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Research Article

Tempo-Quantum and Period-Cohort Interplay in Fertility Changes in Europe. Evidence from the Czech Republic, Italy, the Netherlands and Sweden

Tomáš Sobotka

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Tempo-Quantum and Period-Cohort Interplay in Fertility Changes in Europe. Evidence from the Czech Republic, Italy, the Netherlands and Sweden

Tomáš Sobotka[1]

Abstract

Using detailed data on period and cohort fertility in four European countries, this paper discusses various indicators of period fertility, including indicators adjusted for changes in fertility timing. Empirical analysis focuses on the comparison of cohort fertility and corresponding indicators of period fertility; particular attention is paid to the periods of intensive postponement of childbearing. Some period indicators come consistently closer to the completed cohort fertility than the total fertility rates. This pattern of differential period-cohort approximation widely varies by birth order. Quite a high level of approximation is provided by the tempo-adjusted birth probabilities of parity 1 and a combined indicator of total fertility. Two examples illustrate the use of indicators discussed in the paper: the first provides an estimation of the *tempo* (timing) and *quantum* (level) components in fertility change in the Czech Republic and the second presents projections of cohort fertility in the Czech Republic and Italy.

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1. Introduction

Commonly used indicators of period fertility, such as the total fertility rate and age-specific fertility rates, are sensitive to changes in the timing of childbearing among women. During the phases of the timing shifts in fertility schedule – be it either postponement or advancement of births – period fertility measures reflect an interplay of both *quantum* (level) and *tempo* (timing) components. Postponement of childbearing has become one of the most characteristic features of fertility trends in Europe at the end of the 20th century. As a result, it has 'deflated' the most usual indicator of period fertility, the total fertility rate (*TFR*), which declined in many countries to extremely low levels. For instance the *TFR* for birth order 1 has declined below the level of 0.6 in Spain (1995-98), the Czech Republic (1995-2000), Hungary (1997-2000) and Latvia (1997-99). These values do not indicate an unprecedented increase in childlessness, but rather a distinct deferment of births, which has been most intensive in these countries. They also illustrate that due to the postponement of births the *TFR* has lost its descriptive power as an indicator of period fertility quantum.

Widespread use of the total fertility rates often leads to the misinterpretation of fertility trends, resulting in catastrophic assessments concerning the current level of period fertility as well as the future cohort fertility and their implications for population structure[1]. What are possible solutions to this problem? A radical solution would be to abandon the use of indicators based on the *synthetic cohort*[2] concept. A less radical solution implies a construction of indicators that provide an adjustment for the distortions present in commonly used fertility measures. In spite of occasional attempts to use alternative indicators, extensive discussion did not start until 1998, when Bongaarts and Feeney proposed a simple adjustment of the total fertility rate, which removes the tempo changes.

This paper investigates whether the use of alternative indicators of period fertility can improve our interpretation of period fertility trends and the projections of future period and cohort fertility. The main question of the paper may be formulated in the following way: Do more elaborate measures of period fertility, by removing some distortions present in the *TFR*, provide a better approximation of the completed cohort fertility of women who are currently in their childbearing age? This investigation is directly related to the ambiguous questions about the meaning of the period fertility indicators: Do they adequately represent the period trends? Is it possible to make some inferences or projections of the future cohort fertility based on current period fertility measures? Does the use of adjusted fertility indicators improve our understanding of fertility change?

The goals of the paper are formulated as follows:

1. To discuss specific issues connected with the use of the *synthetic cohort* fertility indicators.
2. To analyse trends in period fertility with the use of indicators that are free of some distortions present in the *TFR*. This analysis is focused primarily on the influences of the *tempo effects*, in particular the postponement of childbearing.
3. To compare period fertility indicators with the data on completed cohort fertility and discuss specific advantages and disadvantages of this approach.
4. To illustrate potential benefits of the use of adjusted period fertility measures.

The analysis is based on period and cohort fertility data for four European countries with different fertility developments: the Czech Republic, Italy, the Netherlands and Sweden. The comparison of period and cohort fertility indicators is performed separately for birth orders 1, 2, and 3+ and for the total fertility.

The paper is divided into ten sections. The Introduction is followed by a theoretical discussion on the period fertility indicators (Section 2). Section 3 provides a description of methods and indicators used, while Section 4 gives an overview of the data. A brief account of recent trends in period and cohort fertility in the four analysed countries is presented in Section 5. Section 6 is focused on the comparison of period and cohort fertility indicators, and further criteria on the use of various period indicators are proposed in Section 7. Section 8 discusses the tempo-quantum and period-cohort interaction, focusing on birth probabilities. Section 9 illustrates some new insights obtained from the use of the adjusted period fertility indicators. The section which follows concludes the paper.

2. Period fertility indicators: Theoretical considerations

2.1. Indicators of period fertility

Fertility rates are computed in different ways. Generally, we may distinguish four basic approaches to measure the level of period fertility. The first is a simple indicator of birth rate, the second and the third are based on the data on births by age and birth order, while the fourth gives prominence to the information on duration (since previous birth or since marriage). All these indicators may be, with varying degrees of accuracy, derived both from the vital statistics and surveys (for analysis of survey data see Wunsch, 1999). However, national statistical offices usually do not collect data needed for the construction of the more complex fertility measures.

(1) The first and the simplest indicator, the *crude birth rate*, relates the total number of births in a given year to the total population size. Alternatively, the total number of births may be related only to the number of women of reproductive age (usually given as age 15 to 49). This indicator is called the *general fertility rate*.

(2) The second approach is based on the *age-specific fertility rates* (*reduced rates*, also called *frequencies*, *incidence rates*, and *rates of the second kind*[3]), which relate number of births women have in a given age group to all women in that age group. The sum of the age-specific fertility rates (*ASFR*) in a particular year is the *total fertility rate*. This is a hypothetical indicator, usually interpreted as the average number of children a woman would have if the age-specific fertility rates of a given year remained constant over her reproductive life. The corresponding cohort fertility indicator, summarising the fertility of a cohort born in the same year, is the completed (cohort) fertility rate (*CFR*). The *TFR* has several advantages, which account for the widespread use of this indicator. Unlike the crude birth rate, the *TFR* is not affected by changes in the composition of the female population by age. It can be easily calculated from the data commonly available in all developed countries and as an indicator of the 'number of children per one woman' it is intuitively understandable. However, the *ASFR* are subjected to distortions in fertility timing – postponement or advancement of births and changes in the shape of fertility schedule. When the data on births by birth order are available, the *ASFR* and the *TFR* are often computed for each birth order separately. The denominator for the computation of the age and order-specific reduced rates is the population of all women in a given age group. This means that order-specific TFR_i are additive indicators; the sum of the TFR_i for different birth orders i gives the *TFR*. However, this also implies that the order-specific $ASFR_i$ does not discriminate between women who were exposed to bearing a child of order *i* (that is, generally, women with *i-1* children) and other women. Thus, the order-specific TFR_i is frequently distorted by the parity[4] composition of population and its changes over time (Kohler, Billari and Ortega, 2002: 644-645).

(3) Age and parity-specific childbearing *probabilities* and *intensities* (also known as *occurrence-exposure rates*) constitute more accurate indicators of period fertility. They reflect the real exposure; probabilities of giving birth of birth order *i* are specified only for women having *i-1* children. The most common summary measures are the *parity-progression ratios* (PPR_i), which are interpreted as probabilities for women with *i-1* children to have another child during their reproductive life. A summary index, analogous to the *TFR*, has been coined as the *parity-adjusted TFR* (Park, 1976) or the

"*index controlling for parity and age*" (*PATFR*; Rallu and Toulemon, 1994: 65-67). Childbearing *probabilities* by parity may be used for a construction of multistate fertility tables, depicting fertility history of the synthetic cohort over its life course (e.g. tables constructed by Bolesławski (1993) for Poland and tables and indicators for Italy (Giorgi, 1993; De Simoni, 1995)). Various indicators of fertility tables were discussed by Park (1976), Willekens (1991) and Ortega and Kohler (2002); the construction of general increment-decrement life tables is described in Schoen (1975). The use of the *PATFR* concept is limited by the inadequate availability of data on the distribution of women by parity and age. Although the *PATFR* eliminates the bias of relating births specified by birth order to all women of a given age, which is present in the order-specific *TFR* and *ASFR*, it is still subjected to distortions caused by changes in the timing of childbearing among women.

(4) Apart from age and parity, time elapsed since the previous birth or since marriage (*duration*) is another important variable influencing number of births of a particular birth order. Several researchers (e.g. Ní Bhrolcháin, 1992: 614; Hobcraft, 1993: 450) have suggested that duration since the previous birth should also be included in period fertility indicators. Feeney (1983: 76) has proposed that the "parity progression schedules which incorporate parity progression rates and birth-interval distributions are arguably the most natural approach to the measurement of fertility". There are examples of complex period fertility indicators using information on age, parity and time since the preceding birth (e.g. Rallu and Toulemon, 1994; Barkalov and Dorbritz, 1996). These data are available only for a few countries and short time periods. Less complex indicators are based only on parity and time since the preceding birth, with the exposure to the first birth analysed since the time of marriage (e.g. Feeney and Yu, 1987; Ní Bhrolcháin, 1987; Brass, 1991).

More detailed overview of various fertility indicators is provided in Rallu and Toulemon (1994), and Ortega and Kohler (2002). The discussion and analysis in this paper focuses on fertility indicators based on reduced rates and birth probabilities. Owing to a lack of data, the indicators based on duration were not included in the analysis[5].

2.2. Attempts to adjust period fertility for tempo distortions

Distortions in the period fertility indicators have stimulated proposals for alternative measures. Since the total fertility rate has become by far the most common indicator of period fertility, specific attempts have been made to adjust the *TFR* for the *tempo* distortions. Brass (1991) calculated estimates of the tempo-adjusted *TFR* for England

and Wales using data on marital fertility by parity and interval since previous birth. Murphy (1994: 53-54) proposed adjustment of the *TFR* based on changes in the mean age of childbearing (more accurately called the *mean age of fertility schedule*). This method was an approximation of Ryder's (1964) "translation formula" between period and cohort fertility. In 1998, Bongaarts and Feeney (hereafter referred to as BF) proposed a similar adjustment based on the order-specific total fertility rates and annual changes in the order-specific mean age at childbearing.

The BF adjustment has generated wider attention to the *tempo* component in fertility rates and to the fertility adjustment indicators in general. Several researchers have applied the BF framework to estimate the *tempo effects* in period fertility in particular countries and regions and to assess the usefulness of the adjusted indicators (e.g. Philipov and Kohler, 2001; Lesthaeghe and Willems, 1999; Bongaarts, 1999 and 2002; Smallwood, 2002a). Nevertheless, controversy surrounded both the idea of adjustment and the meaning of adjusted indicators. Van Imhoff and Keilman (2000), Kim and Schoen (2000) and Kohler and Philipov (2001) pointed out the inadequacies of the BF adjustment, which may be briefly summarised as follows (see also Van Imhoff, 2001: 32 and Keilman, 2000: 10): (1) Period changes affect different cohorts in a different way. Therefore, the tempo changes in fertility may also change the shape of the fertility schedule. This possibility is not taken into account in the BF adjustment that assumes that the shape of the fertility schedule remains constant. (2) The BF adjusted *TFR* as well as the traditional *TFR* may be distorted by changes in the distribution of women by parity.

Some efforts have been made to further improve the adjustment indicators. Kohler and Philipov (2001, hereafter referred to as KP) proposed an extension of the adjusted *TFR* to allow for the variance effects, eliminating thus the first inadequacy (see also the application of this method for Spain in Ortega and Kohler, 2001). Addressing the second bias in the BF method, Kohler and Ortega (2002a, hereafter referred to as KO) have extended fertility adjustment to childbearing *intensities*. Similar to the non-adjusted indicators, adjusted *intensities* enable a computation of summary measures, which may be depicted in the form of fertility tables. Combining the *TFR*, KP *adjusted TFR*, *PATFR* and KO *adjusted PATFR*, it is possible to distinguish the influence of timing change ('*mean tempo effect*') and parity composition ('*parity composition effect*') on the total fertility rate (ibid., p. 20-21). Kohler and Ortega have applied their method to investigate the implications of delayed childbearing on cohort fertility in Sweden, the Netherlands and Spain (Kohler and Ortega, 2002b).

2.3. The meaning of adjusted fertility indicators

Do adjusted measures really provide useful information about period fertility? The fact that the *synthetic cohort* indicators are subjected to timing distortions is widely recognised among demographers. Some of them proposed that their use should be avoided as they give rise to misleading results: "Synthetic cohort…implicitly strings together sequences of events that, in times of change, are not known to occur. Because of the synthetic cohort principle, the TFR misrepresents what occurs in a period." (Ní Bhrolcháin, 1992: 615). Many researchers remain sceptical towards the use of adjusted indicators, pointing out that these indicators are not able to represent the pure *quantum* of period fertility, owing to their unrealistic assumptions (e.g. Van Imhoff and Keilman, 2000).

The adjustment of period fertility raises two controversial questions. What is the interpretation of tempo-adjusted indicators? And do they enable an approximation of completed cohort fertility? Bongaarts and Feeney (2000) consider their adjusted *TFR* to be a variant of the conventional *TFR*, which removes tempo distortions caused by the changes in the timing of childbearing among women and represents the *quantum* component of the *TFR*. They see it as a "technical result that can advance understanding of the level and trend of past fertility, and provides a firmer basis for projecting trends in future fertility" (Bongaarts and Feeney, 1998: 286). Zeng Yi and Land (2001: 23) view it as a measure which provides an "improved reading of period fertility". Kohler and Philipov (2001: 13) regard it as "additional and very useful measure for analysing fertility patterns, especially when fertility is subject to strong and fluctuating tempo effects".

Although Bongaarts and Feeney propose that the adjusted *TFR* does not attempt to estimate completed fertility of any actual birth cohort (2000: 560), they also propose that it reveals "the level of completed fertility implied by current childbearing behaviour" (1998: 286). Moreover, they test the accuracy of their indicator by comparing completed cohort fertility with an average of the adjusted *TFR* over the period during which these cohorts were in their prime childbearing years (1998: 282-283). Applying a more complex framework, Kohler and Ortega (2002a) formulated two scenarios of cohort fertility, completing cohort fertility of women of reproductive age on the basis of their adjustment of period parity progression measures: (1) the *postponement stops scenario*, assuming that the delay of childbearing stops after the reference year and (2) the *postponement continues scenario* assuming that the tempo change observed in a reference year continues over the life course of the cohorts whose fertility is projected. Discussing these two scenarios and other adjusted measures, Van Imhoff (2001: 33-36) found the *postponement stops scenario* the most likely projection of cohort fertility.

