# A Demographic Explanation for the Recent Rise in European Fertility

John Bongaarts
Tomáš Sobotka

Fertility as measured by the period total fertility rate (TFR) rose in the large majority of European countries between 1998 and 2008. This trend represents an unexpected reversal from the historically unprecedented low levels reached by most countries in the 1990s or early 2000s. Increases from these minimum levels have exceeded 0.2 births per woman in 19 European countries (Goldstein, Sobotka, and Jasilioniene 2009). The turnaround has been especially rapid in populations with the lowest fertility: the number of countries with a TFR below 1.3 declined from 16 in 2002 to just one (Moldova) in 2008. This new trend suggests that the potential adverse consequences of population aging and population decline will likely be substantially smaller than feared in the 1990s.

Explanations for this new phenomenon can be provided at two levels, demographic and socioeconomic. Proposed demographic explanations include the disappearance of period tempo effects that distorted the TFR downward in the past as women's age at childbearing rose (Bongaarts and Feeney 1998; Philipov and Kohler 2001; Bongaarts 2002; Sobotka 2004; Goldstein, Sobotka, and Jasilioniene 2009), and a cohort-driven recuperation at older ages of births that were postponed at younger ages (Lesthaeghe and Willems 1999; Frejka and Sardon 2009; Frejka 2010; Goldstein, Sobotka, and Jasilioniene 2009; Neels and de Wachter 2010; Sobotka, Zeman, Lesthaeghe, and Frejka 2011). Further back in the chain of causation are social and economic determinants and pronatalist or family policies that affect the quantum and tempo of childbearing. Analytical attention has been paid especially to changes in family policies (Goldstein, Sobotka, and Jasilioniene 2009; OECD 2011; Hoorens et al. 2011), positive economic trends and declining unemployment before 2008 (Goldstein, Sobotka, and Jasilioniene 2009; Örsal and Goldstein 2010), the possible reversal of the previous negative association between economic development and fertility (Myrskylä, Kohler, and Billari 2009; OECD 2011; Luci and Thévenon 2010), and the potential role of changes in gender equality (Myrskylä, Kohler, and Billari 2011).

This study focuses on the demographic determinants of recent fertility increases in Europe until 2008—that is, until the onset of the severe economic recession that has affected fertility trends in many countries (Sobotka, Skirbekk, and Philipov 2011). The availability of the new Human Fertility Database (HFD) in combination with other sources allows us to analyze fertility trends in much greater detail than before. The HFD provides estimates of numbers of births, exposure to the risk of childbearing, and fertility rates by age, period, cohort, birth order of the child, parity of the mother, and country. The detailed empirical analysis below focuses on three countries included in the HFD—the Czech Republic, the Netherlands, and Sweden—and on Spain. In addition, selected data and indicators are presented for Bulgaria, Denmark, Estonia, Finland, France, Italy, Russia, Slovenia, Switzerland, and the United Kingdom. The "core" four analyzed countries have experienced significant recent upturns in fertility, and they represent different regions of Europe as well as different socioeconomic and institutional contexts. In two of them, the Czech Republic and Spain, the period TFR bottomed out at the extreme low level below 1.2.

After a brief overview of fertility trends as measured by the conventional TFR, we focus on three main topics. First, we provide conceptual and methodological discussion on the potential role of period and cohort influences as drivers of fertility fluctuations and relate the discussion to the recent trends. Second, we examine the role of tempo distortions of period fertility and different methods for removing these distortions. Based on a comparison of different adjusted indicators with completed fertility of women born in 1961–67, we highlight the usefulness of a new indicator, the so-called *tempo- and parity-adjusted total fertility rate* (TFRp*). This variant of the Bongaarts–Feeney (1998) adjustment method also controls for the composition of the female population by parity and provides more stable values than the indicators proposed in the past. Third, using this new indicator, we estimate the role of declines in tempo and parity composition distortions in the recent rise in the conventional total fertility rate in Europe. The removal of these distortions allows us to assess trends in the undistorted quantum of period fertility.

The discussion highlights the analytic difficulties in separating quantum and tempo components of fertility trends that have led to differing interpretations. Our aim is to demonstrate the merits of the new tempo- and parity-adjusted fertility indicator, to stimulate more rigorous research, and to move closer toward a consensus on the demographic causes of recent fertility trends in most developed countries.

## Recent trends in the level and timing of period fertility

The dominant trend in fertility in Europe from the 1960s to the 1990s as measured by the conventional TFR was a downward turn to below replacement. Europe's average TFR declined by more than one child per woman, from 2.6 in 1960 to 2 in 1976 and to a low of 1.37 in 1999, before recovering somewhat to 1.56 in 2008 (VID 2010). Each major region within Europe experienced declines of a similar magnitude, although patterns differed between regions (see Figure 1). A steep decline occurred first in the West and the North between 1965 and 1975, followed by the South in the late 1970s and 1980s and the East in the 1990s. By the end of the 1990s fertility levels converged around a TFR of 1.4, with the Nordic countries and Western Europe (excluding three predominantly German-speaking countries: Austria, Germany, and Switzerland) forming a higher fertility group with TFRs of 1.6–1.7 and Eastern Europe falling slightly below 1.2. These were mostly record lows.

The recent upturn in the TFR has been documented by Goldstein, Sobotka, and Jasilioniene (2009). It was recorded across the whole continent, both in the countries with extremely low TFR levels below 1.3 and in the countries that had never experienced a TFR decline below 1.5. Estimates of the increase in the TFR between the year of the minimum and 2008 for European populations range from 0.03 in Portugal to 0.51 in Denmark (and 0.61 for East Germany, the former GDR). As many as 15 European countries recorded a TFR increase of 0.3 or more:

*Central and Eastern Europe:* Bulgaria, Czech Republic, Estonia, Latvia, Russia, Slovenia, and Ukraine;

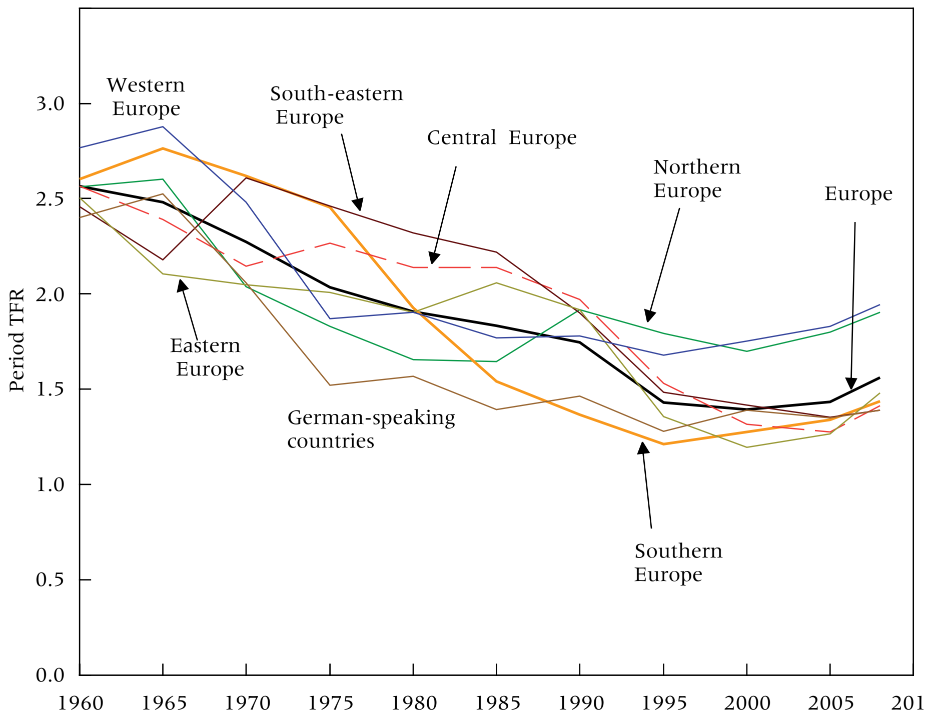
*Northern Europe*: Denmark, Finland, and Sweden;

*Southern Europe*: Spain;

*Western Europe*: Belgium, France, Netherlands, and United Kingdom.

In absolute terms these increases may seem modest, but they usually represent a relative rise in the TFR by more than 20 percent and have important demographic consequences because they close a substantial part of the gap between the minimum fertility and the replacement level. Outside Europe, Australia, New Zealand, Canada, and Japan also saw their period TFRs rising above the minimum values reached around 2000. The United States recorded a brief rise of the TFR above replacement level in 2006–07, the highest since 1971, before experiencing a recession-related decline. Several European countries experienced only small TFR upturns. The most prominent example is Germany (except its eastern part, the former German Democratic Republic), where the period TFR rose slightly in the 1990s from its low of 1.24 in 1994, but remained stable at around 1.35 after 2000.

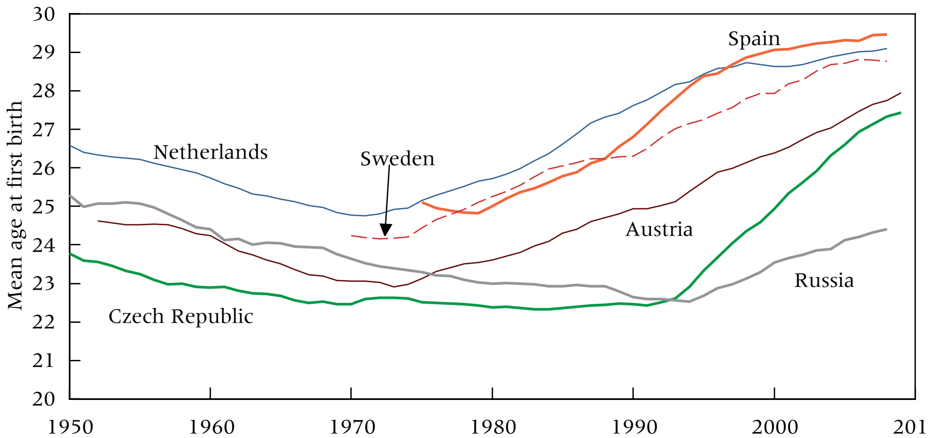
**FIGURE 1 Period TFR in European regions, 1960–2008**




NOTES: Regional data are weighted by population size of countries in a given region. Data for the whole of Europe include all territory of Russia and exclude Turkey and countries of the Caucasus.
Countries are grouped into regions as follows:
*Western Europe:* Belgium, France, Ireland, Luxembourg, Netherlands, United Kingdom
*German-speaking countries:* Austria, Germany, Switzerland
*Northern Europe:* Denmark, Finland, Iceland, Norway, Sweden
*Southern Europe:* Cyprus, Greece, Italy, Malta, Portugal, Spain
*Central Europe:* Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, Slovenia
*South-eastern Europe:* Bosnia-Herzegovina, Bulgaria, Macedonia, Montenegro, Romania, Serbia (recent data exclude Kosovo). Data for Albania were excluded as they are not available for some years.
*Eastern Europe:* Belarus, Moldova, Russia, Ukraine
SOURCES: Own computations based on Eurostat (2010), VID (2010), Council of Europe (2006), and national statistical offices.

In part related to the fall in period fertility was a second major trend since the early 1970s, a continuous long-term rise in women's mean age at childbearing, especially at first birth. This was labeled by some demographers as a "postponement transition" from an early to a late childbearing pattern (Kohler and Ortega 2002; Goldstein, Sobotka, and Jasilioniene 2009). Figure 2 illustrates this shift for six countries representing broad regional trends (data are not available for whole regions). Around 1970, when use of the contraceptive pill started spreading across Europe, women's mean age at first birth stood between 22 and 25 years in most countries. By 2008, it increased to 27–29 years in most European countries, although in Eastern Europe, including Russia, it remains younger. At the same time, the pace of increase in

**FIGURE 2 Period mean age at first birth in six European countries, 1950–2009**

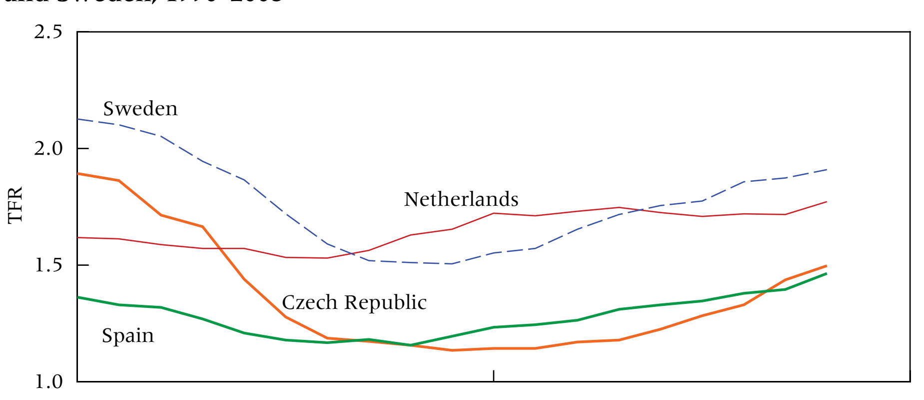



SOURCES: HFD (2010), Council of Europe (2006), and own computations based on Eurostat (2010) and national statistical offices.

the mean age at first birth diminished markedly after 2000 in most countries that had reached high values. This pattern is also observed in Figure 2 for the Netherlands, Spain, Sweden, and the Czech Republic. As we demonstrate below, this reduction in the pace of increase in childbearing age is a crucial factor in explaining the recent rise in fertility.

