility. This conclusion is not correct as is evident, for ex-

ample, from the data for France. The TFR in France has been below 2.0 since the early 1970s, and the average TFR for 1980–94 was 1.80. Despite this low period fertility, the 1960 cohort is expected to have 2.1 children. A similar pattern is observed in Australia, Czech Republic, Hungary, Norway, and Sweden. The reasons for these differences between cohort and period fertility are explored further in a later section.
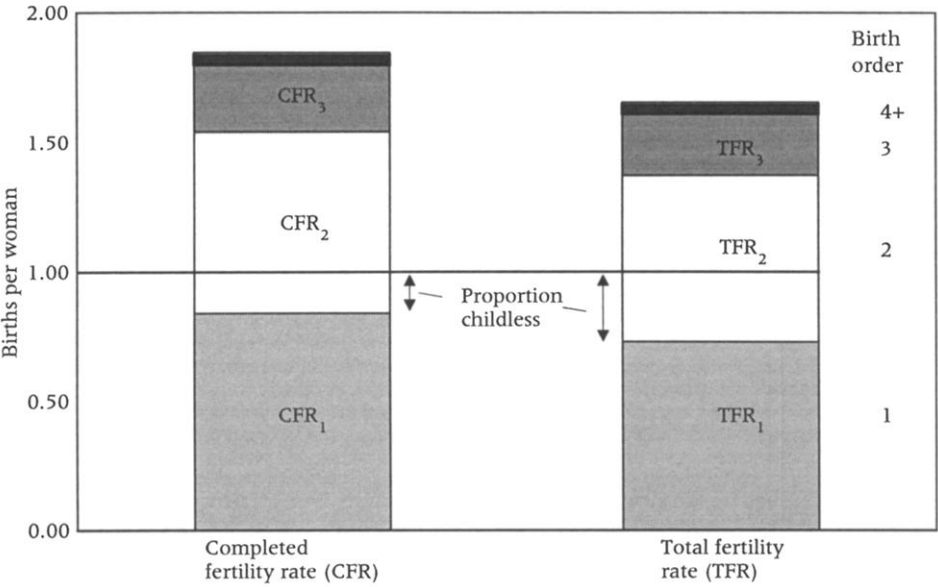
Birth-order components of fertility

The birth-order components of cohort or period measures of fertility are the parts of these measures that are attributable to births of given orders. For example, the first-order component of completed cohort fertility (CFR_1) is simply the average number of first births per woman, which equals the proportion of the cohort that has had a first birth during their lives; the second-order component (CFR_2) is the average number of second births per woman, which equals the proportion that has had a second birth, and so forth. The sum of these components equals the CFR. None of the birth-order components exceeds one, because women can have no more than one birth of any order, and the components decline in size as birth order rises, because no woman can have a birth of a given order without also having had a birth of the preceding order.[2] Similar components can be calculated for the TFR. For example, the component for births of order 1 (TFR_1) equals the average number of first births women would have by age 50 if they were to bear first births at the age-specific rates observed in a given year or period.[3] Throughout the present analysis order refers to the biological birth order of the mother, and data from countries registering births by order within current marriage are therefore not used. Figure 1 illustrates the birth-order decomposition for cohort and period fertility in Japan (Sato 2001). The 1960 cohort on average had 1.84 children, which is the sum of 0.84 births of order 1, 0.70 of order 2, 0.26 of order 3, and 0.05 of order 4 and higher. Similarly, the total fertility rate for 1980–94 was 1.65 births per woman, which is the sum of 0.73 births of order 1, 0.64 of order 2, 0.24 of order 3, and 0.04 of order 4 and higher.

The first-order component of cohort fertility (CFR_1) is of special interest because, by subtracting it from 1.0, we obtain the proportion childless among women in the cohort. For example, the CFR_1 for the 1960 cohort in Japan equals 0.84, which means that 16 percent of these women are childless. Figure 2 plots estimates of the CFR_1 for the 1960 cohort for 17 countries for which these data are available. The CFR_1 ranges in size from 0.97 in Bulgaria to 0.82 in Italy, indicating levels of childlessness of 3 percent in the former country and 18 percent in the latter.
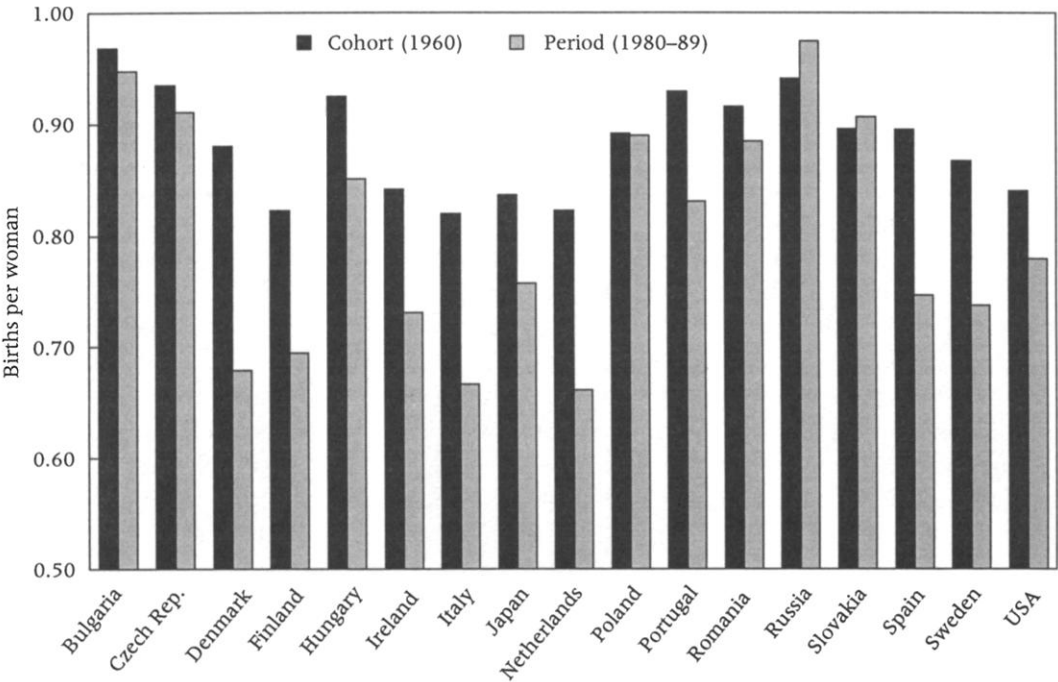
A comparison of these cohort results with the first-order component of period fertility (CFR_1 for the 1960 cohort and TFR_1 for 1980–89, respec-

FIGURE 1 Completed fertility (1960 birth cohort) and total fertility rate (1980–94), Japan