2.4. Focus of the paper: The proximity of period and cohort fertility

Smallwood (2002a: 39) aptly addressed the ambiguous meaning of the adjusted indicators:

"One of the key points in the debate has been whether the resulting adjusted measure is trying to approximate cohort quantum (…). If the intention is to adjust the period data to produce underlying cohort fertility the various proposed methods of adjustment can be tested empirically. If the intention is not this (…) some thoughts should be given to what the Bongaarts and Feeney and other adjusted measures are actually giving."

In the latter case, there are no clear criteria, no benchmarks how to judge the performance of adjusted measures. Should they fluctuate or should they depict some stable pattern? Should they resemble the cohort fertility, or should they be fundamentally different? Ní Bhrolcháin (1992: 614) argued that period fertility measures should be judged by how well they represent period, not cohort, levels and trends. Yet the only general (and unsatisfactory) way to evaluate period indicators expressed in a *synthetic cohort* way is to compare them with the indicators related to real birth cohorts.

Such a comparison has been occasionally performed using visual inspection of period and cohort fertility indicators. Bongaarts (2002: 430) has found that in the case of birth order 1, change in the mean age at childbearing in many developed countries between 1980 and 1990 was very closely related to differences between the average period TFR over the 1980s and the cohort CFR of women born in 1960. Van Imhoff and Keilman (1999 and 2000) compared period and cohort fertility trends in Norway and in the Netherlands. They found large fluctuations in the Bongaarts and Feeney adjustment and inferred that in the case of the Netherlands it brought the adjusted *TFR* "somewhat closer" to the corresponding completed cohort fertility. Smallwood (2002a) concluded that in the case of England and Wales the shape of the BF-adjusted *TFR* was not closely related to the shape of cohort *CFR* and suggested that relatively little is gained from the more elaborate KP and KO adjustments.

Inspired by the discussion on the meaning of fertility adjustment methods, this paper aims to explore whether some period fertility indicators are systematically closer to cohort fertility indicators. The rationale behind this exploration may be formulated in the following way: given that the postponement of births tends to depress the total fertility rates well below the level that would be recorded otherwise, the adjustment of period fertility for *tempo effects*, which provides an estimate of the '*pure quantum*' of period fertility, is also likely to be closer to the ultimate cohort fertility distribution. Further adjustment for *variance effects* and the use of parity-specific measures reflecting real exposure is also likely to give results closer to the ultimate cohort fertility.

Is it useful to know which indicator of period fertility approximates better the completed fertility of birth cohorts having births in a given period? Should we not look at the cohort fertility trends directly, as Van Imhoff (2001) has suggested? The answer may depend on our knowledge of cohort fertility trends. In countries that have seen quite a long period of the postponement of childbearing, such as the Netherlands, we may prefer to analyse the incomplete cohort fertility directly and evaluate the patterns of the postponement and recuperation from the cumulative fertility experience of birth cohorts. Lesthaeghe (2001) proposed a framework for such an evaluation; similarly, Frejka and Calot (2001) analysed relative changes in age-specific cohort fertility rates in 27 low-fertility countries focusing on the extent to which fertility decline among the post-war birth cohorts at young ages was made up later in life. Nevertheless, in many cases we may not obtain much insight by analysing only the trends in cohort fertility. Consider countries in the early stage of the postponement of births, for instance the Czech Republic: the total fertility rate may decline to a level close to 1.0, while birth cohorts reaching the age of 50 still have on average about 2 children. The completed cohort fertility of women, who are currently aged 25, will therefore lie somewhere between 1.0 and 2.0 children. Such a wide range does not constitute a good starting point for a formulation of plausible cohort fertility scenarios.

Provided that some period indicators come consistently closer to the *CFR*, they may offer better insight to the following questions: At what level will the period fertility and consequently also the cohort fertility stabilise if the postponement of childbearing stops? To what extent may women, who are currently postponing births, ‘catch up’ in the future? What will the cohort fertility (childlessness, proportion with three and more children etc.) be among women who are currently in the ages of highest fertility?

2.5. Timing effects in period fertility: An illustration

The post-communist countries of Central and Eastern Europe constitute the last group of countries which experienced the onset of the ‘postponement transition’. Consequently, in combination with the reduction of fertility *quantum*, the *TFR* in these countries declined sharply to a level of 1.0 to 1.4 by the year 2000. An increasingly common phenomenon of the very low levels of the *TFR* has stimulated extensive research on the theories, patterns and explanations of very low fertility (see e.g. Golini, 1998; Lesthaeghe and Willems, 1999; Foster, 2000; UN, 2000; McDonald, 2002). Kohler, Billari and Ortega (2002) have used the term ‘lowest-low fertility’ (defined as the *TFR* below 1.30) to highlight a special situation within a widespread ‘low fertility’ pattern (usually defined as the so-called ‘below replacement fertility’, roughly put as the *TFR* below 2.10). The ‘lowest-low fertility’ is typically associated with a marked postponement of childbearing. Therefore, it is a temporary phenomenon which does not lead to the similarly (lowest-)low cohort fertility[6]. Table 1 provides an illustration of this situation. Suppose that a country experiences a transition from early to late childbearing. This transition takes 35 years, during which the mean age of fertility schedule (*MAB*) increases every year by 0.2 years of age.

Table 1: *An illustration of the postponement effects: Cumulative age-specific fertility rates by age groups, period and cohort fertility indicators in a country with stable TFR (1.35) and ongoing postponement of births*

	year								
age group	**t**	**t+5**	**t+10**	**t+15**	**t+20**	**t+25**	**t+30**	**t+35**	**index (t+35)/t**
15-19	**0.300**	**0.250**	***0.200***	0.150	0.100	0.070	0.040	0.020	*0.07*
20-24	0.650	**0.560**	**0.470**	***0.360***	0.275	0.210	0.150	0.110	*0.17*
25-29	0.240	0.310	**0.380**	**0.490**	***0.560***	0.550	0.540	0.480	*2.00*
30-34	0.100	0.160	0.220	**0.260**	**0.310**	***0.380***	0.440	0.500	*5.00*
35-39	0.050	0.060	0.070	0.080	**0.090**	**0.120**	***0.150***	0.200	*4.00*
40-44	0.010	0.010	0.010	0.010	0.015	**0.020**	**0.030**	***0.040***	*4.00*
TFR	1.350	1.350	1.350	1.350	1.350	1.350	1.350	1.350	
MAB	23.72	24.72	25.72	26.72	27.72	28.72	29.72	30.72	
Change in MAB		1.00	1.00	1.00	1.00	1.00	1.00	1.00	
						Cohort 1	**1.610**		
						Cohort 2		**1.670**	
						Cohort 3			***1.690***

Over the whole period, the *TFR* remains at a low level of 1.35. One might expect a decline in the cohort fertility towards the level of the period *TFR* over such a long period and, more generally, the convergence between the cohort and period *TFR*.

Nevertheless, the sustained low *TFR* persisting over two or three decades does not necessarily induce the decline in cohort fertility to similarly low levels, provided that the postponement of births does not come to an end. Continuous postponement shown in Table 1 even leads to a slight increase in cohort fertility, computed as a diagonal summary of the cumulative fertility rates. Among the three birth cohorts that realised their fertility over the period between the year t and t+35, the completed cohort fertility increased from 1.61 (cohort 1, aged 15-19 in the year t) to 1.69 (cohort 3, aged 15-19 in the year t+10). However such an example implying delay in childbearing among women by 7 years over the period of 35 years may seem unrealistic, various fertility schedules shown in the table correspond to the schedules experienced in European countries over the 1990s. Fertility schedule in the year t resembles the schedule in Bulgaria in 1994 (*TFR*=1.37, *MAB* =24.1 years), the schedule in the year t+10 comes close to the schedule in Romania in 1998 (*TFR*=1.32, *MAB*=25.4 years), the schedule in the year t+25 resembles the situation in Spain in 1990 (*TFR*=1.36, *MAB*=28.9 years) and the schedule in the year t+35 has a similar profile as the fertility schedule in the Netherlands in 1999 (though the *TFR* of 1.65 was considerably higher there; *MAB*=30.3). While the *tempo effects* are now commonly recognised as a source of temporal variations in the *TFR*, many researchers assume that such influences are relatively short-lived. This illustration has shown that the *TFR* may give misleading signals about the trends in cohort fertility over a long period of time.

3. Methods

3.1. Linking period and cohort fertility

The core of the analysis lies in the comparison of period and cohort fertility indicators. The period indicators in a particular year are compared with the values of completed cohort fertility of women who reached the mean age at childbearing[7] in that year. Similarly, figures depicting period and cohort fertility trends display cohort indicators shifted by the period mean age at childbearing to enable a straightforward comparison of the period and cohort values. In other words, period and cohort indicators are linked in the following way:

Let Y be year of birth of a generation of women whose completed cohort fertility of parity i is compared with the period fertility of birth order i in calendar year t. Then

$$Y = t - MAB_i \qquad (1)$$

where MAB_i is mean age of fertility schedule computed from age-specific fertility rates (*ASFR*) of birth order i in the year t. Y is then rounded down or up to the nearest whole number.

For this comparison, only cohorts of women who are estimated to have already realised at least 90% of their ultimate fertility are taken into account (see Table 2 for an overview of birth cohorts included in the analysis). Completed cohort fertility of women who have not reached age 50 was estimated assuming that they will realise the remaining part of their fertility according to the schedule of the *ASFR* for the last available year. Though the use of probabilities would be more appropriate, the estimate deals only with a small fraction of ultimate fertility (0 to 10%) realised at relatively high ages. The potential fertility 'catch-up' is likely to be small in the late ages of childbearing and therefore no specific assumptions have been made.

Differences between period and cohort indicators are compared separately for each birth order (see Section 6). The indicators were computed for all birth orders specified in the source data, with the last category including all the subsequent birth orders (see Table 2). Taking into account the very small share of high birth orders on total fertility, the indicators for birth order 3 and higher were combined for comparative analysis. The average values of annual absolute difference between the period *TFR* and the ultimate cohort fertility serve as a benchmark, establishing how closer other period fertility indicators approximate the *CFR*. Visual inspection of figures comparing the trends of various fertility indicators adds another dimension to the judgement of their 'performance' over time. Selected additional criteria, such as fluctuations in the period fertility measures, the occurrence of 'impossible' values, the performance in 'extreme situations' and the analysis of period-cohort fertility differences in the periods of rapid postponement are discussed in Section 7.

3.2. Indicators of period fertility used in the analysis

Following indicators of period fertility are compared in the analysis:

1. **Total fertility rates (TFR_i)** by birth order i, computed as a sum of reduced age and order-specific fertility rates ($ASFR_i$). The *TFR* is a sum of order-specific TFR_i :

$$TFR_t = \sum_i TFR_{i,t} = \sum_i \sum_a ASFR_{a,i,t} = \sum_i \sum_a \frac{B_{a,i,t}}{P^F_{a,t+0.5}} \qquad (2)$$

where *a* is age, *t* calendar year (*t+0.5* stands for the mid-year population), *B* number of live births, *P* population size and *F* denotes females.

2. The 'tempo-adjusted' order-specific total fertility rates ($adjTFR_i$) proposed by Bongaarts and Feeney are calculated as follows:

$$adjTFR_{i,t} = TFR_{i,t} / (1-r_{i,t}) \qquad (3)$$

where $r_{i,t}$ is the change in the mean age at childbearing of birth order *i* between the beginning and the end of the year *t*. Bongaarts and Feeney (2000: 563, fn. 1) recommend that $r_{i,t}$ be estimated as

$$r_{i,t} = (MAB_{i,t+1} - MAB_{i,t-1}) / 2 \qquad (4)$$

where $MAB_{i,t}$ is the mean age of fertility schedule of order *i*, calculated from reduced rates ($ASFR_{i,t}$). This computation is followed in the analysis. Alternatively, as suggested by Zeng Yi and Land (2001: 19, fn. 7), change in median age may be calculated. Although they found median age less sensitive to random fluctuations, in the case of the four countries analysed in this paper change in the median age displayed on average slightly wider fluctuations than the change in the mean age, particularly in the case of Sweden in 1990-1993.

Analogous to the *TFR* (see eq. 2), the tempo-adjusted total fertility rate for all birth orders is computed as a sum of the adjusted order-specific total fertility rates.

3. Period fertility indicator derived from the parity-specific birth probabilities ($PATFR_i$).

Age-specific and parity-specific birth probabilities $q_{a,i}$ serve as an input of the multistate (increment-decrement) fertility table, treating each birth order separately (for the classification of life tables see Willekens, 1991). Following Rallu and Toulemon (1994: 66), birth probabilities are estimated directly from the data on births and parity and age structure of women:

$$q_{a,i,t} = B_{a,i,t} \Big/ P^{F}_{a,i-1,t} \qquad (5)$$

Thus, Equation 5 expresses the probability that a woman aged *a* and having *i-1* children will give birth during the year *t*. Different from the $ASFR_{a,i,t}$ calculation in Equation 2, the denominator is the parity-specific female population at the beginning of the year *t*.

Here, an illustration of the fertility table computation is provided for parity 1. Consider a population of 10,000 women entering fertility table of parity 1 at age 12:

$$P'^{F}_{12,0,t} = 10{,}000$$

All women are initially childless. The apostrophe distinguishes table population P' from the real population P. Number of women still remaining childless at age *x* ($x \geq 13$) is given as (see Rallu and Toulemon, 1994: 66, Eq. 2):

$$P'^{F}_{x,0} = P'^{F}_{12,0} \prod_{12 \leq y < x} \left(1 - q_{y,1}\right) \qquad (6)$$

and number of ultimately childless women is equal to the table number of childless women at age 50 ($P'^{F}_{50,0}$). The first parity index of total fertility ($PATFR_1$) is computed as a proportion of women who had at least one child during their reproductive life (ages 12 and 50 are considered here as limits for reproduction):

$$PATFR_1 = P'^{F}_{50,i\geq 1} / P'^{F}_{12,0} = (P'^{F}_{12,0} - P'^{F}_{50,0}) / P'^{F}_{12,0} \qquad (7)$$

If, for instance, 1,000 women out of the initial 10,000 were to remain childless at age 50, the $PATFR_1$ would be (10,000-1,000) / 10,000 = 0.90, i.e. 90% of women in the table population would ultimately have at least one child.