Figure 3 plots the TFR for the Czech Republic, Netherlands, Spain, and Sweden for the period after 1990, which covers the recent trough and subsequent rise in period fertility. Fluctuations in fertility since 1990 were largest in the Czech Republic and smallest in the Netherlands. In all four countries increases in the overall TFR were mostly due to increases at birth orders one

**FIGURE 3 Period TFR in the Czech Republic, Netherlands, Spain, and Sweden, 1990–2008**




SOURCES: Council of Europe (2006), HFD (2010), VID (2010), and national statistical offices.

and two, while TFRs at higher orders were flat or declining. As shown in previous research (Bongaarts and Feeney 1998, 2006), any accurate analysis of trends in the quantum and tempo of fertility should be conducted by birth order, and in the remainder of this article we follow this aproach.

## Period versus cohort changes

The driving forces of fertility change, in particular of the recent upward trend in the TFR, have been interpreted differently by various analysts. Goldstein, Sobotka, and Jasilioniene (2009: 690) summarize this debate as follows: "One area of research emphasizes the prominence of period factors in driving fertility change (Ní Bhrolcháin 1992); this view is also explicitly adopted in the tempo-adjustment method of Bongaarts and Feeney (1998). A competing view stresses the prominence of a cohort-driven process of fertility recuperation (e.g., Lesthaeghe and Willems 1999; Frejka and Sardon 2009)." We aim to clarify the differences and agreements between these two perspectives.

### Definitions

Definitions of cohort and period changes in fertility are essential before proceeding. Four ideal types of changes in age-specific fertility rates by birth order can be identified:

1) A *period quantum* change in fertility is defined as an increase or decrease from one period to the next that is independent of age or cohort. As shown in Figure 4a (which pertains to both period and cohort perspectives), this change in quantum simply inflates or deflates the period fertility schedule proportionally at all ages.

2) A *period tempo* change is defined as an increase in the mean age at childbearing from one period to the next with the shift in the fertility sched-

**FIGURE 4a Simulated quantum change**

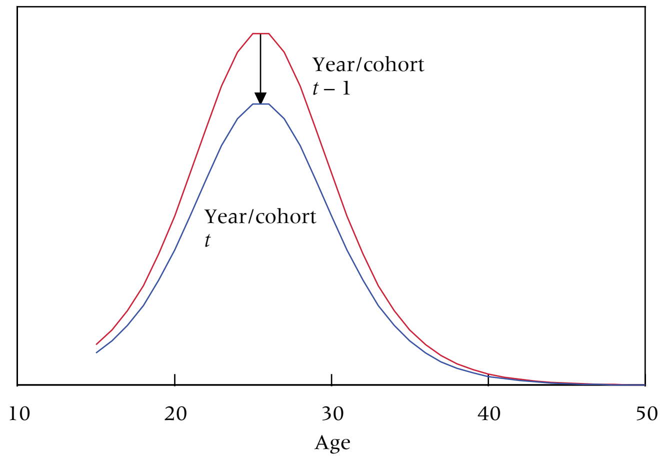
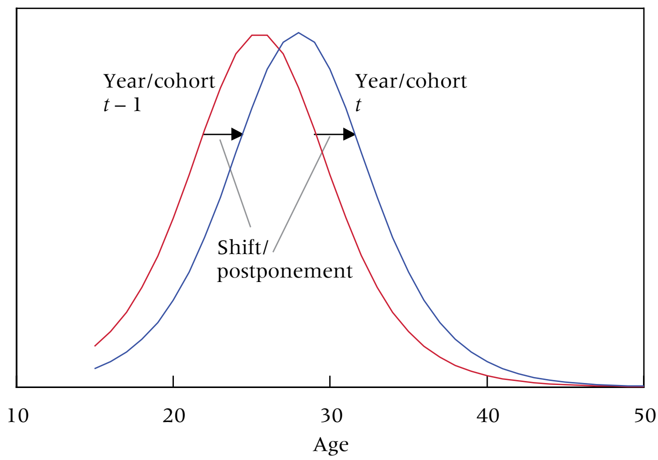


**FIGURE 4b Simulated tempo change**




ule independent of age or cohort. As shown in Figure 4b, this tempo change involves a move up or down the age axis of the fertility schedule while its shape remains invariant.

3) A *cohort quantum* change in fertility is defined as an increase or decrease from one cohort to the next that is independent of age or period, resulting in an inflation or deflation of the cohort fertility schedule proportionally at all ages.

4) A *cohort tempo* change in fertility is defined as an increase or decrease in the mean age at childbearing from one cohort to the next with the shift in schedule independent of age or period, resulting in a move up or down the age axis of the cohort fertility schedule while its shape remains invariant. This shift can also be referred to as postponement (at younger ages) and recuperation (at older ages), or simply as postponement.

Change in the real world is of course more complex than any of these pure changes because period and cohort changes, and quantum and tempo changes, often occur simultaneously to bring about observed year-by-year changes in fertility.

## Are observed fertility fluctuations the result of period or cohort effects?

The question of whether period or cohort effects dominate in determining fluctuations in fertility has been examined in a number of key studies. Brass (1974) concluded that cohort completed fertility reveals no significant feature that distinguishes it from time averages of period indexes. Pullum (1980: 241) concluded that "temporal variations that cut across cohorts, such as economic cycles, appear to be more important than changes in those variables that distinguish cohorts, such as shared socialising experiences." Ward and Butz (1980: 937) posited that completed family size is an outcome of a "sequence of period-specific decisions," where a "couple's plans are revisable" and "the entire time path of births will not be precommitted but will change as new information accrues." In an authoritative review, Ní Bhrolcháin (1992: 600) concluded that "of the two dimensions of calendar time—period and cohort—period is unambiguously the prime source of variation in fertility rates." These studies are essentially in agreement that period influences on fertility are more important than cohort influences.

These findings contrast with the arguments about cohort-driven processes of fertility change. Ryder asserted that "in the model of reproductive behavior, the driving force is change in cohort fertility. The actors are members of cohorts; their behavior is manifested in cross-section period summations in a distinctive manner because of ongoing change in the way those actors are distributing their reproductivity over time" (Ryder 1990: 443).

However, most recent proponents of the "cohort view" of fertility behavior, including Lesthaeghe (Lesthaeghe and Surkyn 1988; Lesthaeghe and Willems 1999; Lesthaeghe 2001), Frejka (Frejka 2010), and Goldstein (Goldstein and Kenney 2001; Goldstein and Cassidy 2010), pursue a more nuanced picture, which, with some simplification, can be summarized as follows. They recognize strong period influences, especially at younger ages when period trends such as increased participation in higher education are dominant. However, their description of fertility change emphasizes the presumably cohort-driven process of recuperation at higher ages, which assumes that the cohorts of women who reduced fertility at younger ages will try to "make up" for at least a part of this decline in order to realize their childbearing intentions. This does not mean, though, that these cohorts would be insensitive to period influences (see also Sobotka, Zeman, Lesthaeghe, and Frejka 2011).

In our view the ongoing debate about the relative roles of period and cohorts would be clarified by emphasizing the following points:

First, the "period paramount" view of Brass, Ní Bhrolcháin, and others can be perfectly consistent with the *description* of fertility change in the cohort postponement–recuperation perspective. The reason is that any change in fertility at age $a$ and time $t$ in cohort $c$ can always be described from either a cohort or a period perspective. A change at age $a$ in period $t$ is the same as the change to cohort $c$ at age $a$ because, by definition, $c = t - a$. As a result, a steady rise in the period mean age at childbearing produces changes in cohort fertility that can be described as postponement and recuperation.

Second, whether fertility is described from a period or cohort perspective is a separate question from whether period or cohort effects are the main underlying force of fertility change. We return to this issue in the next section.

Third, neither a period-driven shift nor cohort postponement and recuperation is sufficient to explain a rise in period fertility. Shifts and postponements can occur for decades in countries with a constant total fertility rate and a rising period mean age at childbearing. An adequate explanation for the recent rise in the TFR therefore requires an additional mechanism as discussed next.

## Tempo distortions as a cause of fluctuations in the TFR

The terms "tempo effect" and "tempo distortion" were first introduced in the demographic literature by Norman Ryder, who made fundamental contributions to the study of quantum and tempo measures in fertility (Ryder 1956, 1959, 1964, 1980). His most important finding was that a change in the timing of childbearing of cohorts results in a discrepancy between the period total fertility rate and the cohort completed fertility rate (see also Ward and Butz 1980). He considered the period TFR to contain a tempo distortion when the timing of childbearing changed, and he demonstrated that the size of this discrepancy depends directly on the pace of change in the mean age at childbearing. Ryder's work was highly influential, and for most of the last half century the idea of tempo distortions in fertility has been widely accepted. The estimation of tempo distortions became simpler in 1998, when Bongaarts and Feeney introduced a new approach to estimating tempo effects. Bongaarts and Feeney defined a tempo distortion as an inflation or deflation of the period TFR when the period (instead of the cohort) mean age at childbearing changes. They also provided a simple equation for estimating period tempo distortion that requires only age-specific fertility rates by birth order ("rates of the second kind"[1]) and does not require cohort data (Bongaarts and Feeney 1998). In the Bongaarts–Feeney framework the observed but distorted TFR in any given year is related to the undistorted TFR* in the same year as

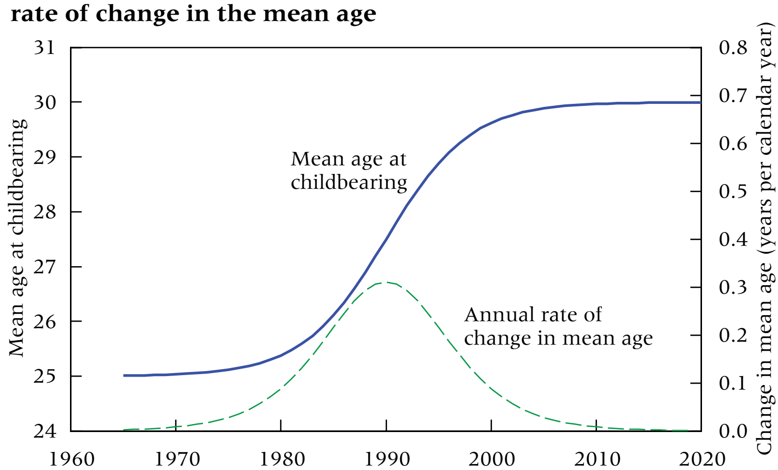
$$\text{TFR} = (1 - r)\ \text{TFR}^*$$

where $r$ denotes the annual rate of change in the period mean age at childbearing in the year. TFR* is referred to as the tempo-adjusted total fertility rate, which equals the total fertility rate that would have been observed had the mean age at childbearing been constant during year $t$. The absolute tempo distortion in the observed TFR equals TFR – TFR*, which is negative when the mean age is rising, that is, when $r > 0$. For example, when the mean age is rising at a rate of 0.1 years per calendar year, the TFR contains a downward distortion of 10 percent. The above equation should be applied separately for each birth order. In a later section we comment on this and other methods for removing tempo effects and their strengths and weaknesses. We also mention the broader issue of the usefulness of estimating "tempo-free" period fertility indicators, because some confusion still exists on the meaning and interpretation of these measures (Ní Bhrolcháin 2011).