FIGURE 2 Completed cohort fertility (1960 birth cohort) and period total fertility (1980–89) for first births
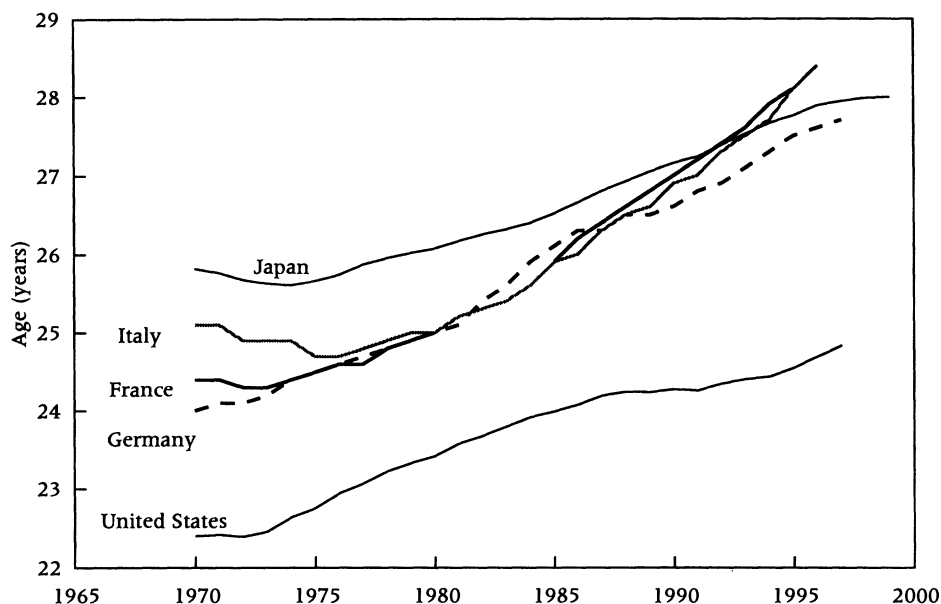
tively[4]) in the same countries reveals substantial differences (see Figure 2). Specifically, the period-based estimates suggest, implausibly, that childlessness is much more common than the level calculated for cohorts in most of these countries. An explanation for the unexpectedly small sizes of these first-order components of period fertility is given shortly.

Timing of childbearing

The most widely used indicator of timing is the mean age at childbearing (MAC). The MAC can be measured either for cohorts or for specific periods, but the focus here is on period measures of timing. In European countries the MAC for 1995 was typically in the late 20s, ranging from 24.3 years in Bulgaria to 30.2 years in Ireland and the Netherlands (Council of Europe 2000). Similar averages are obtained in Japan (29.4) and the United States (26.8) (Sato 2001; Ventura et al. 1997).

Changes over time in the mean age at childbearing are the result of two demographic factors. The first is the decline in higher-order births that occurs as countries move through their fertility transitions. Fertility declines are observed at all orders but they are usually far larger at higher than at lower orders. In other words, in contemporary societies with fertility around 2 births per woman, most women have at least one birth as was the case historically, but the proportion of women with third and higher-order births is much smaller than in the past. As a result, the mean age at childbearing declines even if there is no change in the timing of births of each order. The second factor is the change in the timing of births of specific orders. The net effect of these two factors varies among countries. In many contemporary developing countries the decline in higher-order births is occurring more rapidly than the rise in the timing of individual births, so that the mean age at childbearing is declining (Bongaarts 1999a). In contrast, in most contemporary industrialized countries the rise in the mean age at first and higher-order births is occurring so rapidly that their effect exceeds any birth-order composition effect. The mean age at childbearing has therefore risen over the past two decades in most developed countries (Council of Europe 2000).

For present purposes the trend in the mean age at first births (MAC_1) is of special interest, because it is the key factor determining trends in higher birth orders. Figure 3 plots trends in MAC_1 for a number of large developed countries. In each of these the mean age at first birth has risen sharply since the mid-1970s. During the 1980s increases exceeding one year per decade were observed in many European countries including France, Germany, Italy, and the United Kingdom as well as in Japan and the United States. This upward trend continued unabated in the 1990s in most countries, although in the United States the MAC_1 leveled off briefly around 1990.

FIGURE 3   Mean age of women at first birth in selected
industrialized countries

SOURCES: Council of Europe 2000; Sato 2001; Bongaarts and Feeney 1998.

Fertility preferences

Evidence pertaining to women's childbearing intentions and a comparison of
these intentions with actual fertility can shed light on current childbearing
behavior. Table 2 shows the average number of children ultimately wanted
by women aged 30–34 for 15 countries participating in the Fertility and Fam-
ily Surveys project undertaken in the ECE region (which includes the US and
Canada) in the early 1990s. This preference indicator is obtained by adding
the number of children a survey respondent already has to the additional
number wanted over the remainder of her reproductive years. Average ulti-
mate wanted family size for these women is quite similar within this group
of countries, ranging from 2.0 children per woman in Austria and Germany
to 2.5 in Sweden. There is little variation between preferences of women in
the 30–34 age group and women of other age groups. Changes in prefer-
ences from successive surveys are not available for most of these countries.
Exceptions include the US and the Netherlands, where preferences have been
essentially unchanged since the 1970s (Peterson 1995; De Graaf 1995).

    The preferences for the age group 30–34 were selected for inclusion in
Table 2 because this age group represents cohorts born around 1960 (the
surveys were mostly conducted in the early 1990s). These preferences can
be compared with the CFR for the 1960 cohort to determine the level of
preference implementation. In an ideal world women would bear the num-

**TABLE 2   Number of children ultimately wanted by
women aged 30–34 and completed fertility rate of the
1960 cohort**

Country	Number of children wanted	Completed fertility of 1960 cohort
Austria 1996	2.0	1.69
Belgium 1991–92	2.1	1.84
Finland 1992	2.2	1.95
France 1994	2.3	2.10
Germany 1992	2.0	1.65
Hungary 1992–93	2.1	2.02
Italy 1995–96	2.1	1.65
Netherlands 1993	2.1	1.85
Norway 1988–89	2.2	2.09
Poland 1991	2.3	2.18
Portugal 1997	2.1	1.90
Spain 1994–95	2.2	1.75
Sweden 1992–93	2.5	2.04
Switzerland 1994–95	2.2	1.77
United States 1995	2.3	2.02

SOURCES: For number of children wanted: United Nations Economic Commission for
Europe (various years); US DHHS 1997. For sources for completed fertility see Table 1.

ber of children they want, but this clearly is not the case in contemporary
developed countries. A comparison of the wanted number of children with
the completed fertility estimates from Table 1 shows that completed cohort
fertility falls well short of women's preferences. The shortfall averages 0.3
births per woman in this set of countries. The reasons for the shortfall are
likely to include competing preferences for a career, marital disruption, celi-
bacy, and infecundity. This finding suggests that efforts to help women over-
come the various obstacles to implementing their preferences would lead
to higher fertility, with cohort fertility at least potentially not far below re-
placement level.