Women having their first child at age *a* leave the fertility table of first births and enter the table of parity 2, that is they become exposed to the probability of having a second birth since the age *a+1*. In a similar way as for the first parity, the *PATFR* of parity 2 may be calculated as the table number of women who have at least two children divided by the initial number of childless women:

$$PATFR_2 = P'^{F}_{50,i\geq 2} / P'^{F}_{12,0} = (P'^{F}_{12,0} - P'^{F}_{50,0} - P'^{F}_{50,1}) / P'^{F}_{12,0} \qquad (8)$$

Parity progression ratios, probabilities of having another child by age and current parity and a number of other indicators can be computed from these sequential fertility tables (see Ortega and Kohler, 2002). Tables of fertility also provide the synthetic (table) parity distribution of women by age, given birth probabilities of a selected year or period.

Fertility tables for the highest parity category, denoted as *U* (4+ in Italy, the Netherlands and Sweden; 5+ in the Czech Republic), were estimated as an open-ended category, depicting the probability of having another birth among women with at least *U-1* children:

$$q_{a,i\geq U,t} = B_{a,i\geq U,t} / P^{F}_{a,i\geq U-1,T} ; U > 0 \qquad (9)$$

4. Tempo-adjusted and variance-adjusted period fertility indicator derived from the parity-specific birth probabilities ($adjPATFR_i$)

Kohler and Ortega (2002a) proposed an indicator derived from birth probabilities that provides adjustment both for the *tempo* and *variance* effects. Their method enables an estimation of the period fertility measures that are free of the three distortions present in the *TFR*, namely distortions caused by (1) changes in the parity distribution of women, (2) changes in fertility timing and (3) changes in the variance of fertility schedule. It is an analogy of the method developed earlier by Kohler and Philipov (2001) for an adjustment of the reduced period fertility rates (see also Section 2.2). The authors employ a procedure that iteratively corrects the observed mean age and the inferred tempo for distortions caused by the variance effects (Kohler and Philipov, 2001: 10). They recommend smoothing the observed probabilities before using this method. While using unsmoothed probabilities, only a rough adjustment of birth probabilities for variance effects is provided in this paper[8]. Parity-specific tempo change $r_{a,i,t}$ was computed following Kohler and Philipov (2001: 8, Eq. 11):

$$r_{a,i,t} = \gamma_{i,t} + \delta_{a\text{-}a^*,i,t} \qquad (10)$$

where $\gamma_{i,t}$ is the annual change in the mean age of birth probability schedule of parity i, δ is the annual increase in the standard deviation of the schedule and a^* is the mean age of probability schedule. Indicator $\gamma_{i,t}$ was estimated from the mean age of probability schedule in a similar manner as the Bongaarts-Feeney estimate of $r_{i,t}$ in Equation 4 above. Estimation of δ was based directly on an estimate in Result 12 in Kohler and Philipov (2001: 10), without performing the iterative procedure described in Result 13.

4. Data

Period and cohort fertility data were obtained from various sources listed in Appendix 1. Table 2 provides for each country an overview of the primary data and derived reduced rates and birth probabilities by birth order and age. It further shows for which periods various summary indicators were estimated.

Time series of reduced rates generally cover longer periods of time than the series of birth probabilities. Birth probabilities were computed directly from the data on births by birth order and age of mother and age and parity structure of women, following Equation 5 above. All births were organised in the period-cohort perspective. In the case of the initial data organised in the age-period perspective, a simple linear approximation was used to estimate the structure of births in the period-cohort manner:

$$B_{a,i,t} = (B_{A-1,i,t} + B_{A,i,t}) / 2 \qquad (11)$$

where a is age reached during the year t (cohort age) and A is age in completed years at the time of birth B.

The cohort fertility was reconstructed by combining various data sources. Most recent available estimates of cohort fertility served as a starting point for estimating cumulative cohort fertility by age and parity for a period covering 19 (Italy) to 36 years (Czech Republic), necessary for a computation of parity-specific birth probabilities q.

These time series were obtained by combining the initial cumulative cohort fertility distribution and period reduced rates prior and after the year for which it was available. This method assumes that migration and mortality do not affect cohort fertility, that is the distribution by the number of children in each birth cohort is the same among women who die or migrate and women who survive and stay in the country. Although foreign-born women frequently have a different number of children than their native counterparts, this does not have a large influence on the reconstruction of cohort fertility for a relatively short period of time, particularly in countries with fairly low immigration, such as Italy and the Czech Republic. An overview of the reconstructed cohort fertility data is provided in Table 2; a detailed description of data sources and estimates of cohort fertility is given in Appendix 1.

Table 2: *Overview of period and cohort fertility data used in the analysis*

	Czech Republic	**Italy**	**The Netherlands**	**Sweden**
Primary data	$B_{a,i,}$ $P^F{}_a$	$B_{a,i}$ $P^F{}_a$ (1980-85, 1990-97)	$B_{a,i,}$ $P^F{}_a$	$B_{a,i}$ $P^F{}_a$
		ASFR (1965-79, 1985-89)		
Observation perspective	AP	AP (PC in 1991-97)	PC	PC
Birth order	1-5+	1-5+ (1-4+ in 1965-79 and 85-89)	1-4+	1-5+
Derived measures:				
$ASFR_i$, TFR_i	1966-2000	1965-1997	1965-2001	1975-2000
$AdjTFR_i$	1966-1999	1965-1996	1965-2000	1975-1999
Birth probabilities $q_{a,i}$ and $PATFR_i$	1966-2000	1980-1997	1980-2001	1980-2000
$AdjPATFR_i$	1966-1999	1981-1996	1981-2000	1981-1999
'Corresponding' completed cohort fertility indicators are compared with period fertility measures for a given period:				
	1966-1992	1965-1989	1965-1994	1975-1993
Cohort CFR	C1916-1987	C1933-1983	C1930-1987	C1930-1986
Period for which CFR estimated 1)	1965-2001	1980-1998	1980-2002	1980-2001

Notes:
1) Period for which cumulative cohort fertility by parity is reconstructed for all women of reproductive age.
Observation perspective: AP age-period perspective (births organised by the exact age of mother)
PC period-cohort perspective (births organised by the year of birth of mother)
See Appendix 4 for an overview of symbols for various fertility indicators.

5. Four countries, four fertility histories

Four countries, roughly representing four European regions – Western Europe (the Netherlands), Northern Europe (Sweden), Southern Europe (Italy) and Central-Eastern Europe (the Czech Republic) – also constitute examples of four different fertility histories.

The Netherlands is a country with relatively small fluctuations in the total fertility (Figure 1a). A rather high-fertility regime prevailing till the mid-1960s was after a decade of rapid fertility decline (1965-1975) replaced by fairly stable low-fertility values (*TFR* below 1.65 between 1976 and 1998), influenced by the ongoing postponement of births. The increase in period fertility after 1995 was connected with a slow-down of the fertility postponement (Figure 2). The *TFR* value of 1.72, reached in 2000, was the highest since 1974.

In Sweden, the total fertility rate declined after the moderate baby boom in the mid-1960s, in line with trends in Italy and the Netherlands. However, since 1986 Sweden experienced a distinct baby-boom period culminating in 1990 (*TFR* 2.13). This fertility swing, quite unusual in the countries of the European Union after the 1960s, was partly induced by an extension of the period of eligibility to paid parental leave for mothers in 1986. This measure has ‘speeded up’ the births of second and later children (Sundström and Staffoerd, 1992; Andersson, 1999; Hoem and Hoem, 2000).

In Italy, rapid reduction of fertility following the baby-boom period of the mid-1960s took place later than in the Netherlands and Sweden. Within a period of ten years after 1975, the *TFR* in Italy fell below the levels in the Netherlands and Sweden and further decline squeezed the *TFR* to one of the lowest levels in Europe. In the Czech Republic, trends in period fertility were often contrasting with the other three countries. Gradual decline in the *TFR* during the 1950s and in the first half of the 1960s was interrupted by a short increase around the mid-1960s and mid-1970s. Both swings, of which the latter was more pronounced, were induced by the population policy measures (Frejka, 1980; Koubek, 1990). The 1980s saw a relatively stable level of the *TFR* around 2.0; the sharp decline has started since 1992 hand in hand with the increase in the mean age of the mother at childbearing. In 1999, the Czech Republic was – as measured by the *TFR* which declined to 1.13 – among the countries with the lowest period fertility in the world.

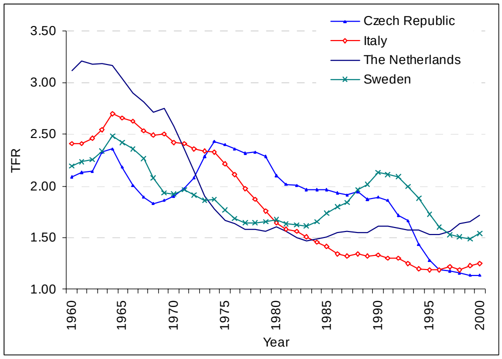


Figure 1a: *TFR in the Czech Republic, Italy, the Netherlands and Sweden, 1960-2000*

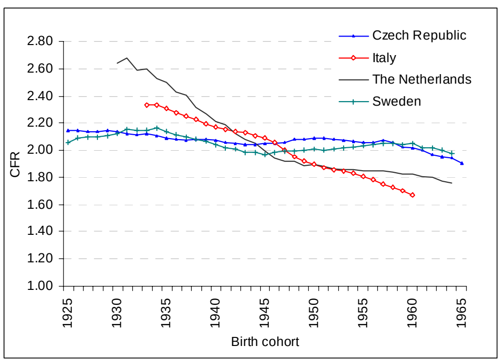


Figure 1b: *Completed fertility of female birth cohorts in the Czech Republic, Italy, the Netherlands and Sweden*

Cohort fertility in these countries was characterised by a considerable stability as the ups and downs of period fertility have affected cohort values to a much smaller degree (Figure 1b). Cohort fertility of women in Sweden and the Czech Republic depicted a stable level around or somewhat above 2.0 children per women up to the cohorts born in the early 1960s. Cohort fertility of Dutch and Italian women was gradually decreasing, more rapidly (and from higher levels) among Dutch women born in the 1930s and in the 1940s and among Italian women born in the 1950s. Cohorts of women born around 1945 had on average around 2 children in all four countries (between 1.95 in the Netherlands and 2.06 in Italy). Among younger cohorts, however, the differences have increased again: in Italy and Sweden women born in 1960 have on average less than 1.7 children and 2.05 children, respectively.

Table 3 and Figure 2 provide an overview of the extent of postponement of first births, as captured by the increase in the period mean age of first-time mothers. The delay in first births had started earlier than in subsequent births and it has had the strongest impact on the total fertility rates. In Italy, the postponement started in 1975 – by several years later than in Sweden and the Netherlands. Since then, the mean age of first-time mothers has increased by almost 4 years in these countries. It is only in the Netherlands that the increase has, at least temporarily, come to an end in 1999. Until then, the Netherlands had been a ‘champion’ of delayed motherhood, having the oldest first-time mothers in the world. In Italy, the delay of childbearing was gaining momentum over time and in the mid-1990s it was more intensive than ever before, still without any signs of slowing down. Consequently, Italian women bearing their first child have become even older than their Dutch counterparts after 1997.

Table 3: *An overview of postponement of first births in the Czech Republic, Italy, Netherlands and Sweden*

	Czech Republic	**Italy**	**The Netherlands**	**Sweden**
MAB_1 before the onset of postponement	22.43 (1991)	24.70 (1975)	24.75 (1971)	<24.21 (1974) b)
MAB_1 (last year available)	24.94 (2000)	28.61 (1997)	28.71 (1998) a)	27.87
Duration of the postponement, years	9	22	27	26+
Total increase in MAB_1, years	2.51	3.91	3.96	3.66
Average annual increase in the MAB_1	0.28	0.18	0.15	0.14
Average annual change in the MAB_1 during the following periods:				
1970-1975	0.01	-0.08	0.08	..
1975-1980	-0.03	0.08	0.11	0.16
1980-1990	0.01	0.17	0.19	0.10
1990-1995	0.17	0.22	0.17	0.17
1995-2000	0.32	0.39 (95-97)	0.04	0.14

MAB_1 Mean of mother at birth of first child (computed from the age-specific reduced rates)

Notes: a) in 1999, the *MAB_1* declined for the first time since 1971

b) no reliable figures for the period before 1974

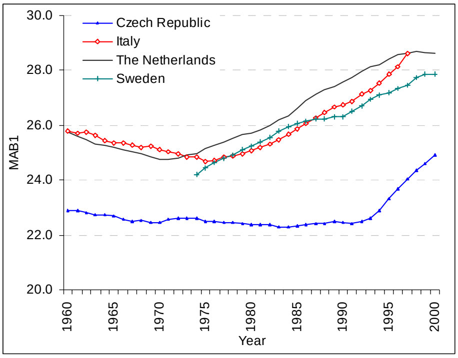


Figure 2: *Mean age of mother at birth of first child in the Czech Republic, Italy, the Netherlands and in Sweden, 1960-2000*

In the Czech Republic postponement has started much later, in 1992. By that time, Czech women were bearing children at an early age, in line with the pattern in other post-communist countries of Europe. Since then postponement of first births has been proceeding much faster there than in the other three countries under discussion. Due to the initially very young age at childbearing, a large scope for further delay still exists in the Czech Republic: by 1999, the mean age of women at birth of their first child has reached the levels recorded in the Netherlands, Sweden and Italy in the early 1970s.

6. Comparison of period and cohort fertility by birth order

6.1. Fertility of birth order 1

More intensive and longer-lasting postponement has 'deflated' period total fertility of first birth order more than fertility at higher orders. Therefore, we could expect that fertility measures adjusted for the *tempo* changes differ from the *TFR* especially in the case of order 1.