### Simulation of period tempo distortions

The impact of tempo distortions on contemporary fertility trends is not always obvious, in part because tempo and quantum changes often occur simultane-

**FIGURE 5a Simulated mean age at childbearing and rate of change in the mean age**



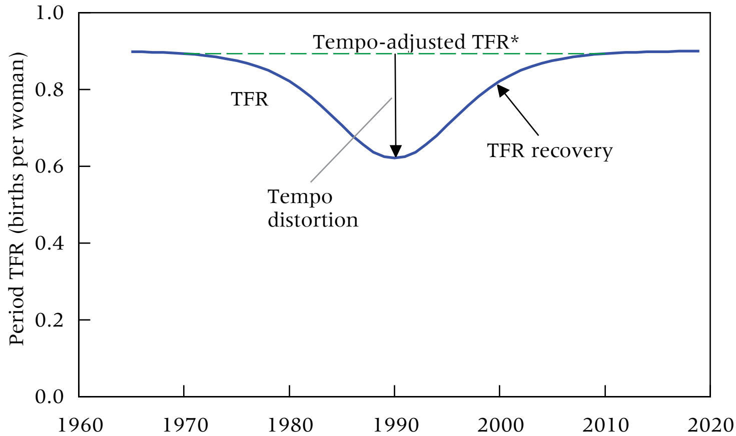

ously. It is therefore useful to begin an examination of tempo distortions with a simulation of a hypothetical population in which conditions are simplified. Specifically, the simulation calculates the pattern of age-specific fertility over a period of 50 years, 1965–2015, in a hypothetical population in which 1) cohort quantum at birth order 1 is constant at 0.9 (i.e., 90 percent of women give birth to a first child) and 2) the period mean age increases by five years from an equilibrium at 25 years before 1965 to another equilibrium at 30 years after 2015. This pattern of change in the mean age at first birth is plotted in Figure 5a. The annual rate of increase in the mean age rises and falls during this transition and is most rapid around 1990 (see dashed line in Figure 5a).

This hypothetical transformation of childbearing represents an obvious simplification of reality, but it nevertheless captures the broad pattern of change in tempo of first births observed in Europe over the past few decades and roughly follows the logistic pattern of the "postponement transition" described by Goldstein, Sobotka, and Jasilioniene (2009). Insights from this simulation can help interpret actual trends in fertility. In particular, it sheds light on the key changes in fertility that result from tempo changes alone, as we demonstrate next.

## The impact of the pace of tempo change on the TFR

The essence of a tempo distortion is that its size depends on the rate of change (and not the absolute value) of the mean age at childbearing. As a result, the simulated trend in the TFR follows the inverse pattern of the trend in the rate of change of the period mean age, which rises and falls over the same period (compare Figures 5a and 5b). That is, the TFR declines from 0.9 to 0.62 between 1965 and 1990 and then rises back to 0.9 in 2015. The increase after

**FIGURE 5b Simulated total fertility rate and tempo distortion**




1990 is the result of a decline in the tempo effect, even though the mean age keeps rising.

The direct relationship between the annual values of the TFR and $r$ is plotted in Figure 5c, with each data point representing one year between 1965 and 2015. The TFR equals 0.9 in 1965 and 2015 when the mean age is not changing ($r = 0$), and it reaches its lowest point of 0.62 in 1990 when $r$ is at its maximum. This relationship is described formally as TFR = 0.9 $(1 - r)$. Because $r$ reaches a maximum of 0.31 in 1990, it follows that TFR reaches a minimum value of 0.9 (1 – 0.31) = 0.62 in the same year.

**FIGURE 5c Simulated TFR by rate of change in the mean age at childbearing, 1965–2015**

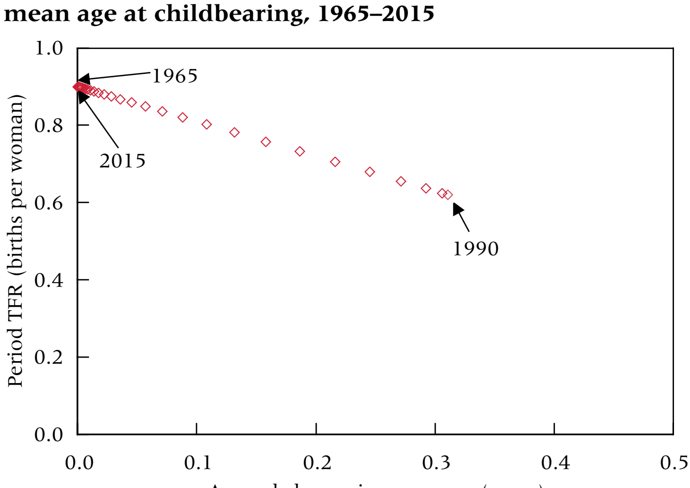
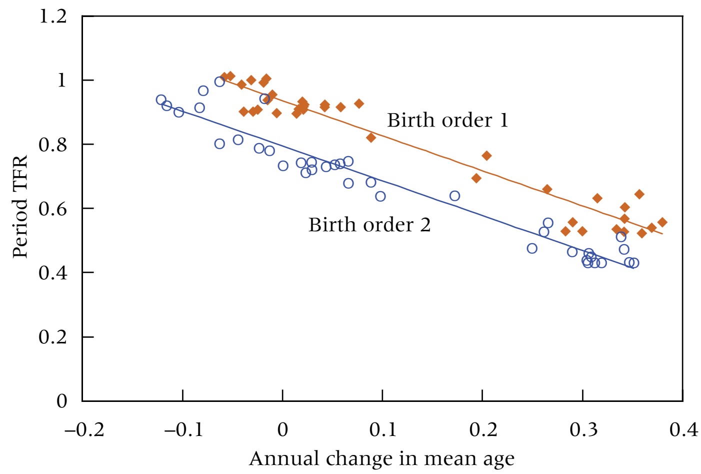


**FIGURE 6 Period TFR by rate of change in the mean age at childbearing (*r*(*t*)): Czech Republic, 1970–2008 (first and second births)**



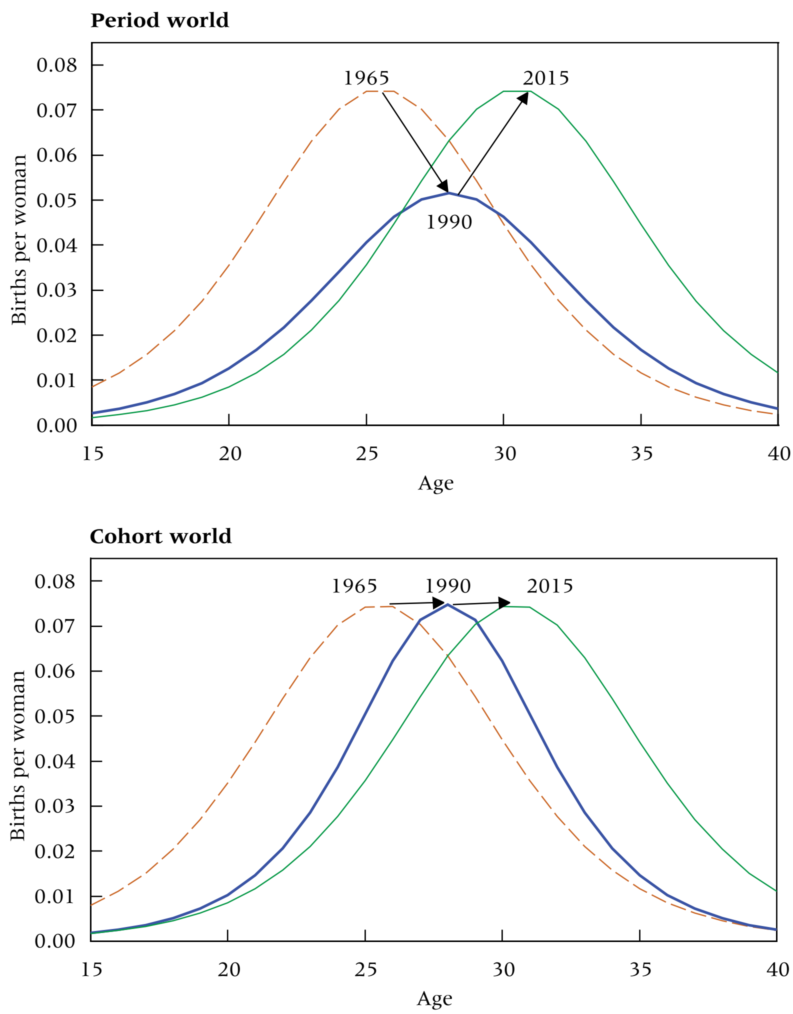

SOURCE: Computations based on HFD (2010).

A broadly similar relationship between annual estimates of TFR and $r$ is observed in 1970–2008 in the four analyzed countries. As shown in Figure 6 the association between these variables in the Czech Republic (analyzed separately for birth orders one and two) is roughly linear, inverse, and statistically significant (data for the Netherlands, Spain, and Sweden not shown, but are available from the authors upon request). The observations for individual years deviate somewhat from the expected linear relationship for the following reasons: 1) the observed TFR is affected by quantum changes and changes in the parity composition of the female population as well as tempo distortions; 2) measurement errors; and 3) deviations from the assumptions in the Bongaarts–Feeney framework. Nevertheless, the empirical evidence clearly supports the theoretically expected relationship between the observed TFR and the rate of change in the period mean age at childbearing.

## The impact of tempo distortions on age-specific fertility rates

We first inspect the simulated fertility changes based on the assumption that these changes are entirely period-driven. Age-specific fertility rates in the simulated population change substantially during the postponement transition. The schedules of age-specific fertility rates are constant before 1965 and after 2015. In the intervening years two related forces operate: the shift of the age schedule from a mean of 25 years before 1965 to 30 years after 2015 and the rise and fall of tempo distortions that affect each age proportionally the same[2] (see Figure 7, "period world"). This complex pattern of change occurs

**FIGURE 7 Simulated period age-specific fertility rates, 1965, 1990, and 2015, based on the assumption that fertility changes are entirely period-driven ("period world," upper panel) and an alternative assumption that these changes are entirely cohort-driven ("cohort world," lower panel)**




solely as a result of a rise in the period mean age at first birth, because the cohort completed fertility is held constant at 0.9.

The rise in the simulated TFR between 1990 and 2015 is of particular interest because it can potentially shed light on the recent upturns in Europe. During this period the simulated schedule of age-specific fertility changes because of the continuing shift in the mean age at childbearing from 27.5 to 30 years combined with the gradual disappearance of the tempo distortions. The latter causes the elevation of fertility curves, resulting in large proportional increases at older ages (e.g., at age 40 the age-specific fertility rate triples from 40 to 120). Note that it is correct to describe the simulated changes in fertility as recuperation for older cohorts and little or no change for younger cohorts. This is correct as a description, even though all change for the entire simulation is assumed to be driven only by period effects.

### Comparison of simulations of period- and cohort-driven fertility change with observed trends

The preceding simulation assumed a ″period world″ in which only period effects occur and the shape of the schedule of period age-specific fertility rates remains invariant over time. The schedule can be inflated or deflated over time to reflect period quantum changes, or it can shift to higher or lower ages to reflect period tempo changes. But the shape remains constant because all cohorts respond in the same way to period influences.

We have also undertaken a simulation of a ″cohort world″ in which only cohort effects occur and the shape of the schedule of cohort age-specific fertility rates remains invariant over time. In this simulation the quantum is also fixed at 0.9 births per woman for all cohorts. The only change being simulated is a postponement transition that moves the mean age at childbearing of cohorts from 25 to 30 years. When these cohort shifts are ″translated″ into period fertility trends, spanning a comparable period as the simulated changes in the ″period world″ above, the annual rate of increase in the mean age rises and falls during this transition and is most rapid around 1990. Age-specific fertility rates in 1965, 1990, and 2015 are presented in Figure 7 (“cohort world″). They show the expected shifting of fertility to higher ages but do not show any changes in the mode (i.e., peak value) of the fertility schedule. The resulting trend in the TFR is similar to the one plotted in Figure 5b with values of 0.9 before the transition, a minimum in 1990, and a rebound to 0.9 after the transition is completed. A notable feature is that the variance of the period fertility schedule (which was constant in the ″period world″) changes during the cohort-driven transition. Variance first falls (alongside the TFR decline) in the first stage of the transition and then increases (alongside the TFR recovery) in the later stage of the transition, regaining the initial values. The rise in the TFR is attributable to this increase in the variance of the period fertility schedule; no change in the mode is evident.