Distortions of period fertility measures

The preceding discussion summarized recent levels and trends in period and
cohort fertility, their birth-order components, and their timing. I turn next
to an examination of the interrelations among these measures.
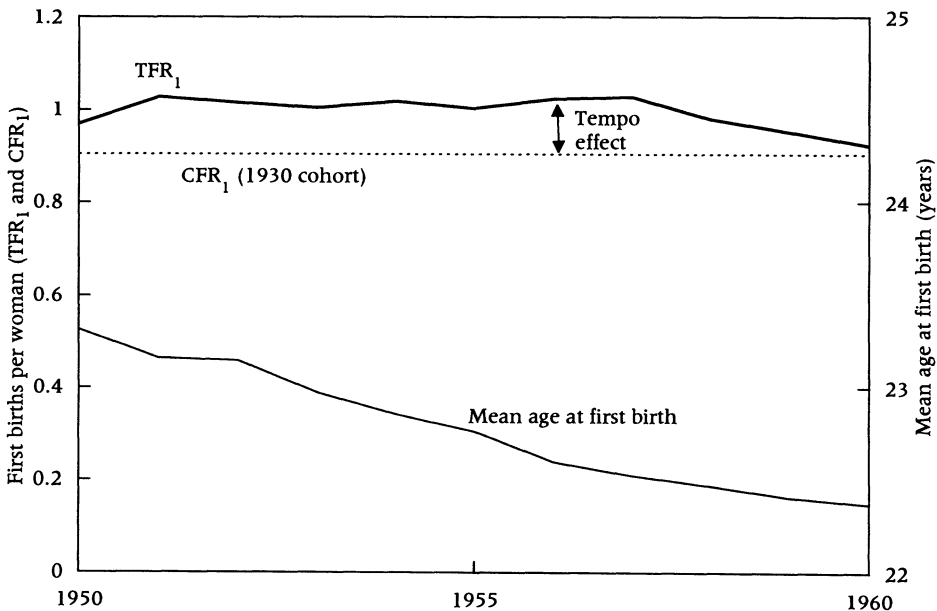
Empirical evidence of tempo distortions

Demographers have long known that changes in the timing of childbearing
affect the relationship between cohort and period fertility. Norman Ryder

(1956, 1964, 1980, 1983) has written a series of influential articles explor-
ing the relationship. He demonstrated that period fertility is lower than co-
hort fertility when the mean age at childbearing rises and the reverse is
true when the mean age at childbearing declines. In effect, when succes-
sive cohorts delay childbearing their births are spread out over a longer pe-
riod than would be the case if the timing were constant; the result is a re-
duction in period fertility. Conversely, when successive cohorts are advancing
their childbearing, their births accumulate more rapidly in periods, thus in-
flating period fertility relative to cohort fertility. These effects are sizable:
one year's worth of births are lost/gained for every one year rise/decline in
the timing of childbearing during a specific interval of time. The difference
between period and cohort fertility caused by changes in the timing of births
is called the tempo or timing effect. Analytically, this tempo effect may be
considered a distortion; it renders conventionally measured TFRs difficult
to interpret.

The existence of timing distortions is readily documented when the age
at childbearing is declining rapidly. In that case, implausible results are usu-
ally obtained for birth-order components of the TFR. For example, as shown
in Figure 4, in most years during the 1950s TFR_1 in the United States ex-
ceeded 1.0, which would literally mean that women had more than one first

FIGURE 4   Total fertility rate for birth-order 1 and mean age of
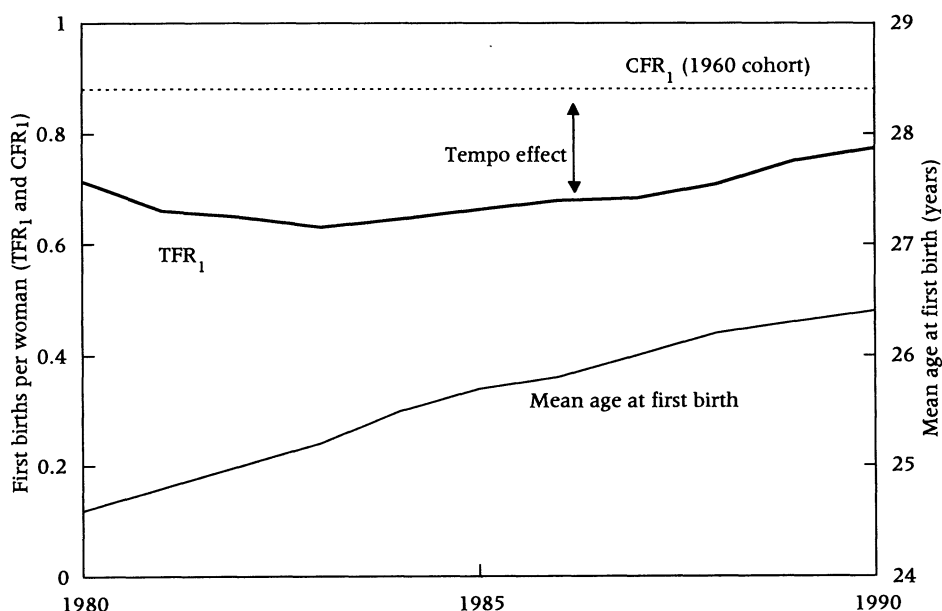women at first birth, United States, 1950–60

SOURCE: Bongaarts and Feeney 1998.

birth on average. This is impossible and these TFR_1 estimates must therefore
be reinterpreted. The main reason why TFR_1 is higher than 1.0 during many
baby boom years is that the age at childbearing declined, with the MAC_1 chang-
ing from 23.3 years in 1950 to 22.4 years in 1960. This decline resulted in a
temporary inflation of TFR_1. The size of this tempo distortion at birth-order 1
can be roughly estimated as the difference between the average TFR_1 in the
1950s and the CFR_1 of the 1930 cohort, which had most of its first births
during the 1950s. The average tempo distortion was positive and equal to
0.10 birth (or 11 percent) in the US during the 1950s, because the average
observed TFR_1 was 1.00 and the CFR_1 for the 1930 cohort was 0.90.

A negative tempo effect is more difficult to document, because an ex-
amination of observed birth-order components of the TFR does not pro-
duce obvious inconsistencies. However, a persuasive case for such an effect
can be made in a number of contemporary countries. For example, as shown
in Figure 5, the average TFR_1 during the 1980s in Denmark was 0.68. If
taken at face value this estimate implies that 32 percent of women would
remain childless. This is clearly an unrealistic estimate, because the actual
level of childlessness for the 1960 cohort (which had most of its first births
in the 1980s) is 12 percent as its CFR_1 equals 0.88 (Sardon 2001). In this
case, the TFR_1 contains a downward distortion because the mean age at