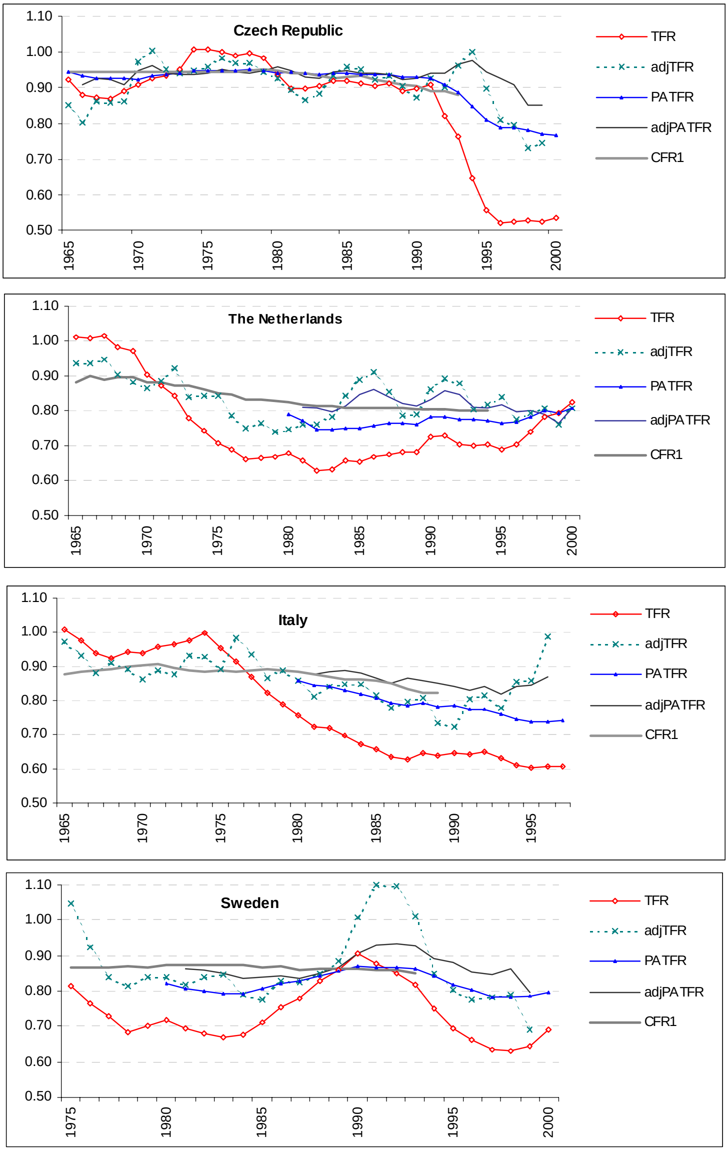


***Figure 3**:* *Period and cohort fertility indicators of birth order 1 in the Czech Republic, Italy, the Netherlands and Sweden*

Country-specific results are depicted in Appendix 3. All analysed alternative indicators provide better approximation of cohort fertility than the TFR_1. Only in the case of the Czech Republic, the Bongaarts-Feeney *adjTFR* did not provide closer approximation of the cohort *CFR*. During most of the analysed period (1966-1992), the timing of first births was very stable there and the *tempo effects* were absent. It is worth mentioning that under these conditions the *PATFR* indicators derived from the fertility table of first births showed considerably higher stability than the *TFR* and displayed only a negligible difference from the cohort *CFR* (see Figure 3). The period around 1975 is of particular interest. Following the recently implemented family policy measures, period indicators increased considerably (TFR_1 was above the level of 1.0 in 1974-1976), coinciding with a short-time advancement of first births. For this period (see Table A in Appendix 3), indicators based on probabilities show that most of the increase in the TFR_1 was due to the timing changes and distortions in the distribution of women by parity. The $PATFR_1$ as well as the adjusted $adjPATFR_1$ show stable values of 0.94-0.95, corresponding closely to the final cohort fertility of parity 1.

During the strong timing-shifts, characterised by the highest differences between the period TFR_1 and the cohort CFR_1, all alternative indicators came considerably closer to the CFR_1. They particularly show different values of period fertility in the Czech Republic during the second half of the 1990s when the TFR_1 declined to an extreme level of 0.52-0.53[9]. Fertility table indicator $adjPATFR_1$ for the same period reached levels of 0.85-0.93 (see Appendix 2), which do not imply a dramatic increase in cohort childlessness in the future.

Table 4 summarises the performance of fertility indicators of birth order 1 for all countries combined. The indicators based on probabilities, the *PATFR* and particularly its adjusted version provide the closest approximation of the cohort CFR_1. The *adjPATFR* comes closer to the cohort fertility in 81% of the cases (non-adjusted *PATFR* even in 89% of the cases) and it reduces on average the difference between TFR_1 and CFR_1 by three-quarters (see 'index of improvement in approximation').

Table 4: *Summary table for birth order 1. Degree to which the period fertility indicators approximate completed cohort fertility in comparison with the TFR*

		adjTFR	PATFR	adjPATFR
1	Total years of observation	101	63	63
2	Of which years with better approximation than TFR1	76	56	51
3	Proportion of years with better approximation (%) (2/1)	**75.2**	**88.9**	**81.0**
	Average absolute differences from completed cohort fertility values			
4	Average abs. difference of TFR1 (%)	10.68	10.55	10.55
5	Average abs. difference of alternative measure (%)	5.44	3.31	2.52
6	INDEX (4-5)/4 (index of improvement in approximation)	**0.49**	**0.69**	**0.76**

Figure 3 displays period and cohort fertility in each country. It amply illustrates the advantages and disadvantages of the use of particular period measures. The adjusted *adjTFR* usually displays values closer to the *CFR* than the ordinary *TFR*. However, it also shows considerable fluctuations with ups and downs that are difficult to interpret. It can also reach ‘impossible’ values of first-order *TFR* over 1.0, for instance in Sweden in 1975 and in 1990-1993 (see Section 7.3). The indicators based on birth probabilities are more stable and, by definition, remain within the theoretically possible range of cohort fertility distributions. The *PATFR* shows high stability and very good correspondence with the cohort fertility in the periods with no changes in fertility timing, such as in the Czech Republic before 1992. On the other hand, it displays systematically lower values than the corresponding cohort *CFR* during the periods of the postponement. Adjusted $adjPATFR_1$ comes close to the ultimate cohort fertility in most cases shown in the graphs and approximates the CFR_1 particularly well in the case of Italy, where trends in period fertility seem to be smooth and without sudden shifts.

We should keep in mind that since all these indicators are related to period fertility they are subjected to fluctuations in time and can never fully approximate cohort fertility. Strong fluctuations of adjusted indicators, particularly the *adjTFR* – in the case of Sweden in 1991-1994 when the *TFR* and the *PATFR* actually came close to the cohort *CFR* and adjusted measures reached very high values – reveal their limitations in times of sudden shifts in fertility patterns, which cannot be easily adjusted for even when changes in the variance of fertility schedule are taken into account.

6.2. Fertility of birth order 2

In most cases, the Bongaarts-Feeney *adjTFR* approximated values of the completed cohort fertility of birth order 2 better than the TFR_2 indicators, particularly in the case of Italy, where the change in the TFR_2 as well as in the mean age at childbearing was without sudden fluctuations (see Table B in Appendix 3). However, there were considerable fluctuations in the *adjTFR* in the Czech Republic (in the second half of the 1960s and around 1993) and in Sweden (around 1994), which again should lead to due care in interpreting this indicator in terms of the cohort fertility expectations. The use of the *PATFR* for an approximation of the cohort fertility of second parity is not justified. It does not come considerably closer to the cohort fertility than the period indicators of the TFR_2 (the average 'improvement' in approximation is only by 25%; see Table 5). Clearly, the *timing effects* influence the fertility table measures of second births in a similar way as they affect the period *TFR*. The summary *PATFR* indicator for parity 2 provided good results only for the Czech Republic in the 1970s and 1980s, that is in the period unaffected by larger shifts in fertility timing.

Though the table indicators are more elaborate than the measures based on reduced rates, they do not lead to a closer approximation of cohort fertility of parity 2 than the relatively simple Bongaarts-Feeney adjustment of the *TFR*. The $adjPATFR_2$ approximated the cohort fertility roughly to the same extent as the $adjTFR_2$. Although the $adjPATFR_2$ came closer to the cohort fertility more often than the $adjTFR_2$ (79% vs. 73% cases), both of them reduced the differences between the *TFR* and the corresponding *CFR* of parity 2 by slightly more than 50% (Table 5). The adjusted *adjPATFR* for parity 2 was also characterised by larger fluctuations than for parity 1.

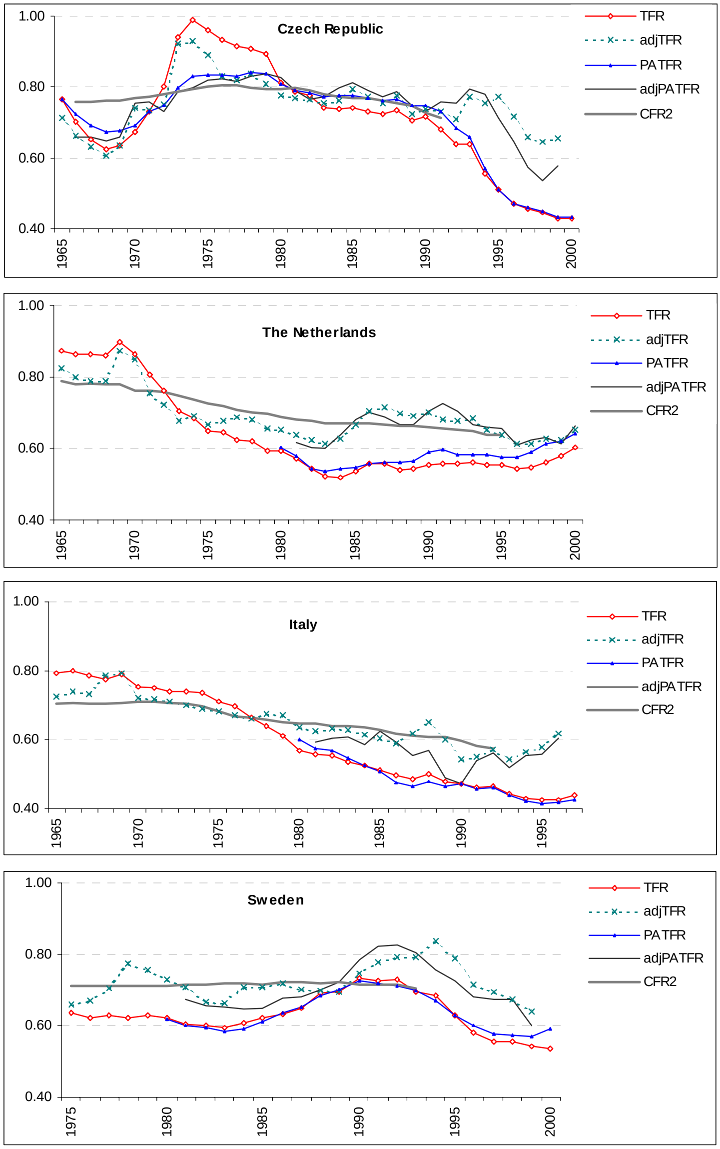


Figure 4: *Period and cohort fertility indicators of birth order 2 in the Czech Republic, Italy, the Netherlands and Sweden*

Table 5: *Summary table for birth order 2. Degree to which the period fertility indicators approximate completed cohort fertility in comparison with the TFR*

		adjTFR	PATFR	adjPATFR
1	Total years of observation	101	63	63
2	Of which years with better approximation than TFR_2	74	50	50
3	Proportion of years with better approximation (%) (2/1)	**73.3**	**79.4**	**79.4**
	Average absolute differences from completed cohort fertility values			
4	Average abs. difference of TFR_2 (%)	11.02	12.28	12.28
5	Average abs. difference of alternative measure (%)	4.93	9.19	5.91
6	INDEX (4-5)/4 (index of improvement in approximation)	**0.55**	**0.25**	**0.52**

6.3. Fertility of birth order 3 and higher

The alternative period fertility indicators do not improve the approximation of completed cohort fertility of birth order 3 and higher. The fertility table indicator ($PATFR_{3+}$) even gives considerably worse results than the period TFR_{3+} in all compared situations (Table C in Appendix 3, Table 6 and Figure 5). The adjusted $adjPATFR_{3+}$ eliminates part of the differences between the $PATFR_{3+}$ and the cohort CFR_{3+}. However, it still provides poorer approximation of cohort fertility than the ordinary TFR_{3+}.

Out of all considered indicators, only the Bongaarts-Feeney $adjTFR_{3+}$ provides a slightly better approximation of the cohort CFR_{3+}. Still, the improvement is very modest: although it comes closer to the CFR_{3+} in 77% cases as compared with the TFR_{3+}, it reduces the difference on average only by 23%.