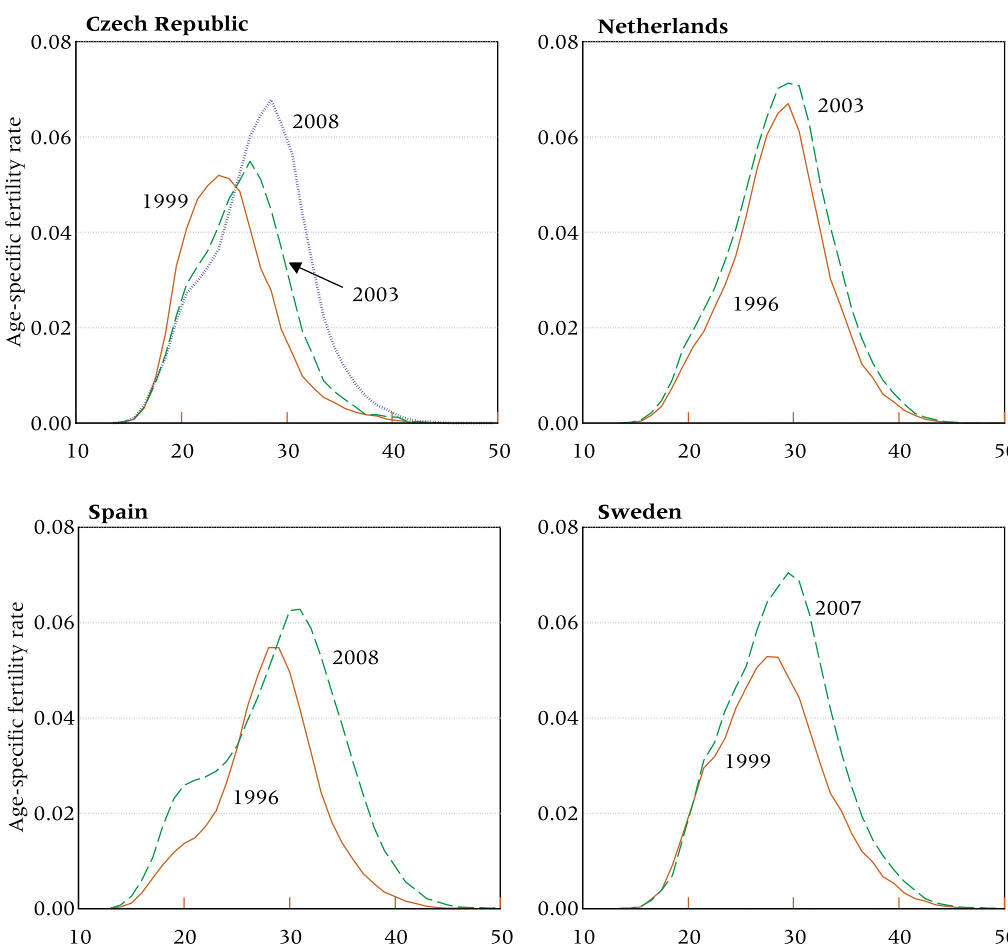
In sum, the overall TFR trends are similar in the simulated period and cohort worlds, but these trends in overall fertility are brought about by different patterns of change in age-specific fertility rates. The key differences are as follows.

*Period world*: The mode of the period age-specific fertility schedule falls and rises over the course of the transition, but the shape of this schedule (and hence its standard deviation) remains constant.

*Cohort world:* The mode of the period age-specific fertility schedule is constant but its shape changes with the variance, which first falls and then rises over the course of the transition.

These simulation results can now be compared with observed trends to assess the roles of period and cohort effects in actual populations. Figure 8 plots the observed patterns of age-specific fertility for birth order 1 in the Czech Republic, Netherlands, Spain, and Sweden, beginning in the year of the most recent minimum TFR (after 1990) and ending between 2003 and 2008, when considerably higher TFRs were reached. The changes are most

**FIGURE 8 Age-specific fertility rates for birth order 1 (rates of the second kind, incidence rates) between a TFR minimum after 1990 and a subsequent TFR maximum between 2003 and 2008**

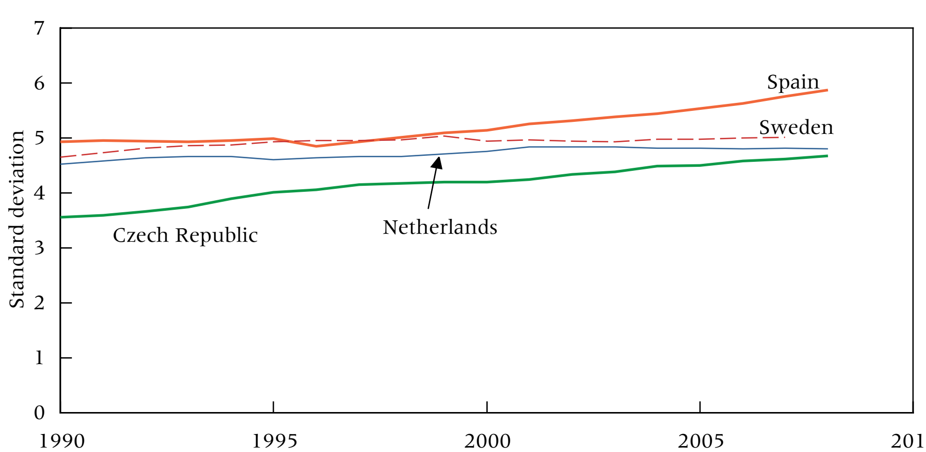



SOURCES: HFD (2010) and Eurostat (2010).

extensive in the Czech Republic and Sweden and smallest in the Netherlands, which is in line with the expectations based on the earlier discussion of aggregate trends in these countries. As in the period world simulation, the observed schedules shift over time to higher ages and they rebound beginning around the year of the minimum in the TFR. The mode clearly rises in all four countries. Spain shows an unusual early childbearing bulge in its fertility schedules after 2000; this is largely due to a rapidly rising population of immigrant women with a young schedule of childbearing (Goldstein, Sobotka, and Jasilioniene 2009).

These empirical patterns are not exactly equal to the simulated period-driven fertility changes because there are changes in childlessness (which was assumed constant in the simulation) as well as deviations from the Bongaarts–Feeney assumption, including the assumptions of a "pure" period-based shift.[3] Nevertheless the complex changes in the observed age pattern are broadly consistent with the changes expected from the simulated postponement transition in a period world, including trends in the standard deviation of the age schedule of period fertility. In the period world, the standard deviation should be constant. The observed variance is plotted in Figure 9 for first births (see Bongaarts and Sobotka 2011: Figure 10, for results on second births). These standard deviations show very little change in the Netherlands and Sweden and significant change in the Czech Republic (mostly at order one) and in Spain. As noted above, the increase in standard deviation in Spain is partly driven by the rise in immigrant fertility at young ages that complicates the interpretation of this trend. These results are largely consistent with the view that period effects are dominant in the Netherlands

**FIGURE 9 Standard deviations in age at childbearing, first births, 1990–2008**




SOURCES: Computations based on HFD (2010) and Eurostat (2003, 2010) for Spain.

and Sweden. Period effects are also important in the Czech Republic and possibly Spain, but significant cohort effects appear to be present as well, especially at order one.

The preceding analysis of empirical evidence was limited to countries for which fertility rates are available by birth order, because quantum and tempo trends differ by birth order. However, when these order-specific trends are similar, an examination of overall age patterns of fertility can be informative. Appendix 2 presents overall fertility schedules for Denmark, France, Italy, and the United Kingdom. The changes in these countries since the mid-1990s also suggest a dominance of period effects.[4]

## Tempo effect and its interpretation

A substantial literature discusses methods for removing tempo distortions in period fertility indicators, their underlying assumptions, and their interpretation (e.g., Bongaarts and Feeney 1998, 2006, and 2010; Yamaguchi and Beppu 2004; Kohler and Ortega 2002; Philipov and Kohler 2001; van Imhoff 2001; Sobotka 2003; Schoen 2004; Luy 2011; Ní Bhrolcháin 2011). These methods estimate tempo-adjusted indexes of period total fertility (denoted here by an asterisk). Before dealing with specific tempo-adjusted indicators, we discuss briefly the purpose and interpretation of tempo adjustment.

In her review, Ní Bhrolcháin (2011: 847) argues that "tempo effects are an integral component of the period fertility trends.... To remove tempo effects from period fertility as explanandum would denude it of an intrinsic and often substantial component of change." In her view, tempo effects are a source of bias and therefore potential candidates for adjustment only when "period synthetic measures are used as a proxy for the cohort equivalents or to predict longer-term fertility, or in some theoretical scenarios" (p. 857).

In contrast, proponents of period tempo adjustment see tempo effects as an undesired distortion that not only frequently leads to a long-lasting contrast between period and cohort fertility measures, but also obscures the measurement of fertility level (quantum). In other words, changes in the timing of childbearing systematically affect the level of the period TFR and other period fertility indicators (Bongaarts and Feeney 2010; Luy 2011). In addition, Sobotka and Lutz (2011) argue that the period TFR is often interpreted as measuring the average number of children per woman, as if it were a cohort indicator of fertility. This often leads to crude misinterpretation by policy analysts of the presumably extreme low levels of the period TFR and exaggeration of the difference (often termed "gap") between intended and achieved family size. They view these perceived shortcomings of the period TFR as good reasons for preferring alternative indicators of period fertility, including the tempo-adjusted ones, which in their view provide an improved reading of period fertility levels and trends.

With simplification, this debate on tempo-adjusted measures in demography deals with two separate questions:

1) Is the tempo effect a distortion or an integral component of period demographic measures?

2) If the tempo effect is indeed a distortion, can it be effectively measured and separated from the "pure period quantum" measures? In fertility research, this question boils down to whether the tempo effect should be included as another important parameter in the computation of period fertility indexes, alongside the age composition of the female population of reproductive age, parity status, and marital status.

As Ní Bhrolcháin (2011) suggests, the answer to the first question depends on the measurement purpose. With respect to the second question, her "skeptical" view emphasizes that period tempo and quantum are interlinked components that are difficult if not impossible to separate in period measures. In addition, she makes a valid distinction between "spurious tempo effects" that are confounded with other distorting factors affecting period fertility measurement (such as the shifts in the parity composition of women of reproductive age) and "genuine tempo effects" that are contained in the measures that properly control for other distorting factors. Researchers who emphasize the difficulty or even impossibility of effectively separating the tempo and quantum components of fertility usually stress the importance of relying on the cohort fertility measures as real and "ultimate" indicators of fertility quantum (Frejka 2010; Lesthaeghe and Willems 1999).[5]

Our answers to these two broad questions underlying the debate on tempo-adjusted measures of fertility are affirmative. We suggest that the tempo effect in most situations constitutes a distortion that should be removed, if possible, to obtain accurate measures of the period fertility quantum. In addition, we are convinced that effective measurement of the tempo effect is possible using the tempo- and parity-adjusted total fertility rate (TFRp*), which is introduced below.

## Measuring the tempo effect: Past indicators and the tempo- and parity-adjusted total fertility rate (TFRp*)

We focus on three tempo-adjusted indicators:

1) *TFR**. The oldest and most widely used tempo-adjusted TFR was proposed by Bongaarts and Feeney (1998). By rearranging the equation presented above, they estimate the tempo-adjusted TFR* in a given year as

$$\text{TFR}^* = \text{TFR} \ / \ (1 - r)$$

A key advantage of this equation is that it requires data only on TFR and $r$ by birth order, which are available for many developed countries.

2) *PATFR**. One of the main criticisms of this simple Bongaarts–Feeney procedure is that it does not take into account changes in the parity distribution of the female population (Kohler and Ortega 2002; van Imhoff and Keilman 2000; Ní Bhrolcháin 2011). To address this issue, Kohler and Ortega (2002) proposed a tempo-adjusted period fertility indicator (we call it PATFR*) that differs in two ways from the Bongaarts–Feeney approach. First, it uses fertility tables that convert age- and parity-specific fertility rates or probabilities into period quantum measures.[6] Second, the tempo adjustment to these probabilities is derived from the rate of change in the mean of the probabilities rather than from the change in the mean age of the conventional age-specific birth rates (i.e., it is based on rates of the first kind). The PATFR* represents a tempo-adjusted version of an index of period fertility, PATFR, introduced by Rallu and Toulemon (1994) and based in part on Park (1976).