**FIGURE 5   Total fertility rate for birth-order 1 and mean age of
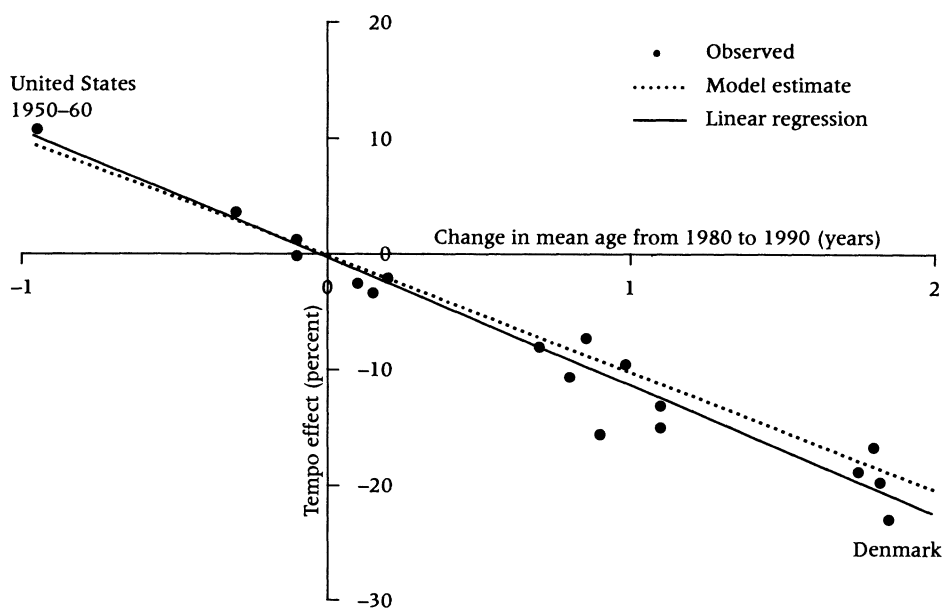women at first birth, Denmark, 1980–90**

first birth rose by 1.9 years from 24.5 to 26.4 years during the 1980s. The size of this tempo distortion is –0.20 births per woman, or 23 percent below the cohort level.

These comparisons of the fertility of the 1960 birth cohort and period fertility during the 1980s for birth-order 1, and the relationship of their difference to the timing of first births have been repeated for 18 additional countries. Results from this exercise are summarized in Figure 6. The horizontal axis plots the change in the mean age at first births during the 1980s (i.e., MAC_1 in 1990 minus MAC_1 in 1980) and the vertical axis plots the tempo effect measured as the percentage difference between the CFR_1 of the 1960 cohort and the average TFR_1 during the 1980s.[5] Each point in this figure represents one country. For example, Denmark, the country with the largest negative distortion during the 1980s, had a –23 percent distortion and a 1.9-year increase in MAC_1. In contrast, the United States during the 1950s experienced an upward distortion of 11 percent because the MAC_1 declined by 0.9 years. In general, the preceding analysis indicates that the tempo effect should be 0 when MAC_1 is constant, it should be negative when MAC_1 rises, and it should be positive when MAC_1 declines. The results pre-

FIGURE 6   Relationship between the tempo effect (percent) at birth-order 1 and the increase in mean age of women at first birth, selected countries, 1980–90, and United States, 1950–60

sented in Figure 6 confirm these expectations: the tempo effect is strongly and inversely associated with the change in the mean age during the 1980s ($R^2 = 0.95$). This finding provides clear support for the existence of tempo distortions of period fertility.

Theoretical estimates of tempo effects

Up to this point only empirical evidence for a tempo effect has been examined. I now discuss the magnitude of the tempo effect expected on theoretical grounds and then compare the two approaches.

In a recent study, Bongaarts and Feeney (1998) propose a procedure for removing tempo effects from the total fertility rate. They demonstrate that (provided fertility is influenced only by period effects[6]) the observed total fertility rate in any given year is related to the total fertility rate that would have been observed in the absence of tempo effects as

$$TFR_o = (1-m_o)TFR_o'. \tag{1}$$

In this equation TFR_o is the observed total fertility rate component for birth-order o, TFR_o' is the tempo-free total fertility rate component for birth-order o, and m_o is the annual absolute change (in years) in the mean age of the age-specific fertility schedule for birth-order o during the year the TFR is observed. Multiplying the tempo-free TFR_o' by the distortion component $(1-m_o)$ yields the observed TFR_o. For example, according to equation (1), an annual increase of one-tenth of one year in the mean age at childbearing ($m_o = 0.1$) reduces the TFR_o by 10 percent below its tempo-free level, because in that case $TFR_o = 0.9TFR_o'$. Similarly, an annual decline in the mean age by just 0.1 year per year ($m_o = -0.1$) inflates the TFR_o by 10 percent. Apparently, modest changes in the timing of childbearing at any birth order can produce substantial changes in observed period fertility. These tempo effects operate instantaneously, that is, a change up or down in the timing of childbearing from one year to the next as measured by m_o results in simultaneous changes in the TFR relative to the tempo-free TFR.

In practice the TFR_o is observed, and the unobserved tempo-adjusted fertility can be estimated from

$$TFR_o' = TFR_o/(1-m_o). \tag{2}$$

By dividing the observed total fertility rate by $(1-m_o)$ at any given birth-order o, one obtains an estimate of the total fertility rate that would have been observed had there been no change in the timing of childbearing. Applying this equation separately to all birth orders and adding the results gives the overall tempo-free total fertility rate: $TFR' = \Sigma\ TFR_o'$. The difference $TFR'-TFR$ equals the absolute tempo effect.

The tempo-adjusted TFR′ should be interpreted as a variant of the conventional TFR. The conventional 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 is likely to experience these observed period fertility rates. The adjusted TFR′ is a similar hypothetical measure, but one in which the distortions caused by tempo changes during the year have been removed. 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. The goal of the TFR′ is simply to remove tempo distortions in observed total fertility rates.

The above tempo-adjustment formula (2) has been analyzed by Kohler and Philipov (2001). They advance a more general equation that incorporates variance effects, but their formula reduces to equation (2) when the shape of the fertility schedule is invariant.

Finally, to compare the theoretical and empirical analyses, we make use of the fact that cohort fertility equals the tempo-adjusted period fertility when cohort and period fertility are constant (but not necessarily equal) and the mean age at childbearing at each order changes by a constant amount each year (Bongaarts and Feeney 1998). In practice these conditions are not observed in any actual population, but during the 1980s these conditions were approximated in many developed countries for births of order 1. In that case the tempo effect at order 1 calculated by comparing the 1960 cohort with period fertility during the 1980s (as in Figures 2 and 6) should be the same as the tempo effect calculated from equation (1) from the annual mean change in the age at first birth during the 1980s. According to equation (1) the proportional tempo distortion of the average TFR_1 during the 1980s equals minus m_1 (MAC_1 in 1980 minus MAC_1 in 1990 divided by 10): the more rapid the rise in MAC_1, the larger the downward tempo distortion. This implies that in a plot of m_1 versus the proportional tempo distortion during the 1980s, countries should lie along a straight line going through the origin with a negative slope. This expected model relationship is plotted in Figure 6 as the dashed line. This line is very close to and statistically indistinguishable from the observed pattern plotted in Figure 6, indicating that in this set of countries the observed tempo effect calculated as the ratio of period to cohort fertility for birth order 1 is well predicted by $(1 - m_1)$. In other words, the empirical and theoretical analyses of the tempo effects are consistent with each other.