Table 6: *Summary table for birth order 3+. Degree to which the period fertility indicators approximate completed cohort fertility in comparison with the TFR*

		adjTFR	PATFR	adjPATFR
1	Total years of observation	101	63	63
2	Of which years with better approximation than TFR_{3+}	71	8	17
3	Proportion of years with better approximation (%) (2/1)	**70.3**	**12.7**	**27.0**
	Average absolute differences from completed cohort fertility values			
4	Average abs. difference of TFR_{3+} (%)	11.99	11.51	11.51
5	Average abs. difference of alternative measure (%)	9.24	28.11	22.18
6	INDEX (4-5)/4 (index of improvement in approximation)	**0.23**	**-1.44**	**-0.93**

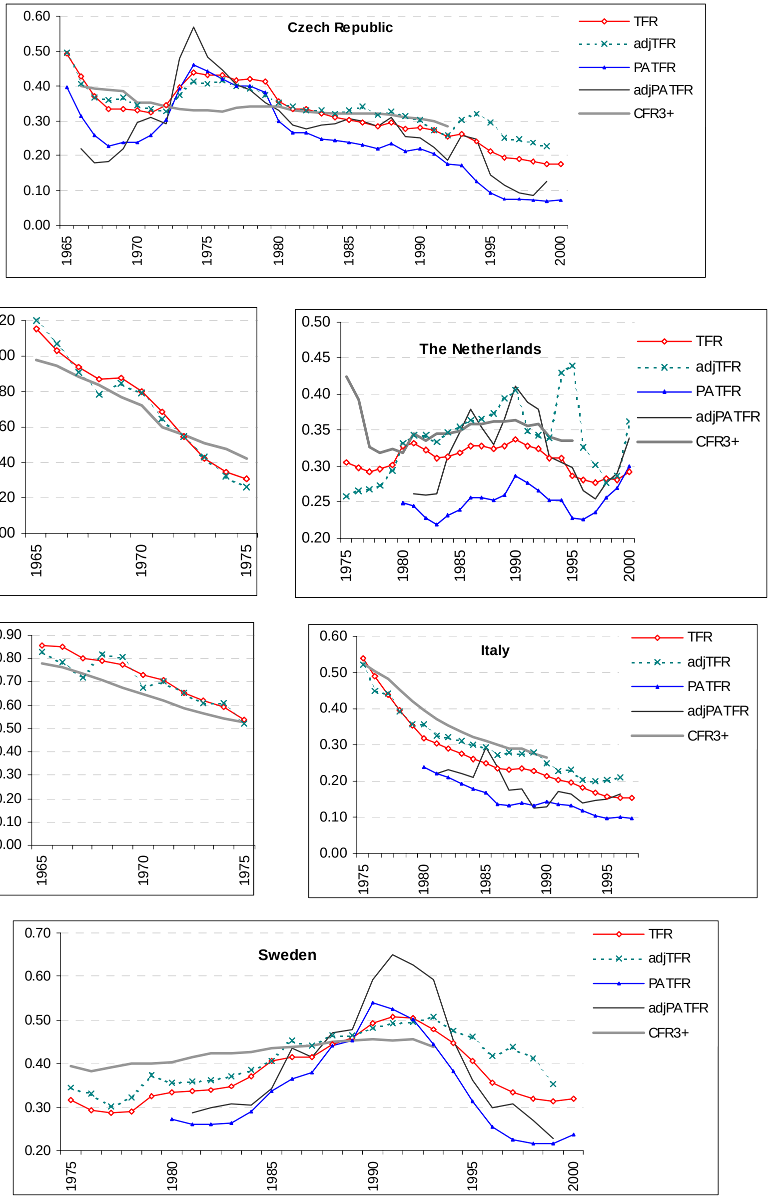


Figure 5: *Period and cohort fertility indicators of birth order 3+ in the Czech Republic, Italy, the Netherlands and Sweden*

Thus, also the performance of the *adjTFR* for birth order 3+ is considerably worse than for the lower orders. Relatively slower postponement of third and later births (as compared with first and second births) as well as random fluctuations in the mean and median age of mother at third and higher birth orders influenced negatively the performance of the Bongaarts-Feeney adjustment. As a result, none of the alternative period fertility measures is suitable even for a rough approximation of higher-parity cohort fertility. This issue is further addressed in Section 8.

6.4. All births combined: Period indicators of total fertility

Table D in Appendix 3, Table 7 and Figure 6 provide an overview of the approximation of cohort fertility using different indicators of period fertility for all birth orders. One additional indicator is introduced here. A hybrid indicator (*comTFR*), which combines the *adjPATFR* indicator for parity 1 and 2 with the *TFR* for birth order 3+. The rationale was to combine indicators that approximate best the cohort fertility at each birth order. For birth order 3 and higher, the *TFR* was chosen instead of the *adjTFR* due to the large year-to-year fluctuations in the latter measure.

Among the analysed indicators, the *PATFR* does not come much closer to the cohort *CFR*. During the periods characterised by shifts in fertility timing, the *PATFR* gives similar results as the *TFR* (see Figure 6). This is particularly due to the very low levels of the *PATFR* at parity 3+. All other indicators approximate cohort fertility better in 79% to 84% of observed cases (Table 7); the *adjPATFR* and *adjTFR* reduce on average less than half of the difference between the *TFR* and the *CFR*. Derived form different methods, they nevertheless often show similar values of period fertility. The hybrid indicator *comTFR* provides – as expected – the closest approximation of the cohort *TFR*. It approximates cohort fertility better than the *TFR* does in 84% of the cases and on average it reduces 62% of differences between the *TFR* and *CFR*. However, it is an indicator computed in an inconsistent way, combining two different indicators, and thus it is also the most difficult to interpret.

Table 7: *Summary table for indicators of total fertility. Degree to which the period fertility indicators approximate completed cohort fertility in comparison with the TFR*

		adjTFR	PATFR	adjPATFR	comTFR
1	Total years of observation	101	63	63	63
2	Of which years with better approximation than TFR	83	47	50	53
3	Proportion of years with better approximation (%) (2/1)	**82.2**	**74.6**	**79.4**	**84.1**
	Average absolute differences from completed cohort fertility values				
4	Average abs. difference of TFR (%)	12.09	10.81	10.81	10.81
5	Average abs. difference of alternative measure (%)	6.56	9.10	6.24	4.15
6	INDEX (4-5)/4 (index of improvement in approximation)	**0.46**	**0.16**	**0.42**	**0.62**

The evidence provided by the order-specific comparison of period and cohort fertility indicators may be summarised as follows:

(i) Various indicators of period fertility provide different results, and therefore often imply contradictory interpretations of fertility trends. Differences between the indicators induced by period effects are heterogeneous with respect to birth order. For instance, during the periods of increasing mean age at childbearing the *PATFR* consistently displays higher fertility than the TFR at birth order 1, but at the same time it shows considerably lower levels of fertility at higher parities (3+).

(ii) All period indicators fluctuate more than the relatively stable cohort fertility rate. This is consistent with the fact that period measures reflect period influences that are often temporary and less stable than the cohort trends, which we may think of as an aggregate result of changes over a long period of time. Some period fluctuations may be interpreted in terms of plausible explanations (population policy measures, economic influences etc.), yet others seem to be artificial results of applying a particular adjustment method or using particular indicators of period fertility. The issue of fluctuation in fertility indicators is further addressed in Section 7.2.

(iii) There appears to be consistency in the degree to which various period fertility indicators approximate cohort fertility. Measures based on birth probabilities, and particularly the adjusted ones, are consistently closer to the *CFR* of first parity than other indicators. For birth order 2, the adjusted *adjTFR* and *adjPATFR* reduce on average more than 50% of differences between the *TFR* and *CFR*. On the other hand, none of the analysed period measures comes considerably closer to the *CFR* of parity 3+ than the *TFR* and the measures based on birth probabilities even display much larger differences.

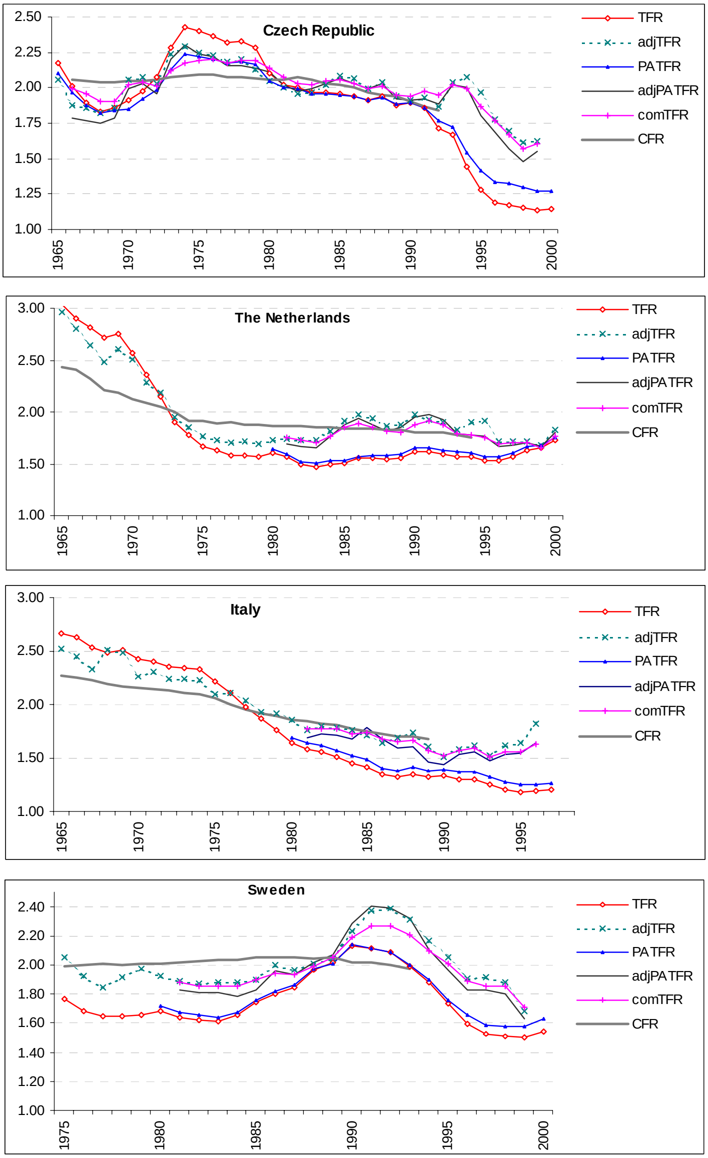


Figure 6 *Period and cohort fertility indicators (all parities) in the Czech Republic, Italy, the Netherlands and Sweden*

7. Additional criteria to analyse the performance of period fertility indicators

7.1. Approximation of cohort fertility in periods of intensive postponement

So far the paper has discussed the period-cohort fertility differences in various situations, including periods with no important changes in fertility timing. However, the main issue of the adjustment is an estimation of fertility quantum in periods when the *TFR* is influenced by the tempo shifts in childbearing. A brief additional analysis focuses on the periods in which the mean age at first birth increased by at least 0.1 years in a calendar year and for which all compared indicators were estimated. This illustration comprises the evidence for 26 calendar years: for the Netherlands between 1981 and 1993, for Italy between 1981 and 1989 and for Sweden between 1981 and 1984.

The summary table (Table 8) suggests that the period indicators other than the *TFR* indeed reduce the difference between the *TFR* and the completed cohort fertility especially in the periods marked by a postponement of childbearing. All indicators in the table came closer to the *CFR* in all the years of observation. While the *PATFR* reduced the *TFR-CFR* difference only by a margin, the remaining indicators reduced this difference on average by more than 60%, the *adjTFR* by 74% and the *comTFR* even by 77%. The average difference between the *TFR* and the *CFR*, which was 17.1%, has shrunk to only 4.0% distance between the *comTFR* and the *CFR*.

If these findings reflect reality – and we would need more observations to draw such a conclusion – then several period indicators provide considerably better approximation of cohort fertility during the shifts in the timing of births and thus indicate to a large extent the 'underlying' levels in cohort fertility and better reflect the period *quantum*.

While the *TFR* and the *PATFR* provide systematically lower values than the cohort *CFR* once the delay of motherhood takes place, we may wonder whether other period indicators also show some consistent pattern of under-estimating or over-estimating cohort fertility during these periods. Given that many women who 'postpone' motherhood may for various reasons, including the increase in infecundity after age 35, actually never 'catch up', adjusted indicators could be expected to show on average higher values than the ultimate cohort fertility. Table 9 indicates, however, that the opposite was true. Although only slightly, the *adjTFR*, *adjPATFR* as well as the *comTFR* on average still indicated lower values than the completed cohort fertility of women giving births during the observed periods. Such underestimation was smallest in the *adjTFR* (-0.9%), in the case of the Netherlands showing slight overestimation (+1.8%), and somewhat higher in the *comTFR* (-2.6%) and the *adjPATFR* (-3.5%).

Table 8: *Summary table of the performance of different period fertility indicators: Degree to which they approximate completed cohort fertility during an intensive postponement of first births*

	adjTFR	**PATFR**	**adjPATFR**	**comTFR**
Total years of observation	26	26	26	26
Of which years with better approximation than TFR	26	26	26	26
Proportion of years with better approximation (%) (2/1)	**100**	**100**	**100**	**100**
Average absolute differences from completed cohort fertility values				
Average abs. difference of TFR (%)	17.13	17.13	17.13	17.13
Average abs. difference of alternative measure (%)	4.53	14.80	6.45	4.02
INDEX (4-5)/4 (index of improvement in approximation)	**0.74**	**0.14**	**0.62**	**0.77**

In sum, adjusted indicators do not seem to provide too optimistic (read: high) approximation of cohort fertility. Moreover, smoothing or averaging values for longer periods erases some random fluctuations and thus further reduces the period-cohort fertility differences.

Table 9: *Average relative differences between period fertility indicators and the corresponding final cohort fertility (CFR) over longer periods of time (in %)*

Period	**The Netherlands 1981-1993**	**Italy 1981-1989**	**Sweden 1981-1984**	**Total**
Years of observation	**13**	**9**	**4**	**26**
TFR	-15.3	-18.7	-19.6	-17.1
AdjTFR	1.8	-2.0	-7.3	-0.9
PATFR	-13.5	-15.2	-18.2	-14.8
AdjPATFR	0.1	-5.5	-10.8	-3.5
ComTFR	-0.6	-2.9	-8.3	-2.6

7.2. Fluctuations in fertility indicators

Period fertility indicators are characterised by less stability than the cohort fertility rates. If one source of instability, the tempo component, is removed, these indicators may be expected to reflect higher stability and fewer fluctuations. However, previous sections have shown that the adjusted indicators are often less stable than the total fertility rates. This instability seems to reflect random fluctuations, which can not be explained by any underlying causes.

To look at these fluctuations in a more systematic way, the average annual absolute change in all the considered indicators was analysed. Table 10 shows the average annual fluctuations as well as relative fluctuations with respect to the *TFR* and *CFR*. It depicts substantial differences by birth order. Period indicators are characterised by considerably more intensive annual changes than the cohort *CFR*. The most stable period indicator of order 1 and 2 is the *PATFR* and for total fertility it is the combined indicator *comTFR*. The adjusted *adjPATFR* is more stable than the *TFR* for order 1 and roughly as stable as the *TFR* for order 2. However, for birth order 3 and higher, all indicators based on birth probabilities are much more volatile than the *TFR*. The *adjTFR* is almost as stable as the *TFR* for birth orders 3+ and for all orders combined, while in the case of birth order 1 it depicts higher fluctuations. In general, we may suspect indicators that are more volatile than the *TFR* – the *adjTFR* for parity 1 and the *PATFR* and *adjPATFR* for parity 3 and higher – to be subjected to the strongest random fluctuations.