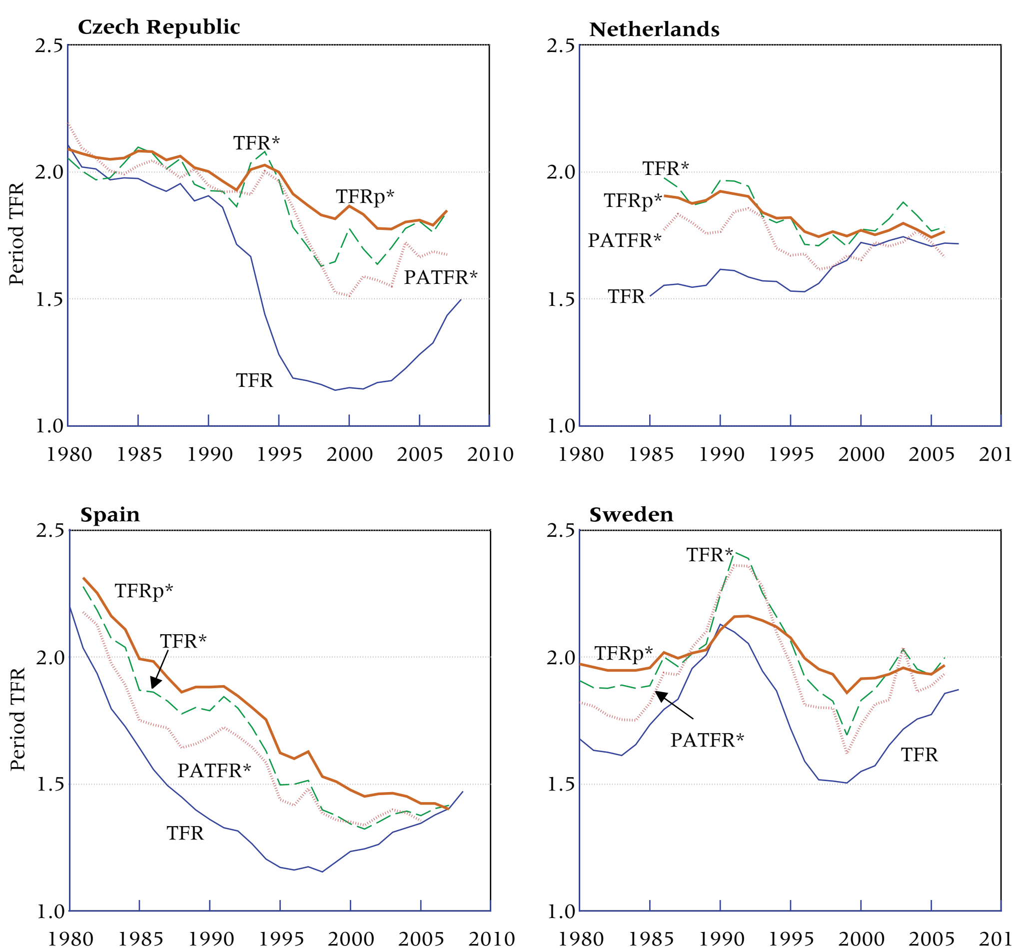
3) *TFRp**. More recently Bongaarts and Feeney (2004, 2006) proposed a variant of the basic Bongaarts–Feeney method. This approach has been used by Bongaarts and Feeney (2003) to estimate mortality tempo effects, but has thus far been neglected in the fertility literature. The main difference between the tempo- and parity-adjusted total fertility, TFRp*, and the basic TFR* is that the former is calculated with fertility tables to convert age- and parity-specific fertility rates ("hazard rates") into period quantum measures. Otherwise the new method is very similar to the basic method: calculations for different birth orders are entirely independent of each other (rather than linked as in the Kohler–Ortega method),[7] and the tempo adjustment of probabilities is made with the original Bongaarts–Feeney method, based on changes in the period mean age of childbearing by birth order. The argument underlying the independent treatment of fertility at each birth order, as used in the TFRp* computations, rather than the classic interconnected framework, has been summarized by Bongaarts and Feeney (2006: 2): "any recurrent event may be resolved into a series of non-recurrent events, which can be analyzed separately." Yamaguchi and Beppu (2004) proposed a very similar approach.

The tempo-adjusted TFRp* aims to remove two distorting effects influencing the conventional TFR: the parity composition effect (attributable to shifts in the parity composition of women of reproductive age) and the tempo effect (attributable to changes in the timing of childrearing). It would be possible to estimate the separate roles of these two effects using a decomposition similar to the one proposed by Ortega and Kohler (2002). In our contribution, however, we focus on the joint influence of both effects, without providing a formal decomposition. Therefore, we simply refer to "tempo and parity composition effects" or simply to "distortions."

The TFRp* addresses two main shortcomings of the tempo-adjusted period TFR*: not controlling for the parity distribution of the population of reproductive age (this can be seen as confounding in the estimation of the tempo effect; Ní Bhrolcháin 2011); and considerable year-to-year instability, which has frequently been identified in the adjusted TFR* (e.g., Sobotka 2003; Schoen 2004; see also below).

The three analyzed tempo-adjusted fertility indexes are plotted in Figure 10 for our four countries for all years for which data are available after 1980 from the HFD or national statistical sources. Generally, all adjusted indicators are higher than the observed TFR, indicating fertility-depressing tempo and parity composition effects, attributable to postponement of childbearing particularly after 1990. Measures can differ substantially, especially during times of rapid fertility changes and trend reversals. This is clearly illustrated by the fertility fluctuations in Sweden around 1991, when rapid changes in

**FIGURE 10 Observed and tempo-adjusted total fertility indexes for all birth orders**




SOURCES: Computations based on HFD (2010) and Eurostat (2003, 2010) for Spain.

birth interval, stimulated by an extension of parental leave, caused a sudden upturn in the conventional TFR and an even more sudden shift in the TFR* and PATFR*. In contrast, the TFRp* is much more stable.[8] Similar results hold for comparisons of adjusted indexes by birth order (see Bongaarts and Sobotka 2011: Figure 12, for first births).

The three different adjusted indicators shed a different light on the recent upturn in the period TFR. The TFRp* suggests a stagnation in the fertility quantum since the year of the minimum TFR, while the other adjusted measures indicate a slight increase in fertility quantum. For reasons presented below, the TFRp* is our preferred indicator for estimating the true fertility quantum.

## Comparison of period and cohort fertility

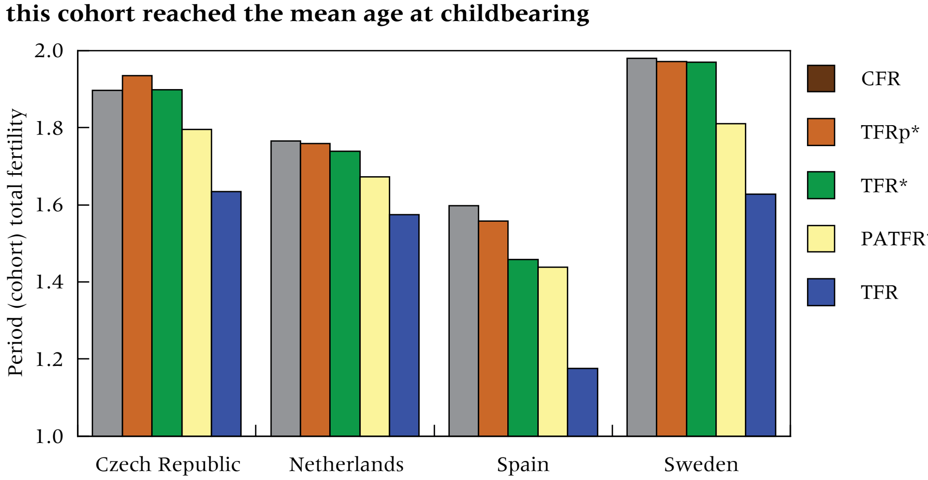
Tempo-adjusted period fertility indicators (TFR*, PATFR*, and TFRp*) can be considered variants of the conventional period TFR that aim to remove tempo distortions caused by changes in the timing of childbearing and, in the case of PATFR* and TFRp*, also attempt to control for the parity composition of the female population. With these TFR distortions removed, the adjusted indicators are estimates of the period fertility quantum. We emphasize that these pure period measures are not intended to predict completed fertility or to forecast future period fertility. The reason is clear: completed fertility of a cohort is accumulated over decades of childbearing, while a period measure reflects childbearing only in a single year.

Nevertheless, there are conditions in which a comparison of cohort fertility with the tempo-adjusted period fertility is appropriate. The simplest situation is one in which completed fertility is constant for successive cohorts (as was the case in the above simulations). In such a hypothetical population, the TFR can fluctuate from year to year as a result of tempo changes, but the tempo-adjusted TFR is constant and equal to the cohort completed fertility rate (provided that the assumption about the constant shape of the period fertility schedule holds and the parity composition of women shifts along with the fertility schedule). In the real world cohort fertility is not constant, and the constant-shape assumption is only an approximation. In contemporary European populations, cohort fertility tends to change slowly and without significant fluctuations, and the shape of the period fertility schedule changes little from year to year. Under these conditions, the tempo effect is the main factor responsible for the observed differences between period and cohort fertility rates. If it is correctly accounted for, period fertility indicators should on average closely approximate completed cohort fertility—not in individual years, but in a longer-term perspective—and a comparison of cohort and adjusted period measures can be helpful in assessing which of the available tempo-adjusted measures is preferable.

Several studies have compared cohort fertility and tempo-adjusted period fertility. Typically, adjusted period indicators for a particular period are compared with the value of completed cohort fertility of women who reached the mean age at childbearing in that period. For example, Bongaarts and Feeney (1998, 2006) compared lagged completed cohort fertility with the adjusted TFR* averaged over the period during which these cohorts were in their prime childbearing years and found good agreement. Sobotka (2003) compared lagged cohort fertility with the tempo-adjusted TFR* for a single year (rather than the average over a number of years); he found somewhat less correspondence because the adjusted TFR* contains seemingly random year-to-year fluctuations. A few other contributions also used annual TFR* data, noting the instability of this indicator (e.g., Schoen 2004 for the United States in the late 1970s). The confounding effect of these annual fluctuations can be minimized by smoothing time series of the adjusted TFR*.

Our analysis of this issue follows these procedures and compares the completed fertility of the cohort born in year *C* with the smoothed tempo-adjusted measures in year *t*, where $t - C$ equals the mean age at childbearing in year *t*. For example, if the mean age at childbirth is 30 years for the cohort born in 1969, then the completed fertility of this cohort is compared with the tempo-adjusted period fertility in 1999. All estimates are made separately for different birth orders (1 to 4+), and the period measures are smoothed using a simple 5-year moving average. Only cohorts whose fertility up to age 40 has

**FIGURE 11 Comparison of the completed fertility rate (CFR) among women born in 1967 (1968 in the Czech Republic) with three adjusted fertility indicators and with the conventional period TFR in the year this cohort reached the mean age at childbearing**




NOTE: Indicators are sorted from those most closely approximating the completed fertility rates to those that are most distant from them in the case of total births (except in the Czech Republic, where TFR* provides a closer approximation than the TFRp*).

SOURCES: Computations based on HFD (2010) and Eurostat (2003, 2010) for Spain.

been observed by the last available year are included, and their fertility after age 40 is assumed to equal the observed schedule above age 40 in that year.