Estimates of tempo-adjusted TFR

The tempo effects that so clearly affect the TFR_1 also affect the TFR components for birth orders 2 and higher. These tempo effects at higher orders can

JOHN BONGAARTS

be larger or smaller than those at order 1 depending on the annual changes in the mean ages at different orders. As was explained above, the adjustment procedure for eliminating tempo effects is applied separately to all orders, and summing these order-specific results then produces the adjusted TFR′. Since the data required for the tempo adjustment were not available in the precise form needed, an indirect procedure was used to calculate the mean ages of births of orders above the first, as described in the Appendix. These results should be regarded as approximations. Estimation of the TFR′ with this procedure was possible in 19 countries for the period 1980 to the late 1990s, with the latest available year varying slightly among countries.

The results of this exercise are summarized in Table 3, which provides average observed and tempo-adjusted TFRs for two periods, 1980–94 and 1990 to circa 1997. Results for France, Germany, and the United Kingdom could not be included in this table because available statistics give births by order within current marriage rather than by biological order for the mother as required for the application of the tempo-adjustment procedure. The main finding in Table 3 is that the tempo effects (measured in births per woman)

TABLE 3   Estimates of observed and tempo-adjusted TFR and the tempo effect, 1980–94 and 1990–ca. 1997

Country	Total fertility rate		Adjusted total fertility rate		Tempo effect (births per woman)	
	1980–94	1990–ca.97	1980–94	1990–ca.97	1980–94	1990–ca.97
Austria	1.46	1.43	1.64	1.62	−0.18	−0.19
Bulgaria	1.85	1.39	1.89	1.56	−0.04	−0.17
Czech Republic	1.89	1.49	2.01	1.89	−0.12	−0.40
Denmark	1.57	1.75	1.86	2.03	−0.30	−0.28
Finland	1.72	1.79	1.84	1.94	−0.13	−0.15
Greece	1.64	1.35	1.89	1.69	−0.25	−0.34
Hungary	1.81	1.62	1.95	1.88	−0.14	−0.26
Ireland	2.40	1.95	2.67	2.26	−0.27	−0.31
Italy	1.38	1.27	1.70	1.62	−0.32	−0.34
Japan	1.65	1.46	1.85	1.63	−0.20	−0.17
Netherlands	1.55	1.58	1.85	1.83	−0.29	−0.25
Poland	2.15	1.81	2.16	2.06	−0.01	−0.25
Portugal	1.75	1.49	1.99	1.82	−0.25	−0.33
Romania	2.05	1.45	2.11	1.63	−0.07	−0.17
Russia	1.89	1.51	1.83	1.56	0.07	−0.05
Slovakia	2.12	1.71	2.15	2.04	−0.03	−0.32
Spain	1.58	1.25	1.95	1.68	−0.37	−0.42
Sweden	1.85	1.88	2.05	2.16	−0.20	−0.28
United States	1.92	2.05	2.06	2.21	−0.14	−0.16

NOTE: For discussion see text and Appendix. Data for Austria are available for 1984–98.
SOURCES: Council of Europe 2000; Sato 2001; Bongaarts and Feeney 1998.

in the last two columns with the single exception of Russia for 1980–94 are negative. This implies that observed TFRs in the 1980s and 1990s in low-fertility countries contain a downward distortion. As expected, the magnitude of the tempo effects varies among countries, with the largest effects in the 1990s in Spain (–0.42), the Czech Republic (–0.40), and Greece and Italy (–0.34). In most countries the negative tempo effect is larger in the early 1990s than in the 1980s.
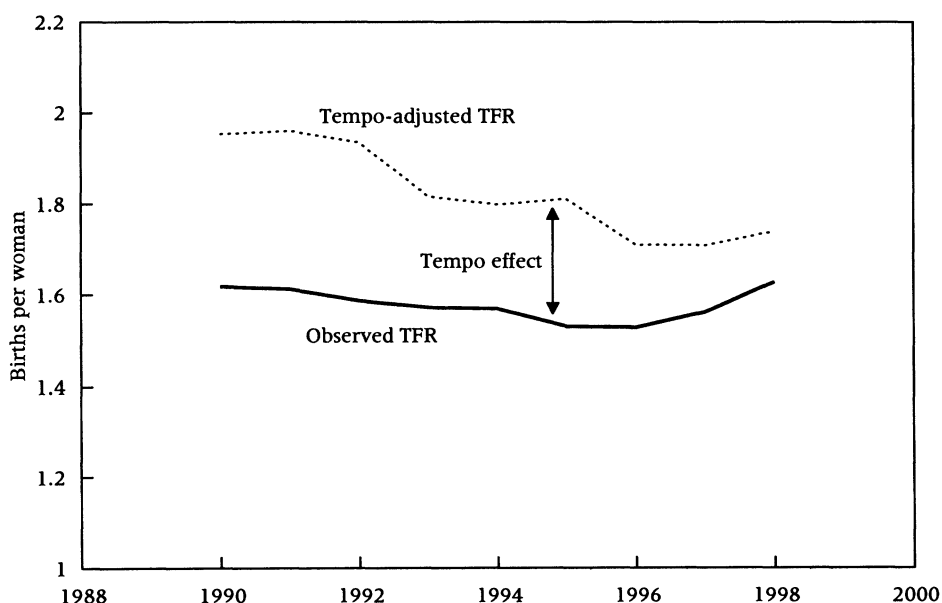
A comparison of the average tempo-adjusted total fertility rate for 1980–94 in Table 3 and the completed fertility of the 1960 cohort in Table 1 reveals generally small but significant differences in a number of countries. These differences are due to three distinct factors: a) the approximate nature of the current estimates of TFR' (owing to the unavailability of published data needed for its calculation); b) violations of the assumptions on which the tempo-adjustment equation (2) is based; and c) variations in cohort and period fertility over time. In other words, the TFR' and the CFR would have been equal if the data for the calculation of the TFR' were available and accurate, if the assumptions underlying equation (2) were not violated, and if cohort and period fertility were constant. When only the first two of these conditions are valid, then the tempo-adjusted TFR' is not equal to the CFR, but the TFR' gives an accurate estimate of the total fertility rate that would be observed in the absence of changes in the timing of childbearing. Of course, in reality, the assumptions on which equation (2) are based are also not entirely valid, and estimates of TFR' are therefore approximate.

Tempo and quantum of fertility

The implication of the preceding analysis is that observed total fertility rates are determined by both the quantum and tempo of period fertility. The terms quantum and tempo are used here to refer to components of the TFR observed during any given year as proposed by Bongaarts and Feeney (1998). The quantum component is what the TFR would have been without tempo effects, that is, the quantum equals the tempo-adjusted TFR. The tempo component is the difference between the quantum component and the observed TFR. This formulation 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 those cohorts. In Ryder's cohort-based formulation, quantum and tempo are observable quantities, if only after the cohorts in question have completed their childbearing years. In the alternative formulation used here, the terms quantum and tempo have meaning and can be calculated only on the basis of a conceptualization that introduces the tempo-adjusted TFR, a new indicator not used by Ryder.