Table 10: *Average absolute annual changes in fertility indicators by birth order. Summary of data for 59 years (Czech Republic 1967-92, Italy 1982-89, the Netherlands 1982-94, Sweden 1982-93)*

	Average annual change in a given indicator (%)					
	TFR	**adjTFR**	**PATFR**	**adjPATFR**	**comTFR**	**C FR**
All parities	2.67	2.79	2.21	3.14	1.98	0.66
Parity 1	2.31	3.69	0.71	1.35	..	0.36
Parity 2	3.06	3.43	2.17	3.15	..	0.63
Parity 3+	3.06	3.43	7.28	11.16	..	1.91
	Changes relative to the TFR (Average fluctuations in TFR = 1.0)					
All parities	**1.00**	1.04	0.83	1.18	0.74	0.25
Parity 1	**1.00**	1.60	0.31	0.58	..	0.16
Parity 2	**1.00**	1.12	0.71	1.03	..	0.21
Parity 3+	**1.00**	1.12	2.38	3.64	..	0.62
	Changes relative to the CFR (Average fluctuations in CFR = 1.0)					
All parities	4.04	4.22	3.35	4.76	3.00	**1.00**
Parity 1	6.33	10.11	1.94	3.69	..	**1.00**
Parity 2	4.85	5.43	3.44	4.99	..	**1.00**
Parity 3+	1.61	1.80	3.82	5.85	..	**1.00**

7.3. ‘Impossible’ cases

It is a well known fact that the *TFR* may reach levels that can not occur in the real birth cohorts, such as the first-order *TFR* higher than 1.0, suggesting an absurd situation of more than 100% of women in a synthetic cohort having their first child. Such cases do not occur in multiplicative measures, where women are not exposed to a birth of certain parity more than once. Impossible values depicted occasionally by the *TFR* may still be acceptable as indicators of the short-time trends in period fertility, but they point out how limited the *TFR* is for any approximations of cohort fertility or assessments concerning the consequences of ‘current’ fertility rates.

From the total of 127 observations, the TFR_1 exceeded the level of 1.0 in 6 cases (4.7%) – in the Czech Republic in 1974-75, in the Netherlands in 1965-67 and in Italy in 1965. The adjusted TFR_1 was in all these cases below 1.0, indicating that the *TFR* was ‘exaggerated’ due to the tempo effects, namely due to the advancement of births. On the other hand, the $adjTFR_1$ exceeded unity in 7 other cases: in Sweden in 1975 and in 1990-1993 and in the Czech Republic in 1971 and 1994. Apparently, the tempo-adjusted *TFR* can not be used for the projections of cohort fertility trends unless extreme caution is exercised.

7.4. Performance in ‘extreme’ situations

Zeng Yi and Land (2001: 23) concluded in their sensitivity analysis of the Bongaarts-Feeney *adjTFR* that the formula “often is not sensitive to its underlying assumption about the invariant shape of the fertility schedules and equal changes in timing across ages” and “usually does not differ from an adjusted *TFR(t),* which allows the shape of the fertility schedule to change at a constant annual rate”. This simplifying assumption was one of the major points of criticism against the use of the Bongaarts-Feeney approach (see Van Imhoff and Keilman, 2000; Kohler and Philipov, 2001 and Van Imhoff, 2001). However, according to Zeng Yi and Land, ‘extremely large’ changes in the fertility tempo and in the shape of the fertility schedule may distort the performance of the BF adjustment. Changes in the mean age of fertility schedule exceeding 0.25 years per calendar year, particularly when coupled with the changes in the interquartile range of fertility schedule exceeding 0.10 years were suggested to be such instances (Zeng Yi and Land, 2001: 23).

Among the countries included in this analysis, such cases of fertility timing changes were not particularly unusual. For instance, the mean age of fertility schedule of birth order 1 has changed by more than 0.25 years in 16 out of 131 cases (12%), the interquartile range of age-specific reduced rates (*ASFR*) of order 1 has changed by more than 0.10 years in 25 cases (19%). Rapid increase in the mean age is typical of the countries with an intensive postponement of births in the 1990s, particularly Italy and the Czech Republic. Especially the Czech Republic after 1993 is a model case of ‘extreme’ situations: the mean age of fertility schedule at first birth has been increasing by an annual rate of 0.24-0.41 years and the interquartile range by 0.09-0.30 years, slowing down only in 2000.

The Bongaarts-Feeney adjustment of first-order fertility in the Czech Republic ($adjTFR_1$, see Figure 3 and Appendix 2) does not – with the exception of a brief upward fluctuation in 1992-1994 – seem to show exaggerated values as would be suggested by Zeng Yi and Land’s (2001) findings. Generally, during the periods of rapid increase in the mean age or intensive changes in the interquartile range adjusted indicators do not show stronger fluctuations or larger differences from cohort fertility. Many fluctuations appear to occur because of random influences or nonsystematic changes, such as large and time-varying changes in the tempo and shape of the schedule (Zeng Yi and Land, 2001: 23). This applies also for the adjustment for variance effects, which often generates additional fluctuations[10].

7.5. Calculating period fertility indicators

There are two major sources of difficulties in the calculation of the ‘alternative’ period fertility indicators. Firstly, not all the necessary data are available. Secondly, calculation of some measures is much easier than the derivation of other indicators. Larger data availability and easier computation potentially contribute to a wider acceptance and more extensive use of analysed indicators.

In almost all European countries data on births by age of mother, necessary for computing the *TFR*, are available. Nevertheless, some countries (Belgium, France until 1996, Germany, United Kingdom and Switzerland) collect and publish data on birth order within the current marriage, which is not a reliable indicator of birth distribution in countries with a high proportion of non-marital births. The use of such data for calculating order-specific indicators should be avoided. In some cases, e.g. in the United Kingdom, large national surveys enable detailed estimates of age and order-specific fertility indicators (see Smallwood, 2002b). The calculation of birth probabilities requires data on births by age of woman and parity as well as the composition of the female population by parity. This is often not available, particularly for the ‘true’ (biological) birth order. Cohort indicators may be estimated on the basis of period data; nevertheless, time series covering sufficiently long periods of time are usually unavailable.

Provided that the necessary data are available, computation of the *TFR* and *adjTFR* indicators is simple. The calculation of the *PATFR* is more complex, while the calculation of tempo and variance-adjusted measures, proposed by Kohler and Philipov (2001) and Kohler and Ortega (2002a), involves an elaborate procedure. It is therefore very likely that the latter indicators will not become widespread and generally recognised alternatives to the *TFR*.

8. Discussion on the tempo-quantum and period-cohort interaction

Why are there such large differences by birth order in the degree to which various period fertility indicators approximate cohort fertility? Especially the very poor approximation provided by the indicators based on birth probabilities for parity 3 and higher is confusing. This section outlines several reasons why the approximation of higher-parity cohort fertility will always be an extremely risky undertaking.

Relative to the annual changes in cohort fertility, and compared to other period fertility indicators, the *TFR* of birth orders 3+ shows quite high stability over time (Table 10). The tempo effects have influenced the *TFR* at higher orders considerably less than at lower orders. One reason for that is obvious: postponement of births proceeds in several stages, starting with the delay of first births. Adopting a cohort perspective, we may think of a cohort of women that in their young age initiate postponement of first births, which in turn causes a subsequent delay of second births and by a decade or so later also the delay of third and later births. As a result, postponement at higher parities always starts later than the postponement of first parity. Moreover, women having third or higher-parity children form a special family-oriented group bearing children earlier than other women do. Consequently, postponement at higher parities is less pronounced than at parity 1 and 2.

This may explain why the *TFR* at higher birth orders is often relatively stable and less influenced by the tempo distortions. But why do the period measures based on birth probabilities diverge so much both from the *TFR* and the completed *CFR* in cases of birth order 3 and higher? One explanation lies in the way the *PATFR* is computed, which takes into account fertility decline at younger ages and thus also the shift in age of having children but ignores the high likelihood of the future ‘catch-up‘ among older women. This effect is intensified with increasing birth order.

Cohort perspective is useful to illustrate this point. The *PATFR* is a hypothetical measure summarising reproductive experiences of many different cohorts of women – not only birth cohorts but also hypothetical parity cohorts – in a calendar year. Consider the fertility history of a woman belonging to the birth cohort experiencing pronounced postponement of childbearing. Suppose she has her first child in the year *t*. Since the postponement started only recently, it has been manifested mostly by the decline in birth probabilities among younger childless women as compared with the previous years. Decline in the first birth probabilities at younger ages causes (1) a decline in the overall period probability of having a first child $PATFR_1$ and (2) a strong increase in the mean age at experiencing first birth, as derived from the fertility table. The cohort trajectory of first birth will in a later stage display some recuperation among older women, leading to a further increase in the mean age and higher *CFR* as compared to the period *PATFR*. Moving to the higher parities, the effect of not accounting for the plausible future recuperation, resulting in smaller numbers of women progressing to having a(nother) child in the period fertility table calculations is further multiplied. Even larger distortions are caused by the fact that in the *synthetic cohort* perspective, postponement makes women leave the fertility table of parity 1 and subsequently become exposed to births of parity 2 at increasingly higher ages. While this depicts the real trend, period probabilities of parity 2 and higher in the same year *t* still pertain to the cohorts of women who experienced first birth earlier in life and whose fertility schedule was considerably younger in comparison with the future cohort schedule of the birth cohort of our interest. The period calculation will therefore show an increasingly shorter exposure of an 'average' woman to higher-parity births, squeezed into the higher ages and coupled with the unrealistically 'young' fertility schedule pertaining to the older birth cohorts and 'exaggerating' the birth probabilities at young ages while not accounting for the future catching-up among older women.

In sum, the effect of combining probabilities of women belonging to different parity cohorts in the period fertility table and the resulting discrepancy between the period *PATFR* and the cohort *CFR* during the postponement are intensified by:

(i) increasing parity (multiplicative effects of not accounting for the future recuperation of birth probabilities at higher ages)

(ii) the length of birth intervals (longer birth intervals lead to the increasing time difference in experiencing the higher-parity births between the period fertility table and the cohort experience)

(iii) the intensity of postponement (more intensive delay of childbearing leads to the stronger discrepancies between the period fertility table and the cohort fertility probabilities, particularly at higher reproductive ages)

These features are specific to indicators based on the notion of sequential parity progression, that is birth probabilities and corresponding multistate fertility table calculations. They apply to a smaller extent also to the adjusted *adjPATFR*. The *PATFR* in fact reveals the consequences of current childbearing patterns under the hypothetical scenario of no 'catch-up' effects in the future. Many women may be postponing first birth till such a high age, when they will not be able to have a second or a third birth – an aspect which Kohler and Ortega (2002b) label as a '*fertility ageing effect*'. This effect will gain in importance in countries where women are giving birth to their first child at a very high age: in Italy, for instance, further postponement of childbearing may indeed ultimately lead to the very low levels of fertility of third and higher parity, as currently indicated by the *PATFR* indicators.

9. The use of the alternative period fertility indicators: An illustration

This section provides two examples of the potential use of adjusted period fertility indicators. The first one is an estimate of the *tempo* and *quantum* components in fertility change in the Czech Republic over the 1990s, the second one is an assessment of the implications of the recent period birth probabilities for cohort fertility in the Czech Republic and Italy.

9.1. Estimating tempo and quantum components in period fertility change

The tempo-adjusted measures provide a framework, which enables us to estimate the *tempo* and *quantum* components in fertility change and it addresses the following questions: Was the decline in period fertility driven by the reduction in the level of fertility (fertility *quantum*) or by the postponement of births (*tempo effect*)? What would the level of period fertility be in the absence of postponement of births? Were different birth orders affected differently by the *tempo* and *timing* effects? As the postponement of births in the Czech Republic started after 1990, we may assume that the value of the *TFR* in 1990 reflects the period quantum for that year.

Table 11 compares the *TFR* by birth order in 1999 with the order-specific fertility indicator that provides the best approximation of cohort fertility, which is the *adjPATFR* for birth order 1 and 2, the *adjTFR* for orders 3+ and the *comTFR* for total fertility. Due to the use of different indicators, the sum of the order-specific indicators (1.66) differs from the indicator *comTFR* shown in the table (1.61). The difference between the *TFR* in 1990 and the adjusted indicator in 1999 is assumed to represent the *quantum effect*, that is the ‘real’ decline in fertility level. The difference between the adjusted indicator in 1999 and the *TFR* in 1999 is assumed to represent the *timing effect*, depressing temporarily the *TFR* level.

Table 11: *Quantum and tempo components in the change of the total fertility rate in the Czech Republic between 1990 and 1999*

	parity 1	parity 2	parity 3+	all parities
(1) TFR / 1990	0.897	0.715	0.282	1.893
(2) TFR / 1999	0.526	0.458	0.189	1.133
(3) Reduction in the TFR (1)-(2)	-0.371	-0.257	-0.092	-0.760
(4) % change 1990-1999 (3)/(1)	-41	-36	-33	-40
Adjustment method / fertility indicator	adjPATFR	adjPATFR	adjTFR	ComTFR
(5) Adjusted TFR 1999	0.853	0.578	0.227	1.608
Fertility change 1990-1999:				
(6) Quantum effect (5)-(1)	-0.044	-0.137	-0.055	-0.285
(7) Tempo effect (2)-(5)	-0.327	-0.120	-0.038	-0.475
(8) % quantum effect (6)/(3)	12	53	59	38
(9) % tempo effect (7)/(3)	88	47	41	63

The role of the *tempo* and *quantum* components has varied by birth order. Decline in the first-order *TFR* after 1990 – more intensive than for other orders – was almost entirely driven by the postponement of births, with only 12% of it estimated as *quantum effect*. This is the most surprising finding of the analysis. The decline in the TFR_2 was almost equally driven by the *quantum* and *tempo* change and the *quantum* component has been slightly prevailing (59%) in the decline of the *TFR* of orders 3 and higher. The postponement of childbearing has had a prominent influence on the overall *TFR* decline. While the *TFR* for 1999 was at the lowest level ever reached, 1.13, the *comTFR* indicated a considerably higher level of 1.61, suggesting that only 38% of the *TFR* decline since 1990 (*TFR* 1.89) occurred because of the reduction in the *quantum* of fertility. This example clearly illustrates how the use of the tempo-adjusted indicators may change our perception of period fertility trends.