Figure 11 presents data for the most recent cohort analyzed (1967 for the Netherlands, Spain, and Sweden and 1968 for the Czech Republic) and compares them with the three adjusted period indicators as well as the conventional period TFR. In addition, Table 1 compares the cohort completed fertility rate with all these indicators analyzed for each birth order up to 4+. The main finding is that the TFRp* and CFR are in close agreement in all four countries. TFRp* is therefore our preferred indicator for the analysis of tempo and parity composition distortions. Figure 11 also shows that one of the criti-

**TABLE 1 Latest available completed cohort fertility (CFR) and period fertility indicators in the year in which the latest cohort observed (1967 or 1968) reached mean age at childbearing (by birth order, period indicators based on a 5-year moving average)**

| | Birth order | | | | |
|---|---|---|---|---|---|
| | **Total** | **1** | **2** | **3** | **4+** |
| **Czech Republic** | | | | | |
| CFR (1968 cohort) | 1.897 | 0.919 | 0.716 | 0.189 | 0.072 |
| TFRp* | 1.934 | 0.929 | 0.759 | 0.180 | 0.065 |
| TFR* | 1.898 | 0.909 | 0.746 | 0.177 | 0.066 |
| PATFR* | 1.795 | 0.932 | 0.731 | 0.100 | 0.031 |
| TFR | 1.634 | 0.889 | 0.564 | 0.126 | 0.055 |
| **Netherlands** | | | | | |
| CFR (1967 cohort) | 1.766 | 0.817 | 0.645 | 0.217 | 0.086 |
| TFRp* | 1.758 | 0.813 | 0.640 | 0.217 | 0.088 |
| TFR* | 1.739 | 0.807 | 0.629 | 0.215 | 0.089 |
| PATFR* | 1.673 | 0.803 | 0.618 | 0.190 | 0.063 |
| TFR | 1.575 | 0.724 | 0.567 | 0.201 | 0.083 |
| **Spain** | | | | | |
| CFR (1967 cohort) | 1.597 | 0.864 | 0.579 | 0.119 | 0.035 |
| TFRp* | 1.557 | 0.872 | 0.542 | 0.115 | 0.029 |
| TFR* | 1.458 | 0.788 | 0.537 | 0.103 | 0.030 |
| PATFR* | 1.439 | 0.860 | 0.476 | 0.075 | 0.028 |
| TFR | 1.176 | 0.605 | 0.440 | 0.100 | 0.031 |
| **Sweden** | | | | | |
| CFR (1967 cohort) | 1.980 | 0.878 | 0.724 | 0.269 | 0.109 |
| TFRp* | 1.971 | 0.888 | 0.724 | 0.256 | 0.104 |
| TFR* | 1.969 | 0.906 | 0.710 | 0.249 | 0.104 |
| PATFR* | 1.811 | 0.891 | 0.665 | 0.207 | 0.048 |
| TFR | 1.627 | 0.747 | 0.575 | 0.211 | 0.095 |

NOTE: Indicators are sorted from those most closely approximating the completed fertility rates to those that are most distant from them in the case of total births (except in the Czech Republic, where TFR* provides a closer approximation than the TFRp*).

cisms of the use of tempo-adjusted measures, namely that they may give an inflated impression of tempo-*f*free fertility in a period, is not warranted.

To summarize our analysis of the close approximation between cohort fertility and the corresponding adjusted period fertility, Table 2 displays the average absolute difference between them in the cohorts of 1961–67. This difference is our main measure for assessing the accuracy of the tempo adjustment achieved by different indicators. As expected from the results in Figure 11, the adjusted indicators largely close the substantial gap between observed period TFR and cohort fertility. This is especially the case for the two indicators derived using the Bongaarts–Feeney method: TFR* and TFRp*. In particular, TFRp* shows a remarkably good approximation to the CFR in all four countries analyzed, often removing 80–90 percent of the initial difference between TFR and CFR. For instance, it reduces the gap between the TFR and the corresponding CFR in the Netherlands from 13.8 percent to just 0.8 percent and in Spain from 25 percent to below 3 percent.

An examination of the birth-order dimension in Table 2 shows that all adjusted indexes display a remarkable correspondence with the CFR in the case of first births. Fertility rates at later births, however, show a major weakness of the adjusted PATFR* index. In contrast, TFR* and TFRp* depict fairly

**TABLE 2 Differences between completed cohort fertility and period fertility indicators (in percent), average of cohorts 1960–1967**

| Period indicators | Czech Republic[a] | Netherlands | Spain | Sweden | Average for four countries |
|---|---|---|---|---|---|
| **Total births** | | | | | |
| TFRp* | 1.9 | **0.8** | **2.7** | **1.8** | **1.8** |
| TFR* | **0.3** | 1.4 | 3.3 | 5.3 | 2.6 |
| PATFR* | 4.6 | 5.0 | 7.3 | 3.4 | 5.1 |
| TFR | 9.9 | 13.8 | 25.0 | 8.5 | 14.3 |
| **First births** | | | | | |
| TFRp* | 1.1 | **1.2** | 3.4 | **2.0** | 1.9 |
| TFR* | **0.5** | 2.6 | 5.5 | 8.6 | 4.3 |
| PATFR* | 0.9 | 1.3 | **1.7** | 2.5 | **1.6** |
| TFR | 1.7 | 13.9 | 25.5 | 7.5 | 12.2 |
| **Third births** | | | | | |
| TFRp* | **4.7** | **1.0** | **4.7** | **3.7** | **3.5** |
| TFR* | 4.9 | 1.8 | 9.4 | 4.7 | 5.2 |
| PATFR* | 38.5 | 18.3 | 38.5 | 15.3 | 27.7 |
| TFR | 29.3 | 12.1 | 20.6 | 13.6 | 18.9 |

NOTES: The indicator that is closest to completed cohort fertility is shown in bold. Indicators are sorted from those most closely approximating the completed fertility rates to those that are most distant from them in the case of total births (except in the Czech Republic, where TFR* provides a closer approximation than the TFRp*).
[a]Data for the Czech Republic pertain to the 1966–67 cohorts only, as the older cohorts experienced only a very minor shift in their childbearing ages.
SOURCES: Computations based on HFD (2010) and Eurostat (2003 and 2010) for Spain.

good correspondence with the completed fertility at higher birth orders. As in the case of all birth orders combined, TFRp* performs best of all indicators for third births, and its performance has exceeded our expectations. The similarly good performance of the TFR* is in part attributable to the 5-year smoothing of period fertility series used here, which removed most of its annual variation. It is not surprising that the TFRp* performs better than the TFR* because the former corrects both tempo and parity composition distortions while the latter removes only tempo effects. And, of course, cohort CFR is free from any tempo and parity composition distortions.

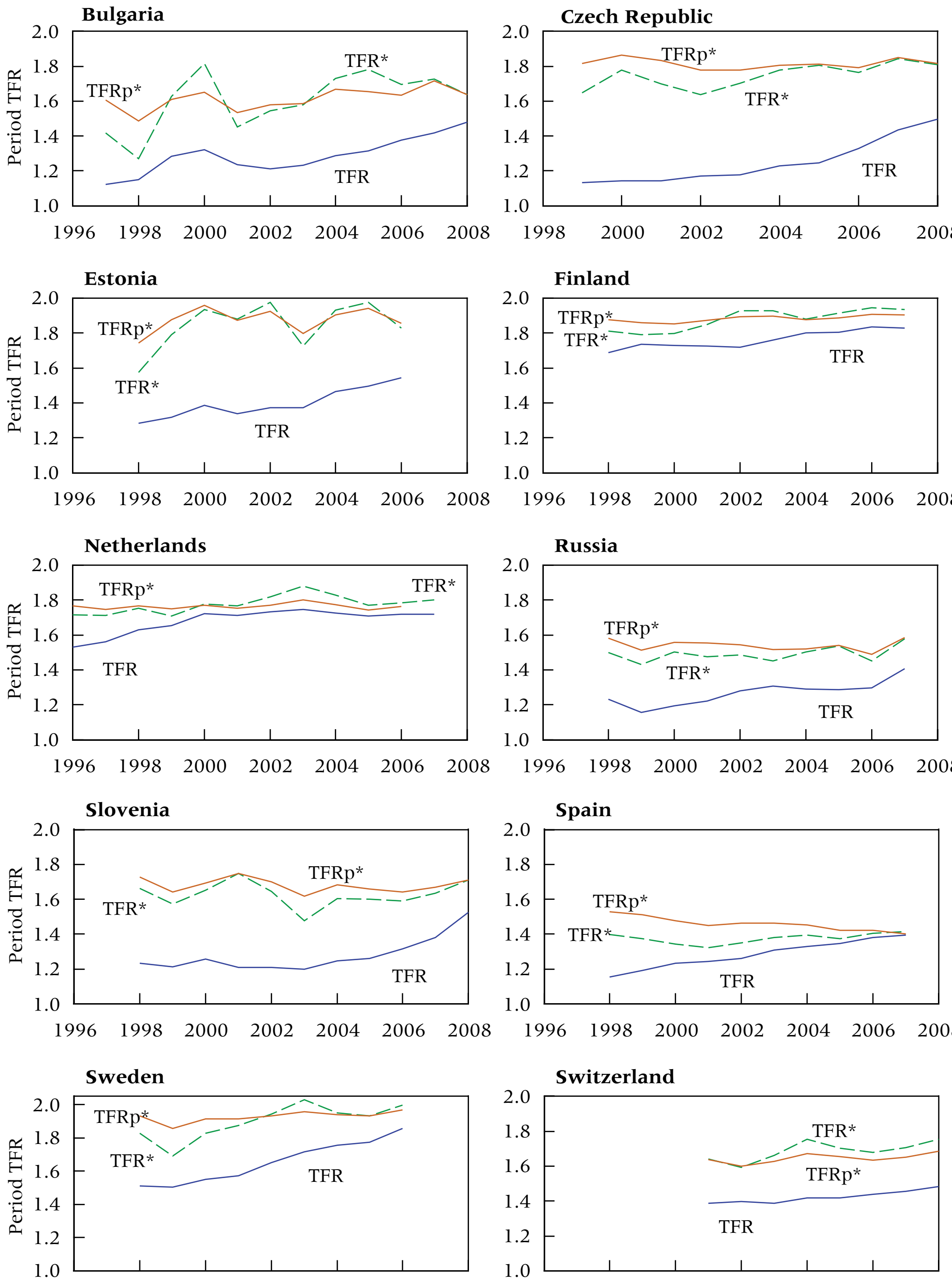
There are also theoretical grounds for preferring the TFRp*. In a classic fertility table framework, the interconnectedness of fertility tables of different birth orders is a disadvantage in periods with rapidly changing timing of childbearing because a tempo effect at one birth order may magnify a similar distortion at the subsequent birth orders. This appears to be a key factor in the relatively poor performance of the PATFR* for higher birth orders.[9] The TFRp* and TFR* avoid this problem by treating each birth as a separate event, disconnected from the previous and subsequent births.

## Contribution of declining distortions to the recent rise in TFR

One of the main purposes of the adjusted indicators is to examine whether the observed changes in conventional TFR could be attributed to a genuine change in fertility *quantum* or whether they are mostly due to changing *tempo* or *parity composition effects*. The recent increase in the period TFR across most developed countries provides a suitable opportunity for such analysis (see Goldstein, Sobotka, and Jasilioniene 2009). The widely used tempo-adjusted TFR* is subject to year-to-year instability, which necessitates smoothing the annual data and thus losing the most recent year(s) of observation. As Figure 10 showed, the new tempo- and parity-adjusted total fertility, TFRp*, displays more stable values and is therefore more suitable for examining the role of trends in distortions during the recent phase of increasing period TFR. To produce a more accurate picture not affected by peculiar trends in the four countries analyzed in this article, we use data for an expanded set of ten European countries, including in addition Bulgaria, Estonia, Finland, Russia, Slovenia, and Switzerland. In Switzerland, only a minor increase in the TFR took place during the period through 2008; this trend, also typical for two neighboring Central European countries, Austria, and Germany, illustrates the heterogeneity in the recent TFR upturns across the continent.

Figure 12 presents trends in the TFR, TFR*, and TFRp* since the year of the fertility trough in the late 1990s or the early 2000s. Two findings are notable. First, the distortions (as measured by the gap between the adjusted TFRp* and unadjusted TFR) decline over time in all countries (only a small

**FIGURE 12 Period TFR during the phase of its recent increase as compared with three tempo-adjusted indicators in ten European countries**




SOURCE: Computations based on HFD (2010) and Eurostat (2003 and 2010) for Spain.

decline in distortions is observed in Switzerland). In Spain, the negative distortions first diminish and then entirely disappear. Second, the TFRp* shows no significant trend in most countries, indicating a roughly constant fertility quantum. Small deviations from this pattern are observed in two countries: a gradual decline in the TFRp* in Spain and a slight increase in Switzerland. As noted earlier, the TFRp* gives smoother trends over time than the simpler adjusted TFR* and is relatively little interrupted by year-to-year fluctuations typical of the latter indicator. Also the distortions derived from the TFRp* are larger than the tempo effect derived from the adjusted TFR* during the period when the conventional TFR reaches a trough. This suggests that the negative tempo and parity composition effects in many low-fertility countries in the late 1990s were actually higher than previously estimated.