Trends in period fertility are the net result of trends in tempo and quantum. There are two situations in which an analysis of tempo effects is of special interest. The first is in countries where the tempo effect is large. This is the case, for example, in Italy and Spain during the 1990s as already noted. In these two countries the effect is large and negative, which implies that the observed TFR (1.27 and 1.25, respectively) is substantially lower than the undistorted rates of 1.62 and 1.68. The second situation where an analysis of the tempo effect is important is in countries where it is changing rapidly. In such circumstances both the level and trend of the TFR can give misleading impressions, and tempo trends can mask underlying quantum trends. An example of this occurred in the United States in the late 1980s. Between 1985 and 1990 the TFR rose from 1.84 to 2.07. However, this rise in the TFR was largely due to a disappearance of the tempo effect, and the tempo-free TFR remained nearly constant around 2.0 births per woman during this period (Bongaarts and Feeney 1998). Another example of a country with a clear downward trend in the tempo effect is the Netherlands during the 1990s. As shown in Figure 7, the tempo effect was about 0.35 births per woman at the beginning of the 1990s, but it declined to about 0.10 in 1998. The TFR remained relatively unchanged during most of this period, as the decline in the

FIGURE 7   Observed and tempo-adjusted TFR, Netherlands, 1990–98

NOTE: For discussion see text and Appendix.
SOURCE: Council of Europe 2000.

tempo effect offset a decline in the tempo-free TFR. In the late 1990s the TFR turned up slightly and the reduction in the tempo effect is apparently in part responsible for this upturn.

A rise in fertility has also been observed in 1999 in a number of other European countries (Sardon 2001). Whether declines in tempo effects are responsible for or are contributing to these slight upturns in fertility will remain unclear until additional data become available.

Implications for future fertility

As in the past, future trends in the quantum and tempo of fertility will be driven largely by socioeconomic, sociopsychological, and cultural developments. Most analysts attribute low and delayed fertility to the difficulties women in contemporary industrialized societies face in combining child-rearing with their education and a career, and to a rise in individualism and consumerism (Frejka and Calot 2001; Lesthaeghe 2001; McDonald 2000; van de Kaa 1987). These recent trends in childbearing are part of a larger process of social and demographic change usually referred to as the second demographic transition. In addition to declines in fertility, these new transitions are typically accompanied by widespread changes in attitudes and behaviors regarding sexuality, contraception, cohabitation, marriage, divorce, and extramarital childbearing (van de Kaa 1987). Lesthaeghe (2001) identifies the following set of factors affecting childbearing behavior in post-transitional societies:

> (i) increased female education and female economic autonomy; (ii) rising and high consumption aspirations that created a need for a second income in households and equally fostered female labour force participation; (iii) increased investments in career developments of both sexes, in tandem with increased competition in the workplace; (iv) rising "post-materialist" traits such as self actualization, ethical autonomy, freedom of choice and tolerance for the non-conventional; (v) a greater stress on the quality of life with a rising taste for leisure as well; (vi) a retreat from irreversible commitments and a desire for maintaining an "open future"; (vii) rising probabilities of separation and divorce, and hence a more cautious "investment in identity."

There is no agreement on which of these potential explanatory factors are most important in determining fertility trends—in part because, as Lesthaeghe (2001) aptly notes, "we have more explanatory factors than observations." In any case, explanations are likely to vary from society to society; and even if past behavior could be explained, the implications for future fertility trends would not necessarily be clear, because many trends may have run their course and new factors influencing fertility might emerge.
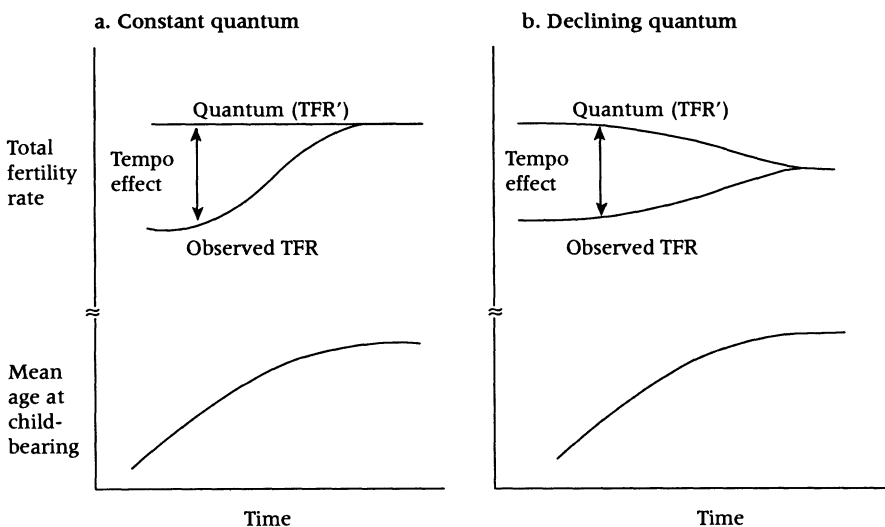
Future tempo effects

Although existing theory is of little help in projecting future trends in the quantum of fertility, it is possible to make some general predictions about the tempo component. Tempo effects are by their nature temporary. They exist only as long as the mean age at childbearing rises, disappearing when the change in the timing of childbearing ends. This is true regardless of the level of the mean age. The tempo effect becomes zero even if the mean age is high, provided the latter is constant.

The combined consequences of future changes in quantum and tempo effects can lead to a wide range of possible outcomes. Figure 8 presents two illustrative examples. Both scenarios assume that the current TFR is deflated by a significant negative tempo effect, and that this tempo effect will disappear at some unspecified point in the future because the mean age at childbearing will stop rising. The scenario presented in Figure 8a further assumes that the quantum remains constant at current levels. As a consequence of these two trends, the TFR will rise over time from its current level to equal the quantum, that is, the adjusted TFR. An example of such a trend is the United States in the late 1980s, as discussed earlier.

A second scenario is summarized in Figure 8b. In this case the quantum of fertility is assumed to continue to decline over time. The disappearance of the tempo effect again puts upward pressure on fertility, but the rise in the TFR is not as large as in Figure 8a because there is an offsetting decline in the quantum. This scenario corresponds roughly to trends ob-

FIGURE 8 Fertility impact of future reductions in the tempo effect

a. Constant quantum   b. Declining quantum

served in the Netherlands in the 1990s as summarized in Figure 7. Of course if the future decline in the quantum is sufficiently rapid, then it is possible that no rise at all or a decline would be observed in the TFR, despite the disappearance of the tempo effect.

A number of other scenarios could be envisioned, although the two presented in Figure 8 are deemed most plausible. It is obviously not possible to predict trends in the quantum and tempo components in any future year. However, since the mean age at childbearing cannot rise forever, it must stabilize eventually. When that happens the disappearance of the tempo effect will put upward pressure on the observed TFR. In fact, even a slowdown in the pace of increase in the timing of childbearing reduces the size of the tempo effect and this in turn exerts upward pressure on period fertility.