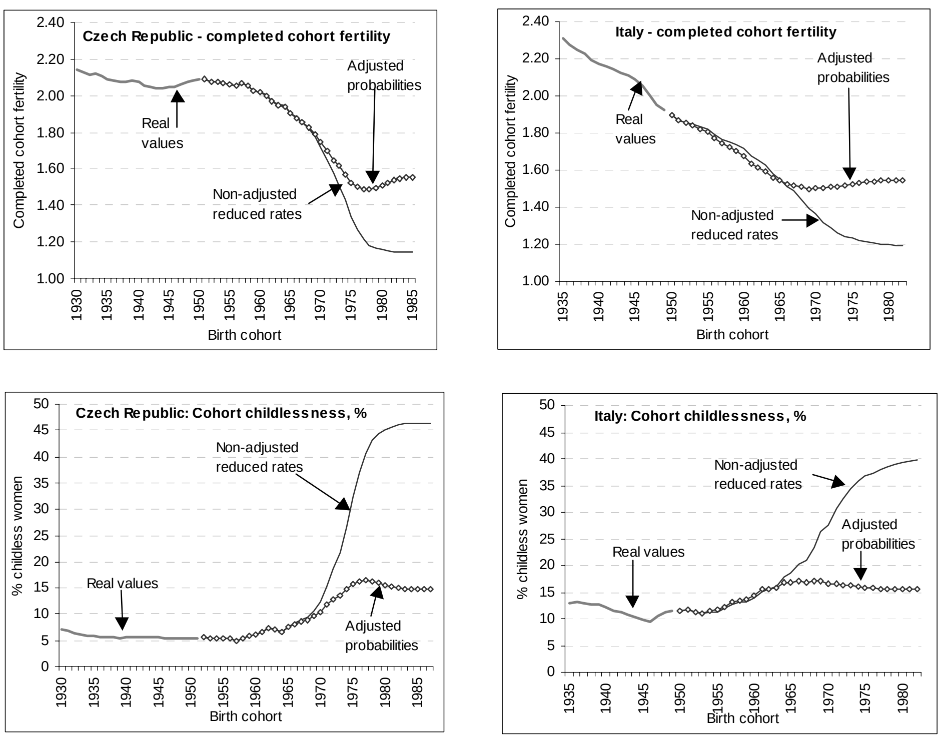
9.2. Implications of period fertility trends for cohort fertility

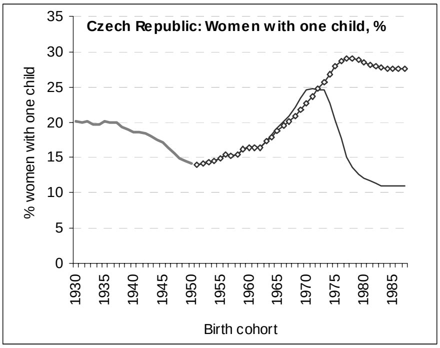
Cohort fertility scenarios and resulting assessments of the implications of current period fertility for future cohort fertility and family composition are still often formulated on the basis of the trends in the TFR. However, a very simplistic scenario which assumes that the reduced fertility rates may continue indefinitely into the future frequently provides misleading and very unrealistic scenarios of cohort fertility. In contrast, a still relatively simple scenario assuming that the current tempo and variance-adjusted childbearing probabilities will prevail in the future offers rather realistic estimates of the future cohort fertility.

This section discusses the scenarios of cohort fertility for two countries with extremely low levels of the period *TFR* – the Czech Republic and Italy. Both countries have experienced decline in the *TFR* below 1.2 around the mid-1990s, which stimulated discussions concerning the ultimate cohort fertility of women having children during this period. In the two scenarios of cohort fertility, birth cohorts of women are subjected to the most recent (1) age and order-specific reduced rates (*ASFR*) and (2) age and parity-specific tempo-adjusted and variance-adjusted birth probabilities. The latter approach corresponds with the *'postponement stops'* cohort fertility scenario proposed by Kohler and Ortega (2002a and 2002b). The cumulative cohort fertility of women on 1st January 1998 (Italy) and 2001 (Czech Republic) serves as a starting point of the analysis. Since then, women in Italy are assumed to experience the order-specific *ASFR* of 1997, respectively adjusted birth probabilities of 1995[11] and women in the Czech Republic the *ASFR* of 2000, respectively adjusted probabilities of 1999. While the computation of cohort scenarios is simple and straightforward in the case of the order-specific *ASFR*, the multiplicative nature of birth probabilities makes the calculation of cohort scenarios more complex. For each age and parity category of women, the proportion of women experiencing 1, 2, 3 etc. additional births till the end of their reproductive lives has to be calculated. The resulting age-specific table with all transition probabilities between various parities (0-1, 0-2, 2-3, 3-4, 4-5+, 2-3, 2-4, 2-5+ etc.) is then applied directly to the most recent cohort distribution of women. The proportion of women having one additional child was calculated according to Ortega and Kohler (2002: 12, Eq. 5). The proportion of women having more than one additional child was derived from the formula in Park (1976: 16). The last parity considered was 5+ in the Czech Republic and 4+ in Italy.

The results of the two scenarios, compared in Figure 7, provide a highly contrasting picture of the future parity distribution among women. They also suggest interesting similarities in the future cohort fertility trends in the Czech Republic and Italy. In the scenarios based on adjusted probabilities, the complete cohort fertility ultimately stabilises around the level of 1.55 in both countries as compared with the values below 1.2 suggested by the reduced rates scenario. The scenarios differ most radically with respect to ultimate childlessness: while the continuation of current reduced rates would imply a dramatic increase in childlessness among the birth cohorts born after 1960 in Italy and after 1970 in the Czech Republic, the adjusted probability scenario indicates only a moderate increase in childlessness to the level of about 15%. Under the 'current rates' scenario, childlessness would become the most common parity status of women at the end of their reproduction. Under the 'current adjusted probabilities' scenario, families with two children remain the most common living arrangement: there is a surprising stability in the proportion of Italian women bearing two children for all generations born since 1950 (41-44%), and a gradual decline in the Czech Republic among the cohorts born in the 1970s (53% among women born in 1970 and 46% among those born in 1979). While the prevalence of childlessness will not probably reach extremely high values, many more women are likely to have only one child. The 'current adjusted probabilities' scenario shows a sharp increase in the proportion of women with one child in the Czech Republic, up to the level of 28% among women born after 1975 (15% in the 1957 cohort) and a gradual increase in Italy, initiated among women born after the Second World War (20% in the 1945 cohort, 30% in the 1972 cohort).

Figure 7: *Scenarios of the future cohort fertility in the Czech Republic and Italy based on the most recent reduced rates and adjusted probabilities*




Czech Republic: Women with one child, %
% women with one child
0
5
10
15
20
25
30
35
1930
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1940
1945
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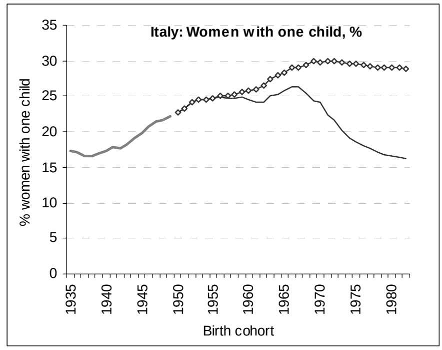
1955
1960
1965
1970
1975
1980
1985
Birth cohort


Italy: Women with one child, %
% women with one child
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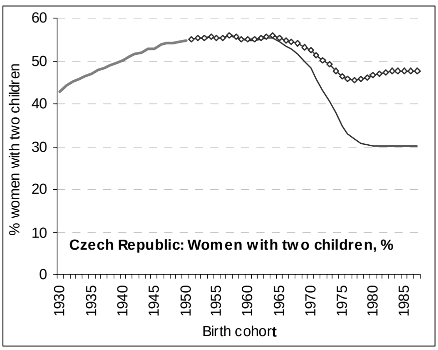
Birth cohort


Czech Republic: Women with two children, %
% women with two children
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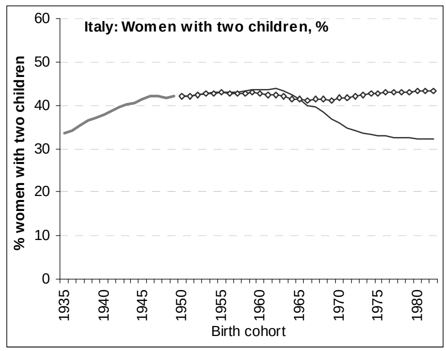
Birth cohort


Italy: Women with two children, %
% women with two children
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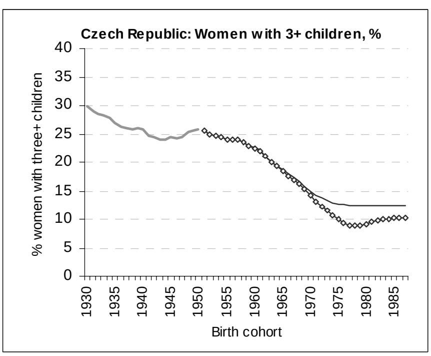
Birth cohort


Czech Republic: Women with 3+ children, %
% women with three+ children
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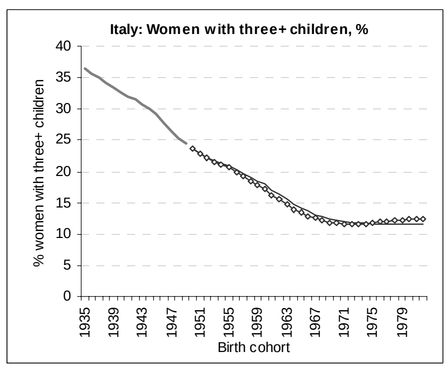
Birth cohort


Italy: Women with three+ children, %
% women with three+ children
0
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1951
1955
1959
1963
1967
1971
1975
1979
Birth cohort

The two scenarios resemble each other only in the case of cohort fertility of birth orders 3+. In Italy, the long-lasting decline in higher-order fertility would fade out among women born at the beginning of the 1970s; of which about 12% would ultimately have 3 or more children. In the Czech Republic, the ‘adjusted probabilities’ scenario results in a low proportion of large families – 10% – among women born in the mid-1970s; the second scenario indicates a more gradual decline toward 13% of women born in 1975 having ultimately 3 or more children.

The scenarios based on unadjusted reduced rates clearly provide unrealistic results, such as a dramatic increase in childlessness. In comparison, the scenarios based on adjusted probabilities suggest trends that are fairly plausible: a moderate increase in childlessness, a more intensive increase in the proportion of women with one child and a further decline in the proportion of larger families.

10. Conclusions

This paper discusses a fairly controversial issue of whether some indicators of period fertility come systematically closer to the corresponding ultimate cohort fertility of women than the total fertility rate does. All the analysed indicators were based on the ‘synthetic cohort’ approach, which, despite some shortcomings, provides convenient and intuitively understandable means of comparing period fertility across time and space. The indicators of period fertility analysed in this paper are free of one or more distortions present in the *TFR*, and therefore depict more closely the ‘pure level’ (*quantum*) of period fertility. The paper focuses primarily on the distortions due to the changes in fertility timing (*tempo*) that are associated with the very low *TFR* in many European countries. Detailed analysis of the period-cohort fertility differences reveals two major findings. Firstly, some period indicators indeed appear to come consistently closer to the ultimate cohort fertility, particularly during the phases of intensive changes in fertility timing. Secondly, this pattern of differential period-cohort approximation considerably varies by parity.

Table 12 summarises findings on the degree of the period-cohort fertility approximation and some additional criteria concerning analysed indicators. It clearly indicates that there is no ‘ideal’ period indicator which would enable an easy and straightforward estimation of the ultimate cohort fertility among generations that have not completed their reproduction. The selection of a particular indicator may depend not only on the extent to which it approximates the cohort fertility, but also on the availability of data, random fluctuations or the occurrence of ‘impossible’ values in the indicators derived from reduced rates.

Based on the data from four countries, the evidence encapsulated in Table 12 should be considered tentative. By no means does it give a definitive answer to the questions posed in introductory part of the paper; further research is necessary to provide support for these findings. Since the main focus of the paper was on the periods marked by the postponement of childbearing, it is possible that some conclusions concerning the proximity of period and cohort indicators may not equally apply in the case of advancement of fertility. Keeping this in mind, the analysis has revealed that the approximation of cohort fertility was most successful in case of birth order 1 and for the total fertility. Indicators based on birth probabilities have shown considerable reduction of the TFR_1-CFR_1 differences: tempo-adjusted and variance- adjusted $adjPATFR_1$ reduced these differences on average by 76%.

Table 12: *Summary table comparing approximation of cohort fertility by various period fertility indicators and selected additional criteria to evaluate them*

	TFR	adj TFR	PATFR	adj PATFR	com TFR
Extent of approximation of cohort fertility					
Parity 1	-	0	+	+ +	n.a.
Parity 2	-	+	+	0	n.a.
Parity 3+	-	-	- -	- -	n.a.
Al parities	-	0	-	0	+
All parities, intensive postponement	- -	+	-	0	+
Over/underestimation of cohort fertility 1)	strong under-	no	strong under-	slight under-	slight under-
Annual fluctuations	average	large at parity 1	small at par. 1 large at par. 3+	small at par. 2 large at par. 3+	small
'Impossible' values	yes	yes	no	no	n.a.
Complexity of calculation	no	no	moderate	yes	yes

Explanations:

Extent of approximation of cohort fertility (based on the % of the average annual difference between the period and the ultimate cohort fertility): + + very good (<3%); + good (3-4.9%); 0 average (5-7.9%); - poor (8-14.9%); - - very poor (15+%).

Note: 1) during the periods of intensive postponement of first births

The *PATFR* and *adjPATFR* are thus much more suitable indicators of the long-time implications of current period fertility trends at birth order 1 than the *TFR*. For the total fertility, the compound indicator *comTFR* came closest to the ultimate *CFR*, reducing the *TFR-CFR* difference on average by 62%. None of the considered indicators came systematically closer to the ultimate cohort fertility of birth orders 3 and higher; the

PATFR and *adjPATFR* provided consistently poorer approximation than the *TFR* of orders 3+. A similar conclusion holds for the comparison of period and cohort fertility in the periods with intensive postponement of childbearing, characterised by the largest differences between the period *TFR* and the cohort *CFR*. Then, the *comTFR* reduced the *TFR-CFR* difference on average by 77% and came closer to the *CFR* in all considered cases.

The most complex period indicators do not necessarily provide the closest approximation of cohort fertility. Relatively simple tempo-adjusted *adjTFR* has shown better approximation of the overall cohort *CFR* than the tempo and variance-adjusted *adjPATFR* and in the phases of intensive postponement almost as good approximation as the combined indicator *comTFR*. In particular adjustment for the variance effects, which is relatively complex, does not change significantly the values of the adjusted *adjTFR* and *adjPATFR* indicators. Additional analysis, not shown in this paper, has revealed that the tempo-adjusted *PATFR* has been in most cases almost equal to the tempo and variance-adjusted *adjPATFR* and both have approximated the cohort *CFR* to the same extent.