Table 3 indicates the percentage of the TFR increase that is attributable to the diminishing distortions since the lowest TFR in the 1990s or the early 2000s in nine countries with an observed TFR rise exceeding 0.1. In these countries the TFR rose by 0.14 in Finland up to 0.37 in the Czech Republic in the period through 2008 (or the most recent observed). Our preferred indicator, the TFRp*, shows a paramount role of diminishing tempo and parity composition effects in explaining the recent TFR upturns. The proportion of the recent TFR increase attributable to the reduction in these distortions ranges from 57 percent in Estonia to 100 percent in the Czech Republic and Spain; the average across the nine countries analyzed was 81 percent. Ex-

**TABLE 3 Percent TFR increase attributable to diminishing tempo and parity composition effects since the year the lowest TFR was reached**

| | | | Percent TFR increase due to diminishing distortions | |
|---|---|---|---|---|
| **Country** | **Period** | **Absolute TFR increase** | **TFR*** | **TFRp*** |
| Bulgaria | 1997–2008 | 0.36 | 38 | 90 |
| Czech Republic | 1999–2008 | 0.37 | 56 | 100 |
| Estonia | 1998–2006 | 0.26 | 3 | 57 |
| Finland | 1998–2007 | 0.14 | 13 | 82 |
| Netherlands | 1996–2003 | 0.22 | 24 | 85 |
| Russia | 1999–2007 | 0.25 | 41 | 71 |
| Slovenia | 2003–2008 | 0.32 | 28 | 71 |
| Spain | 1998–2007 | 0.24 | 93 | 100 |
| Sweden | 1999–2006 | 0.35 | 14 | 69 |

NOTES: The computations based on the adjusted TFR* estimate only the influence of a tempo effect, while the computations based on the adjusted TFRp* estimate the influence of both tempo and parity composition effects. Switzerland, with only a minuscule TFR increase of 0.1, was excluded because the small magnitude of observed TFR change can make the estimation of the tempo and quantum components of fertility change unstable.
SOURCES: Computations based on HFD (2010) and Eurostat (2003 and 2010) for Spain.

cept for Spain, these estimates are substantially larger than those obtained by Goldstein, Sobotka, and Jasilioniene (2009) using the tempo effect based on the adjusted TFR*. In three countries—Estonia, Finland, and Sweden—the traditional adjusted TFR* indicated a negligible role of a declining tempo effect in the observed TFR increases since the late 1990s, ranging between 3 percent and 14 percent; the average across the nine countries was 34 percent. Despite considerable declines in the distortions of the TFR in the years up to 2008, in several analyzed countries tempo and parity distortions remained substantial in 2008. The reason is that the postponement transition is not yet complete. These countries, and a number of other countries not analyzed here, including Austria and Germany, may therefore see future declines in tempo effects and increases in the TFR until the postponement transition ends.

## Conclusions and discussion

Our analysis pertained to a unique period of a Europe-wide increase in period total fertility rates, which occurred on such a scale for the first time since the baby boom period of the mid-1960s. We began our analysis of the recent rise in European TFR by reviewing the ongoing debate about the relative roles of period and cohort effects. We compared observed trends in age-specific fertility rates in four countries (Czech Republic, Netherlands, Spain, and Sweden) with hypothetical trends from simulations of pure period and cohort "worlds." This comparison demonstrated that the changes in the observed age pattern of fertility are broadly consistent with the changes expected from the simulated postponement transition in a period world. Significant period effects were present in all four countries. In addition, cohort effects were present especially in the Czech Republic and perhaps Spain (where high immigrant fertility has yielded unusual age patterns of fertility that are difficult to interpret).

These findings can be reconciled with previous studies by noting that:

—The "period paramount" perspective can be perfectly consistent with the description of fertility change in the cohort "postponement–recuperation" perspective. A period-driven rise in the mean age at childbearing can produce changes in cohort fertility that can be described in terms of postponement and recuperation.

—Whether fertility is described from a period or cohort perspective is a separate question from whether period or cohort effects are the main driving force of fertility change. Independently of the driving force, both approaches provide a valid perspective for describing fertility change.

—Neither a period shift nor cohort postponement and recuperation is sufficient to explain a rise in period fertility. Shifts and postponements can occur for decades in countries with a constant total fertility rate and a rising period mean age at childbearing.

We then examined the hypothesis that the rise in period total fertility in Europe is caused by the end of the postponement transition. During the peak of this transition in the 1990s, substantial tempo distortions were present in most countries. However, as the postponement transition nears its end and annual increases in the mean age at birth decline, these tempo distortions are becoming smaller, thus leading to a rise in the TFR. To assess the importance of diminishing tempo effects for explaining the recent rise in period total fertility rates across Europe, we made extensive use of a new indicator of period fertility, termed the *tempo- and parity-adjusted total fertility rate* (TFRp*). This indicator, which was proposed by Bongaarts and Feeney (2004, 2006) and developed independently in a similar form by Yamaguchi and Beppu (2004), is based on a fertility table computation using hazard rates with births of different birth order treated as separate (disconnected) events.

Our analysis rests on an assumption that the tempo effect is in most situations a distortion which obscures the measurement of period fertility levels and trends and leads to their incorrect interpretation and therefore should be eliminated where possible. We are also convinced that the *tempo* and *quantum* components of period fertility can be reasonably well disaggregated. To that end, our study gives a positive assessment of the new TFRp* indicator. Why should one choose this indicator over the growing and at times bewildering set of adjusted and nonadjusted period fertility rates? First, because, unlike the Bongaarts–Feeney adjusted TFR*, it controls for the parity composition of the female population of reproductive age. Second, partly related to that, for its empirical performance, especially its relative stability from year to year. Third, because of its remarkably close approximation to the completed cohort fertility among women of prime childbearing age in a given period. This proximity is also apparent in order-specific analysis, especially at higher-order births, where other period indicators often fail to get significantly closer to completed fertility.[10] Finally, there are theoretical reasons why fertility table measures, such as the PATFR* index, perform poorly at higher birth orders when the timing of childbearing changes. This problem is avoided with the new indicator. The use of the TFRp* still needs to be more extensively tested with data for more countries and different situations with regard to changes in fertility timing. Our analysis has focused on one region over a relatively short time when the period TFR changed in many countries while completed fertility rates were relatively stable or changed gradually. Also, the theoretical underpinning of this and other fertility indicators must be studied more thoroughly. Nevertheless, the TFRp* is our preferred tempo- and parity-adjusted fertility measure, and we recommend it in place of the conventional TFR and other adjusted measures. The large tempo and parity composition distortions evident in many countries imply that unadjusted TFR trends are often misleading and that adjusted measures are needed to assess true trends in the quantum of fertility. When data availability allows, these measures should become standard indicators supplementing the traditional TFR in official statistical publications.

The computation of the TFRp* is more data-demanding than the computation of the TFR or its adjusted version, but the recent expansion of the Human Fertility Database makes it far easier to obtain the data needed to compute this or other more sophisticated fertility indicators for many developed countries with high-quality vital statistics. When parity-specific data are unavailable and the TFRp* cannot be computed, the traditional adjusted TFR* remains an acceptable alternative for estimating period fertility quantum. It should, however, be computed as a smoothed average for several years (as it is done in the *European Demographic Datasheet* (VID 2010)) rather than for individual years, which may produce high year-to-year fluctuations. It may also underestimate fertility levels around the time when tempo effects reach their maximum.

Our main conclusion, based on an analysis of trends in TFRp*, is that distortions played a considerably more prominent role in the recent increase in the conventional TFR than previously estimated with other tempo-adjusted fertility indicators. In other words, the TFRp* provides a straightforward demographic explanation of recent fertility trends: in most European countries there was little or no increase in the level (quantum) of fertility between the late 1990s and 2008, while most of the observed TFR rise (and the entire TFR rise in the Czech Republic and Spain) can be attributed to a diminishing pace of the postponement of childbearing.[11] Highlighting the key role of tempo and parity distortions in driving period fertility changes in Europe in the last two decades does not mean that socioeconomic and policy factors are irrelevant for explaining the TFR upturns. Rather than explaining the *quantum* change in period fertility, they might have had an effect on the trends in fertility *timing* (see Örsal and Goldstein 2010).

Our finding that the quantum of fertility has changed little in the past decade is consistent with trends in cohort fertility. Cohort fertility has declined slowly but steadily among women born in the 1940s–1960s, but this decline appears to have ended in most countries and completed fertility is expected to broadly stabilize in the 1970s cohorts (Prioux, Mazuy, and Barbieri 2010; Sobotka, Zeman, Lesthaeghe, and Frejka 2011; Myrskylä, Goldstein, and Cheng 2011; Frejka 2010). As we have shown, the completed fertility of cohorts born in the late 1960s corresponds very closely to the quantum estimates provided by the TFRp*.

In a majority of European countries the recent economic recession has temporarily reversed the trend of increasing period total fertility or has halted its previous increase (Sobotka, Skirbekk, and Philipov 2011). Beyond this presumably short-term disturbance, two of our findings shed light on likely future fertility trends and are therefore useful for the formulation of projections. First, the quantum of fertility has been roughly constant in the last two decades; therefore it seems reasonable to assume that it will remain close to recent levels for some time in the future (except for the distorting influences of economic recession). Second, the tempo effect has declined in the past decade, and we believe it is likely to continue to do so once the recession and its aftershocks come to an end. Eventually, the tempo effect and the related parity composition distortions will disappear as the postponement transition concludes. The average tempo effect in the EU was 0.12 births per woman as measured by TFR* around 2006 (VID 2010). As we have demonstrated, this estimate may have some downward bias, so the actual tempo effect was probably slightly larger. For the EU the recent (2008) TFR stood at 1.60, while the adjusted TFR* equaled 1.72 around 2006. The actual period quantum is probably close to the cohort fertility estimate of 1.74 for women born in 1968 (VID 2010), hinting at a possible future stabilization of completed fertility. In the absence of quantum effects, we expect period TFR to rise at a slow pace to this level once the recession-induced economic uncertainty diminishes.

## Appendix 1: Fertility indicators used in this study

The unadjusted and adjusted period fertility indicators used in this study are estimated from three distinct unadjusted age- and order-specific birth rates defined as follows:

*f(a,t,i)*: age-specific fertility rates of the second kind (i.e., incidence rates) in year *t*, at age *a*, and order *i*. Denominators of these rates equal all women aged *a* at time *t*, regardless of their parity;

*h(a,t,i)*: conditional fertility rates of the first kind (i.e., hazards) with births of each order treated as repeatable events. Denominators of the exposure-specific rates for order *i* and age *a* are equal to women of parity *i* – 1;

*p(a,t,i)*: conditional fertility rates of the first kind with births of each order treated as separate non-repeatable events. Denominators of the hazard for order *i* equal all women who have not yet reached order *i*.

Indicators are estimated as follows:

—*TFR(t)*, the conventional period total fertility rate, is calculated from rates of the second kind

$$TFR(t) = \sum_i TFR(t,i) = \sum_i \sum_a f(a,t,i) \tag{1}$$

—*TFRp(t)*, the total fertility rate derived from rates of the first kind (births non-repeatable; Bongaarts and Feeney (2004 and 2006); Yamaguchi and Beppu 2004)

$$TFRp(t) = \sum_i TFRp(t,i) = \sum_i \{1 - \exp[-\sum_a p(a,t,i]\} \tag{2}$$

—*PATFR(t)*, the total fertility rate derived from rates of the first kind *h(a,t,i)* with births treated as repeatable events; see Rallu and Toulemon (2004) for details. *PATFR(t)* can be computed from increment–decrement fertility tables, where the computation of the indicator for any parity above 1 depends partly on the output (i.e., table births) from the lower-parity tables. This interconnectedness across parities may be the main source of greatly magnified tempo distortions at higher birth orders, resulting in very low levels of PATFR, below the ordinary TFR. For birth order one, the *PATFR(t)* equals the *TFRp(t),* but at higher orders they differ because the computation of the *TFRp(t)* resembles traditional survival curves: all women are assumed to be exposed to having a birth of any parity at the beginning of their reproductive age, and the computation of births and survivorship is provided for each parity independent of the other parities.