It is of interest that the scenarios depicted in Figure 8 are consistent with the fertility projections made by the United Nations. As noted, the UN has recently abandoned its earlier assumption that all countries will eventually maintain fertility at the replacement level. The latest projections incorporate complex assumptions about future trends in fertility in countries with below-replacement fertility. The main assumption is that in the long run countries will level off at the completed fertility rate of cohorts born in the early 1960s, which implies TFRs in 2050 between 1.7 and 1.9 births per woman for most low-fertility countries (United Nations 2001). As is clear from the earlier discussion, this assumption implies significant increases from current TFRs in the large majority of developed countries. The reasoning behind the UN's assumption is not spelled out in detail, but the implied disappearance of the tempo effects and resulting future trends in the observed TFR are broadly similar to those shown in Figure 8.

Conclusion

During much of the past half-century the attention of the scientific and policy communities has focused on fertility declines, particularly in the developing world. By the mid-1990s fertility transitions in most of these countries were well underway or even nearing completion, and these issues have therefore become somewhat less urgent. Attention has increasingly turned to a relatively new and unexpected development, namely the very low fertility observed in most post-transitional societies. The common past view among demographers that fertility would level off at or near the replacement level is now seen as ill-founded and indefensible (Demeny 1997). The aggregate concept of replacement fertility is a theoretical threshold that has little or no direct meaning for individual couples building their families. Coalescence on 2 as the model desired family size is, however, a micro-equivalent of replacement fertility.

What happens next is far from clear. The future course of fertility in countries where it is already at or below replacement is one of the most hotly debated topics in contemporary demography. There is no doubt that fertility in much of the developed world has reached historic lows and will almost certainly remain below replacement in the future. However, the present analysis has demonstrated that observed period fertility measures such as the TFR are temporarily depressed by a rise in the mean age at childbearing in most of these countries. This postponement effect has been present in many developed countries since the 1970s and could continue for years into the future. But once this rise ends—as it eventually must—the corresponding fertility-depressing effect stops, thus putting upward pressure on period fertility. When the tempo effect becomes smaller or disappears, the downward trend in period fertility could end, and a slight upturn is a distinct possibility. Such a rise could occur even while the mean age at childbearing is still rising, if the rate of increase becomes less steep than in the past. Additional upward pressure on period fertility would result if the obstacles that prevent women from achieving their desired family sizes could be removed. Women on average want about two children in contemporary societies for which preference measures are available. Although these preferences have been quite stable since the 1970s, there is, of course, no assurance that preferences will remain at current levels in the future. Moreover, removing existing obstacles to preference implementation is difficult and expensive.

In an analysis of the most recent fertility trends in the European Union (EU), Sardon (2001) concludes: "Fertility...increased in over half of the [EU] member states in 1999 (Netherlands, France, Belgium, Denmark, Finland, Luxemburg, Spain, Greece, Italy, Portugal) plus Norway and Switzerland." This is a reversal of past trends even though the increases are small. It is too early to tell why the reversal is happening and whether it is a temporary phenomenon. In view of the analysis presented here this new development is not a surprise; indeed one would expect an end or reversal of the downward trend in fertility sooner or later. The implication is that countries with very low fertility and substantial tempo effects in the EU and elsewhere could well experience a period of modest rises in fertility in the near future if the timing of childbearing stabilizes. Even if this happens, however, it seems unlikely that fertility will climb back to the replacement level.

Appendix

Data for this study are primarily taken from Council of Europe (2000) and Sardon (2000, 2001). These references provide annual statistics for the following variables in many European countries:

TFR: Total fertility rate (all birth orders combined)

TFR_1: Total fertility rate for births of order 1

MAC: mean age at childbearing (all orders combined)

MAC_1: mean age at first birth

B: total number of births (all orders combined)

B_o: number of births of orders 1,2,3,4, and 5+ (o is birth order)

Because these sources do not include estimates of TFR_o and MAC_o for birth orders above 1, the following indirect procedure was developed.

Estimates of the TFR_o for orders above 1 were obtained from

$$TFR_o = (TFR - TFR_1) \ B_o/(B - B_1). \tag{A1}$$

The mean ages at childbearing for birth orders higher than 1 were estimated as

$$MAC_o = MAC_1 + (o - 1)I, \tag{A2}$$

where I equals the interval between the mean ages at successive birth orders. I is assumed constant across birth orders but varies with time. The average age at childbearing is a weighted average of the mean ages at each order:

$$MAC = (MAC_1 TFR_1 + (MAC_1 + I)TFR_2 + (MAC_1 + 2I)TFR_3 + (MAC_1 + 3I)TFR_4 \\ + (MAC_1 + 4I)TFR_5)/TFR. \tag{A3}$$

Rearranging gives

$$I = TFR(MAC - MAC_1)/(TFR_2 + 2TFR_3 + 3TFR_4 + 4TFR_5). \tag{A4}$$

Substitution of the order components of the TFR from (A1) in (A4) gives an estimate of I that when substituted in (A2) gives estimates of MAC_o. Application of equation (2) in the main text then produces estimates of the tempo-adjusted TFR_o.

Since direct estimates of TFR_o and MAC_o were available for the Netherlands from Eurostat (1997), it is possible to compare the above indirect procedure for estimating TFR' with the TFR' obtained directly from TFR_o and MAC_o for each year from 1980 to 1994. The average absolute error in the TFR' during this 14-year period resulting from the above indirect procedure was 0.008 births per woman. The smallness of this error suggests that the proposed indirect procedure is sufficiently accurate for present purposes. In general the procedure gives acceptable results in countries with very low fertility, but the accuracy declines as the proportion of fertility at birth orders 2 or higher rises. The procedure is not recom-

mended in populations for which direct estimates exist of TFR_o and MAC_o for several birth orders.

Notes

1 In this study the term developed world refers to what the UN (2001) calls the "More developed regions," which comprise Europe, Northern America, Japan, Australia, and New Zealand.

2 Once the components of CFR_o are known, other order-specific measures can be calculated. For example, the parity progression ratio at parity o equals CFR_{o+1}/CFR_o and the proportion of the cohort that has exactly o births equals $CFR_{o+1} - CFR_o$.

3 It is computationally straightforward to calculate total fertility for any specific birth order. Instead of including births of all orders in the numerators of the age-specific fertility rates on which the TFR is based, only births of a single order are included and the same denominators are used. The result of such a calculation for each birth order o is a set of birth-order components TFR_o that when summed equal the TFR (TFR = ΣTFR_o).

4 For first births the period 1980–89 is used for comparison with fertility of the 1960 cohort, because the large majority of first births occur when women are between ages 20 and 30.

5 The tempo effect in percent is calculated as $T=100*(TFR_1 - CFR_1)/CFR_1$. MAC_1 is measured at the beginning of 1980 and 1990 to obtain the change during the 1980s.

6 The 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 move the level of period age-specific birth rates up or down and translation 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. For further discussion of this tempo-adjustment procedure see Bongaarts and Feeney (2000), Kim and Schoen (2000), and van Imhoff and Keilman (2000).

References

Bongaarts, John. 1999a. "The fertility impact of changes in the timing of childbearing in the developing world," *Population Studies* 53: 277–289.

———. 1999b. "Fertility decline in the developed world: Where will it end?" *American Economic Review* 89(2): 256–260.

Bongaarts, John and Rodolfo A. Bulatao (eds.). 2000. *Beyond Six Billion: Forecasting the World's Population.* Washington, DC: National Academy Press.

Bongaarts, John and Griffith Feeney. 1998. "On the quantum and tempo of fertility," *Population and Development Review* 24(2): 271–291.

———. 2000. "On the quantum and tempo of fertility: Reply," *Population and Development Review* 26(3): 560–564.

Calot, Gérard. 1999. "Fertility in Europe and North America," in UN/ECE, *Proceedings of Regional Population Meeting, December 1998.* Budapest.

Caldwell, John C. 1982. *Theory of Fertility Decline.* New York: Academic Press.

Chesnais, Jean-Claude. 1996. "Fertility, family, and social policy in contemporary Western Europe," *Population and Development Review* 22(4): 729–739.

————. 1998. "Below replacement fertility in the European Union (EU-15): Facts and policies, 1960–1997," *Review of Population and Social Policy* 7: 83–101.

Coale, Ansley J. 1986. "Demographic effects of below-replacement fertility and their social implications," in Kingsley Davis, Mikhail S. Bernstam, and Rita Ricardo-Campbell (eds.), *Below-Replacement Fertility in Industrial Societies: Causes, Consequences, Policies* (Supplement to *Population and Development Review* 12), pp. 203–216. New York: Population Council.

Coleman, David. 1996. "New patterns and trends in European fertility: International and sub-national comparisons," in David Coleman (ed.), *Europe's Population in the 1990s*. Oxford: Oxford University Press, pp. 1–61.

Council of Europe. 2000. *Recent Demographic Developments in Europe 2000*. Strasbourg: Council of Europe Publishing.

De Graaf, A. 1995. "Vrouwen zijn minder onzeker over hun kindertal," *Maandstatistiek van de Bevolking* 43(1): 14–20.

Demeny, Paul. 1997. "Replacement-level fertility: The implausible endpoint of the demographic transition," in Gavin W. Jones et al. (eds.), *The Continuing Demographic Transition*. Oxford: Clarendon Press, pp. 94–110.

————. 1999. "Policy interventions in response to below-replacement fertility," in *Below Replacement Fertility*, Population Bulletin of the United Nations, Nos. 40/41, pp. 183–193. New York: United Nations, 2000.

Eurostat. 1997. Unpublished data provided to author.

Frejka, Tomas and Gérard Calot. 2001. "Cohort reproductive patterns in low-fertility countries," *Population and Development Review* 27(1): 103–132.

Kim, Young J. and Robert Schoen. 2000. "On the quantum and tempo of fertility: Limits to the Bongaarts–Feeney adjustment," *Population and Development Review* 26(3): 554–559.

Kohler, Hans-Peter and D. Philipov. 2001. "Variance effects in the Bongaarts–Feeney formula," *Demography* 38(1): 1–16.

Lesthaeghe, Ron. 2001. "Postponement and recuperation: Recent fertility trends and forecasts in six Western European countries," paper presented at the IUSSP Seminar on "International perspectives on low fertility: Trends, theories, and policies," Tokyo, 21–23 March.

Lesthaeghe, Ron and Paul Willems. 1999. "Is low fertility a temporary phenomenon in the European Union?" *Population and Development Review* 25(2): 211–228.

McDonald, Peter. 2000. "Gender equity in theories of fertility transition," *Population and Development Review* 26(3): 427–439.

Ní Bhrolcháin, Máire. 1992. "Period paramount? A critique of the cohort fertility approach to fertility," *Population and Development Review* 18(4): 599–629.

OECD. 1998. *Maintaining Prosperity in an Ageing Society*. Paris: Organisation for Economic Co-operation and Development.

Peterson, Linda. 1995. "Birth expectations of women in the United States: 1973–88," *Vital and Health Statistics*, Series 23. Data from the National Survey of Family Growth 1995(17): 1–36.

Ryder, Norman B. 1956. "Problems of trend determination during a transition in fertility," *Milbank Memorial Fund Quarterly* 34(1).

————. 1964. "The process of demographic translation," *Demography* 1(1): 74–82.

————. 1980. "Components of temporal variations in American fertility," in R. W. Hiorns (ed.), *Demographic Patterns in Developed Societies*. London: Taylor & Francis, pp. 15–54.

————. 1983. "Cohort and period measures of changing fertility," in Rodolfo A. Bulatao and Ronald D. Lee (eds.), *Determinants of Fertility in Developing Countries*, Vol. 2. New York: Academic Press, pp. 737–756.

Sardon, Jean Paul. 2000. "The demographic situation of Europe and the developed countries overseas," *Population: An English Selection* (12): 293–328.

————. 2001. Unpublished data on total fertility rate for birth order 1.

Sato, Ryuzaburo. 2001. Unpublished data provided to author.

United Nations Economic Commission for Europe. *Fertility and Family Surveys in Countries of the ECE Region*. New York and Geneva: Standard Country Reports for: Austria 1998; Belgium 1999; Finland 1998; France 1998; Germany 1996; Hungary 1999; Italy 2000; Netherlands 1997; Norway 1996; Poland 1997; Portugal 2000; Spain 1999; Sweden 1997; Switzerland 1999.

United Nations. 1999. *World Population Prospects: The 1998 Revision*. New York.

—————. 2000a. "Future expectations for below-replacement fertility," in *Below Replacement Fertility*, Population Bulletin of the United Nations, Nos. 40/41, pp. 137–160. New York.

—————. 2000b. "Fertility trends among low fertility countries," in *Below Replacement Fertility*, Population Bulletin of the United Nations, Nos. 40/41, pp. 35–125. New York.

—————. 2001. *World Population Prospects: The 2000 Revision*. New York.

United States Department of Health and Human Services (US DHHS). 1997. Centers for Disease Control and Prevention. National Center for Health Statistics. *Fertility, Family Planning and Women's Health: New Data from the 1995 National Survey of Family Growth*. Series 23, No. 19. Hyattsville, MD.

World Bank. 1994. *Averting the Old Age Crisis*. New York: Oxford University Press.

van de Kaa, Dirk J. 1987. "Europe's second demographic transition," *Population Bulletin* 42(1).

van Imhoff, Evert and Nico Keilman. 2000. "On the quantum and tempo of fertility: Comment," *Population and Development Review* 26(3): 549–553.

Ventura, Stephany J. et al. 1997. "Report of final natality statistics, 1995," *Monthly Vital Statistics Report* 45(11S): 1–40.