—*TFR*(t),* the tempo-adjusted version of *TFR(t)* (Bongaarts and Feeney 1998, 2006)

$$TFR^*(t) = \sum_i TFR^*(t,i) = \sum_i \sum_a \frac{f(a,t,i)}{1-r(t,i)} = \sum_i \frac{TFR(t,i)}{1-r(t,i)} \tag{3}$$

with

$$r(t,i) = (MAB(t+1,i) - MAB(t-1,i))/2 \tag{4}$$

where $MAB(t,i)$ is the mean age at birth, given by

$$MAB(t,i) = \sum_a (a+0.5) f(a,t,i) TFR(t,i) \tag{5}$$

—*TFRp*(t),* the tempo-adjusted version of *TFRp(t)* (Bongaarts and Feeney 2004, 2006)

$$TFRp^*(t) = \sum_i TFRp^*(t,i) = \sum_i \{1 - \exp[-\sum_a \frac{p(a,t,i)}{1-r(t,i)}]\} \tag{6}$$

Yamaguchi and Beppu (2004) proposed a very similar approach. Their equation for estimating the tempo-adjusted period fertility is

$$adjTFR(t) = \sum_i adjTFR(t,i) = \sum_i \{1 - (1 - TFRp(t,i))^{\frac{1}{1-r(t,i)}}\} \tag{7}$$

Substitution of (2) in (7) and simplifying shows that *adjTFR= TFRp*.*

We note that while the *TFRp(t)* is free from the effects of the changing parity distribution among women, this is not entirely the case for adjusted *TFRp*(t),* because the tempo adjustment factor $1-r(t,i)$ is derived from rates of the second kind. There is no good alternative at the moment (future research might find one). At present the literature contains two general approaches for making period tempo adjustments: one, represented by Bongaarts and Feeney's (1998) TFR*, is derived from rates of the second kind and is less data demanding. The second approach, represented by Kohler and Ortega's (2002) PATFR*, is based on rates of the first kind. The latter is problematic because the mean age of the schedule of rates of the first kind can in theory be infinite for fertility and is in fact infinite in standard mortality life tables.

In theory there is a third approach: computing the mean age on the basis of the order-specific distribution of births in the fertility table based on conditional rates *p*. This method is also flawed because conditional rates *p* are distorted by tempo effects, as are quantum and tempo measures derived from them (Bongaarts and Feeney 2006).

—*PATFR*(t),* the tempo-adjusted version of *PATFR(t)* calculated from occurrence-exposure rates *h(a,t,i).* For details see Kohler and Ortega (2002). In this approach the tempo adjustment is based on the rate of change in the mean age of the schedule of hazard rates (instead of the Bongaarts–Feeney approach based on the mean age of the schedule of rates of the second kind). We employ a simplified version of this adjustment without iterative corrections to the observed mean age and the inferred tempo of fertility (corrected for distortions caused by the variance effects).

We examined a fourth tempo-adjusted indictor in which the Bongaarts–Feeney tempo adjustment is applied to remove the tempo effect from hazard rates *h(a,t,i)* and thus constitutes a simplification over a complex computation of the *PATFR**. The ability of this indicator to match cohort fertility is approximately the same as for the *TFR**.

This summary has presented the derivation of aggregate period fertility indicators. It is possible to calculate all the unadjusted measures for cohorts, using cohort fertility rates by age and birth order. The three measures discussed here give identical results and equal the cohort completed fertility. Tempo adjustment is of course not needed for cohorts.

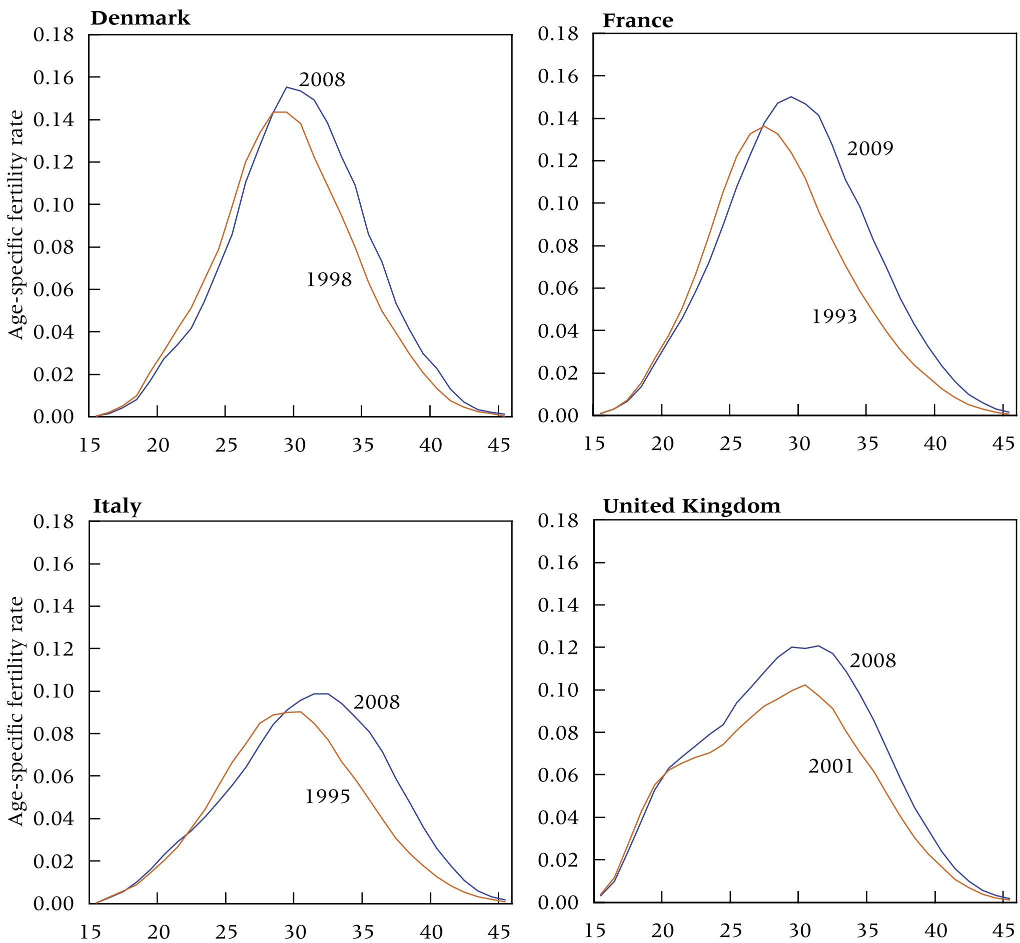
## Appendix 2: Age patterns of fertility in Denmark, France, Italy, and the United Kingdom

The comparison of simulated period and cohort fertility schedules with empirical ones has been limited to countries for which fertility rates are available by birth order. This implies that some of the largest countries in Europe, including France, Italy, and the United Kingdom, had to be excluded from our earlier analysis, because order-specific information is lacking for them (we do not discuss the case of Germany, where no perceptible increase in the period TFR took place in the analyzed period and where fertility trends have been partly affected by the dynamic developments in the former East Germany).

There are, however, conditions under which an examination of the changing shape of the overall fertility schedule is instructive. Specifically, if the fertility quantum at each birth order is constant over time and if changes in the tempo effect are the same for all birth orders, then the characteristic changes in the age patterns of fertility will hold for the overall fertility schedule and not just for each birth order separately. We believe that these conditions are approximately valid in many countries in Europe since the late 1990s (see discussion in the last section of the main text).

Appendix Figure 1 plots recent trends in age-specific fertility rates for Denmark, France, Italy, and the United Kingdom. In all four countries the TFR rose since reaching its lowest point between 1993 (France) and 2001 (UK). As of 2008, the absolute TFR increase amounted to 0.17 in Denmark, 0.33 in France, 0.22 in Italy, and 0.33 in the UK; the figures cover the years between the most recent minimum and maximum. Each of these countries shows an increase and a shift in the mode, which are the key characteristics of a period-driven pattern of change (termed "period world" in Figure 7). The standard deviation of the fertility schedules shows little change. These results therefore suggest a dominance of period effects in recent fertility upturns in these four countries. This conclusion must be tentative because the assumptions made about the quantum and tempo changes may not hold exactly, and order-specific patterns of change may differ to some extent.

**APPENDIX FIGURE 1 Changes in age-specific fertility between the year of reaching a minimum TFR in the 1990s and the recent (2008 or 2009) maximum, Denmark, France, Italy, and United Kingdom**



## Notes

Previous drafts of this article were presented in September 2010 at the European Population Conference in Vienna; in April 2011 at the Annual Meeting of the Population Association of America in Washington, DC; and in November 2011 at the first Human Fertility Database symposium organized by the Max Planck Institute for Demographic Research in Rostock, Germany. We thank Hans-Peter Kohler, Tomas Frejka, and conference participants for their comments and suggestions. An earlier and more detailed version of this article with additional tables and figures is available (Bongaarts and Sobotka 2011).

1 Age-specific birth rates by birth order can be of the first or second kind. In both cases the numerator of the rate consists of the number of births of a given order. For rates of the second kind the denominator consists of women of all orders while for rates of the first kind the denominator consists only of women at risk of giving birth of a given order.

2 The surface is described as $f(a,t) = (1 - r(t))\ f(a - (MAB(t) - MAB(1965)))$, where $MAB(t)$ is the mean age at birth and $r(t) = dMAB(t)\ /\ dt$.

3 It is possible, however, that some cohort-driven change in fertility does not significantly violate the assumptions contained in this and other tempo-adjusted period indicators of fertility.

4 Because our analysis does not cover the whole period of the "postponement transition," which started in some countries in the early 1970s, our conclusion about the prominence of period- or cohort-driven changes pertains only to the recent rise in the period TFR.

5 A specific indicator of period fertility quantum derived from the completed cohort fertility of all the cohorts giving births in a given period—average completed fertility (ACF)—was developed by Butz and Ward (1979) and later analyzed by Schoen (2004). This can be seen as a "cohort world" counterpart to the period tempo-adjustment indicators that are based on the "period world" assumptions discussed above. Its clear shortcoming is the need to wait until all cohorts giving birth in a period of interest complete their reproductive histories (or the need to estimate their completed fertility before that point). This requirement, together with an impractical need to collect long series of fertility data covering the entire reproductive span of many cohorts, renders this indicator useless for analyzing the recent upturns in the period TFR that are the focus of our article. For example, if we were to compute average completed fertility for the latest year of our analysis, 2008, we would need to know for each country the completed fertility rate of each of the 30 cohorts across the range of fertile years in that year, that is, the cohorts born in 1964–1993 (neglecting cohorts with fertility close to zero and assuming a restrictive definition of fertile years of ages 15–44). Assuming this rather narrow definition of reproductive range, the completed fertility of the youngest cohort involved, 1993, will be known only after 2037 (i.e., 1993 + 44)—a quarter of a century from now—or will have to be estimated before then.

6 In estimating these probabilities, only women at parity $i - 1$ are at risk of having a birth of order $i$ (i.e., births are assumed to be repeatable events: giving an $i$-th birth exposes one to having an $i$+1th birth, and so on).

7 In the TFRp method age-specific birth hazard rates are estimated assuming that all women who have not reached parity $i$—and not only women with $i - 1$ births as in the case of the PATFR computation—are exposed to the risk of having an $i$-th birth. Births are assumed to be separate non-repeatable events. For instance, the computation of the TFRp for second births is independent of that for first births, while in the PATFR framework the computation of the PATFR for second births is based on both first- and second-birth parity-specific fertility rates by age.

8 The TFR* is considerably more variable than TFRp*. This instability is most visible in the case of birth-order-specific data, where TFR* may show large year-to-year changes and implausible values, as in the case of the first-order TFR* above 1 (Bongaarts and Sobotka 2011). These fluctuations are in part

due to fact that TFR* is sensitive to errors or slight changes in the registration of birth order in the official vital statistics and to violations of its underlying assumptions.

9 Another problem is the instability of age- and parity-specific birth probabilities at younger ages in conventional fertility tables.

10 The close correspondence between the period TFRp* and completed cohort fertility raises the question of the potential usefulness of TFRp* for cohort fertility projections or for fertility forecasting in general. Under certain conditions, especially when completed fertility is relatively stable or changing gradually, the TFRp* might be used to estimate its level for the cohorts in prime childbearing ages. But this estimate should recognize the period nature of this indicator, should rest on time series of several years rather than on single-year data, and should be supplemented with the proper cohort-based analysis where possible. The TFRp* is likely more useful than other adjusted indicators for forecasting future trends in the period TFR, assuming the tempo and parity composition distortions will eventually end. Even in this case, however, analysts must abandon the simplistic expectation that the quantum of fertility, as measured by TFRp*, will remain stable, and they should formulate alternative scenarios where fertility quantum changes over time (see Bongaarts 2002 for a discussion of this issue, based on the adjusted TFR*).

11 The changing pace of postponement also caused changes in the parity distribution among women, which have contributed to the TFR distortions.

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