The data pertaining to four different European countries aptly illustrate various advantages and disadvantages of particular indicators of period fertility. Relatively smooth change in the fertility timing and level in Italy, and to a smaller extent also in the Netherlands went hand in hand with a relatively close approximation of the cohort *CFR* by the adjusted indicators. Very intensive postponement of childbearing in the Czech Republic since 1994 has caused a large divergence between the *TFR*, respective *PATFR* indicators and the adjusted *adjTFR* and *adjPATFR* measures. Abrupt shifts in fertility in Sweden in the first half of the 1990s, characterised by the changes in the inter-birth intervals and complex changes in the variance of fertility schedule, have coincided with very high values of adjusted indicators, diverting strongly from the cohort *CFR*. Thus, the Swedish example points out the limitations of the analysed indicators. Their use for assessing implications of current period fertility trends and for the projections of cohort fertility should be exercised with caution. Ideally, it would serve as a complementary means to the careful analysis of cohort fertility trends.

Nevertheless, this paper has shown that in the cases of the Czech Republic and Italy, that is countries with very low *TFR* levels and intensive postponement of childbearing, the straightforward use of the adjusted birth probabilities may provide rather realistic scenarios of cohort fertility development. According to these scenarios, the decline in cohort fertility in these two countries may occur primarily due to the reduction of fertility at higher parities (3+) and the increase in the proportion of women with only one child. On the other hand, as opposed to the trends suggested by the reduced rates, increase in childlessness is likely to be modest, and the two-child families are expected to remain the most common family size.

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Erratum:

There is an error in equation 10 on p. 165. The equation should be correctly written as follows:

$$r_{a,i,t} = \gamma_{i,t} + \delta_{i,t}(a - a^*_{i,t}) \qquad (10)$$

(the incorrect version was:

$$r_{a,i,t} = \gamma_{i,t} + \delta_{a-a^*,i,t} \qquad (10)$$)

Notes

[1] There are many examples of oversimplified assumptions concerning the future cohort fertility levels, which are based on current total fertility rates. For instance, Golini (2000) constructed a projection of the Italian population, in which the medium variant was based on the assumption of continuing *TFR* of 1.27 till 2047 and zero net migration. The results led him to pose the following questions: “Is it desirable to have 18 million people over 65 and 2.5 million children under 10? What type of psychological and social climate will these children have to face? (…) Each child would be surrounded by a large number of older people to take care of him, overcrowding him with care and attention and ready to satisfy any physical and emotional desires.” (Golini, 2000: 261). In the same publication, Chesnais (2000: 126) suggested that “the fertility decline…tends to stabilize between a wide spectrum of values, going from 0.8-0.9 (former East Germany, northern regions of Italy and Spain) to 1.7-1.8 (Scandinavia, United Kingdom)”. This statement, too, is based on the total fertility rates and it is not related to the real experience of any birth cohort of women.

[2] Synthetic cohort is a hypothetical cohort constructed purely on the basis of observed rates in a given period.

[3] The term ‘reduced rates’ is used in this paper.

[4] Following the Multilingual demographic dictionary (IUSSP, 1982: par. 634) the term ‘parity’ is used for fertility indicators that restrict the denominator to the women of the parity at risk. It is also used to denote the fertility composition of birth cohorts. In other cases, the term ‘birth order’ is used.

[5] The duration analysis of fertility data is fairly rare in countries included in this analysis. Koschin (2001) has recently analysed parity progression ratios in the Czech Republic based on birth interval data for parities 2 to 4. However, his data pertained to the period of 1991-1999 only.

[6] If another indicator of fertility than the *TFR* (for instance the *PATFR*) had been used, many of the lowest-low fertility countries would drop out of this category.

[7] Alternatively, median age or modal age could be chosen. Since the differences between these three indicators of fertility timing are usually less than 1 year of age, the results remain virtually unaffected by the choice of a particular timing indicator.

[8] The application of the Kohler-Ortega iterative procedure with the use of non-smoothed probabilities resulted in large fluctuations in the adjusted KO *PATFR*. These indicators are not included in this analysis.

[9] Such low levels of period *TFR* may lead to the incorrect interpretations of their eventual effects on family size. For instance, Rychtaříková (1999: 27) argues that "from the cross-sectional perspective, the proportion of childless women dramatically increased to almost 50 per cent in 1996-1997, thus reflecting changes in birth order fertility".

[10] The analysis of Spanish fertility by Ortega and Kohler (2001, Appendix) is an interesting example. The TFR_1 has been gradually declining between 1977 (0.98) and 1996 (0.57), with a short period of stabilization around 1988 (0.69). Such low levels were obviously reached due to the tempo effects, namely the postponement of births. The $adjTFR_1$ shows considerable fluctuations reaching up to 1.13 in 1980 and 1.02 in 1991 and down to 0.67 in 1996. The adjustment for variance effects proposed by Kohler and Philipov (2001) – *KP TFR* – indicates, however, even more pronounced fluctuations, with the *KP* $adjTFR_1$ reaching these extreme values: 1.21 (!) in 1977, 0.76 in 1983, 1.08 in 1991 and 0.67 in 1996. It is very difficult to provide a reasonable interpretation for these fluctuations.

[11] The most recent year for which adjusted birth probabilities were estimated was 1996; however since the values for 1996 were considerably higher than during the previous 5 years, data for 1995 were chosen as more representative of recent period.

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APPENDIX

APPENDIX 1 – Computation of period and cohort fertility indicators

CZECH REPUBLIC

Period fertility

Data on births by age of mother and birth order were obtained from the following sources:

1965-1985 (birth order 1-5+, age 15-45+, including stillbirths): FSU (1966-1986). Derived age-specific fertility rates were roughly adjusted for stillbirths (age-specific fertility rates for all births were multiplied by the proportion of live births to the total number of births). For a computation of birth probabilities, number of births was also roughly adjusted for stillbirths.

1986-1988 (live births, age 14-45+, birth order 1-4+): POPIN CR (2001). For the computation of birth probabilities, births of birth order 4 and 5+ by age were estimated according to the distribution of births in 1985.

1989-1999 (live births, age 13-49, birth order 1-5+) data were obtained from the Czech Statistical Office in 2000 (CSU, 2000).

2000 (live births, age 12-50+, birth order 1-5+): EUROSTAT (2002).

Age structure of women for January 1st comes from these sources:

1965-1980: FSU (1966-1981)

1981-1994: POPIN CR (2001)

1995-1999: CSU (2000)

2000-2001: CSU (2001)

Cohort fertility

Distribution of women according to the number of live-born children among birth cohorts 1916-1965 was obtained from the 1980 Population Census (1st November 1980; see FSU, 1982b). This statistics was also published for the 1991 Census. However, a comparison of these two censuses revealed a possible undercount of fertility at higher parities in 1991[1]. Therefore only the 1980 Census data were used.

[1] More detailed information can be obtained from the author on request.

Based on the combination of the 1980 Census results and the vital statistics data for 1965-2000, parity-specific cumulative cohort fertility of birth cohorts born up to 1986 was estimated for 1st January 1966-2001.

ITALY

Period fertility

For the periods of 1965-1979 and 1986-1989 reduced rates for birth orders 1-4+ (age 15-45) published by ISTAT (1996) were used for all the subsequent calculations and estimates.

1980-1985 and 1990-1997 (live births, birth order 1-5+, age 15-49): EUROSTAT (2002). Data for 1980-1985 and 1990 are organised in the age-period perspective, data for 1991-1997 in the period-cohort perspective. The 1997 data are preliminary.

Age structure of women for 1980-1998 comes from EUROSTAT (2002).

Cohort fertility

Cumulative cohort fertility by parity and age for 1st January 1980-1998 (birth cohorts 1933-1982) was reconstructed on the basis of the period fertility data. The experience of oldest cohorts (1933-1935) was partly reconstructed from the period fertility data (age and order-specific reduced rates) kindly provided by Willy Bosveld.

The NETHERLANDS

Period fertility

Data on live births by birth order (1-4+) and age of mother (14-49) for 1965-2001 were obtained from the CBS (2002). Data are organised in the period-cohort perspective.

Age structure of women in 1965-2002 was also obtained from CBS (2002).

Cohort fertility

Data on cohort fertility by parity and age up to 1st January 2000 for birth cohorts 1950 to 1970 were obtained from the Statistics Netherlands (courtesy of Joop de Beer). Data on cohort fertility up to 1st January 1996 for birth cohorts 1935-1970 were obtained from the Statistics Netherlands (courtesy of Gijs Beets).

Parity-specific cumulative cohort fertility of women in 1980-1999 (birth cohorts 1935-1984) was reconstructed on the basis of the 1996 cohort fertility data and period fertility data for 1980-1999. Cumulative cohort fertility of women in 2000 -2002 was reconstructed on the basis of the 2000 cohort fertility data (1996 for birth cohorts up to 1949) and period fertility data for 2000-2001 (or 1996-2001 respectively). Cumulative cohort fertility by parity for women born in 1930-1935 was estimated from the overall cohort fertility data published in Festy (1979) and parity distribution of the 1935 birth cohort.

SWEDEN

Period fertility

Data on live births by birth order (1-5+) and age of mother (14-50+) for 1974-2000 come from EUROSTAT (2002). Data are organised in the period-cohort perspective. Available data also cover the period of 1968-1973, however, only for the birth order within current marriage.

Age composition of women in 1974-2001 was obtained from the EUROSTAT (2002).

Cohort fertility

Parity-specific cohort fertility rates until 1992 for birth cohorts 1940-1977 were provided by courtesy of Willy Bosveld. Data were originally estimated at the Statistics Sweden on the basis of period fertility data for 1974-1992. For fertility realised before 1974, data were estimated at the Statistics Sweden (Bosveld, 1996: 51).

Cumulative cohort fertility in 1980-2001 was estimated by combining these cohort fertility indicators with the period fertility data specified above.

Parity-specific cohort fertility of birth cohorts 1930-1939 was estimated from the overall cohort fertility data in Festy (1979).

APPENDIX 2: Period and cohort fertility indicators

1. Summary indicators of total fertility

CZECH REPUBLIC

Year	TFR	adj TFR	PATFR	adj PATFR	com TFR	MAB	Cohort fertility: birth cohort	CTFR
1965	2.18	2.06	2.11			25.54	1932	2.12
1966	2.01	1.87	1.96	1.79	2.00	25.35	1933	2.12
1967	1.90	1.86	1.88	1.76	1.95	25.15	1934	2.11
1968	1.83	1.82	1.82	1.75	1.90	25.06	1935	2.09
1969	1.86	1.86	1.84	1.79	1.90	25.02	1936	2.08
1970	1.91	2.06	1.85	2.00	2.02	24.97	1937	2.08
1971	1.98	2.07	1.92	2.03	2.04	25.11	1938	2.08
1972	2.07	2.03	1.99	1.96	2.01	25.13	1939	2.08
1973	2.29	2.24	2.13	2.20	2.12	25.26	1940	2.07
1974	2.43	2.29	2.24	2.30	2.17	25.24	1941	2.06
1975	2.40	2.25	2.22	2.24	2.19	25.12	1942	2.05
1976	2.36	2.23	2.20	2.22	2.20	25.07	1943	2.04
1977	2.32	2.18	2.18	2.16	2.17	24.98	1944	2.04
1978	2.32	2.20	2.19	2.16	2.19	24.91	1945	2.05
1979	2.29	2.13	2.17	2.13	2.20	24.83	1946	2.05
1980	2.10	2.05	2.04	2.11	2.14	24.66	1947	2.06
1981	2.02	2.00	2.00	2.02	2.07	24.69	1948	2.08
1982	2.01	1.96	1.99	1.97	2.03	24.64	1949	2.09
1983	1.96	1.97	1.96	1.99	2.02	24.58	1950	2.09
1984	1.97	2.02	1.96	2.03	2.05	24.55	1951	2.09
1985	1.96	2.08	1.95	2.07	2.06	24.58	1952	*2.08*
1986	1.94	2.07	1.94	2.03	2.03	24.64	1953	*2.08*
1987	1.91	1.99	1.92	2.00	2.00	24.67	1954	*2.07*
1988	1.94	2.04	1.93	2.03	2.02	24.72	1955	*2.06*
1989	1.87	1.94	1.89	1.93	1.95	24.75	1956	*2.06*
1990	1.89	1.92	1.89	1.91	1.94	24.76	1957	*2.07*
1991	1.86	1.93	1.86	1.92	1.97	24.73	1958	*2.05*
1992	1.71	1.87	1.77	1.88	1.95	24.83	1959	*2.03*
1993	1.67	2.04	1.72	2.02	2.02	25.04	1960	*2.02*
1994	1.44	2.08	1.55	2.00	2.00	25.37	1961	*2.00*
1995	1.28	1.96	1.41	1.80	1.87	25.76	1962	*1.97*
1996	1.19	1.78	1.33	1.69	1.77	26.09	1963	*1.95*
1997	1.17	1.70	1.32	1.57	1.67	26.36	1964	*1.94*
1998	1.16	1.61	1.30	1.48	1.57	26.62	1965	*1.90*
1999	1.13	1.63	1.27	1.55	1.61	26.86	1966	*1.87*
2000	1.14		1.27			27.18	1967	*1.84*

SWEDEN

Year	TFR	adj TFR	PATFR	adj PATFR	com TFR	MAB	Cohort fertility: birth cohort	CTFR
1974	1.87					26.70	1932	2.14
1975	1.77	2.05				26.72	1933	2.14
1976	1.68	1.92				26.87	1934	2.16
1977	1.64	1.85				26.99	1935	2.14
1978	1.64	1.91				27.35	1936	2.12
1979	1.66	1.97				27.45	1937	2.10
1980	1.68	1.92	1.71			27.57	1938	2.08
1981	1.63	1.88	1.67	1.83	1.88	27.73	1939	2.07
1982	1.62	1.87	1.65	1.81	1.86	27.89	1940	2.04
1983	1.61	1.88	1.64	1.81	1.85	28.05	1941	2.02
1984	1.66	1.88	1.67	1.79	1.85	28.26	1942	2.01
1985	1.74	1.89	1.75	1.83	1.89	28.36	1943	1.99
1986	1.80	2.00	1.82	1.96	1.94	28.41	1944	1.99
1987	1.84	1.97	1.86	1.93	1.93	28.50	1945	1.97
1988	1.96	2.01	1.97	2.02	1.99	28.52	1946	1.99
1989	2.01	2.04	2.01	2.07	2.05	28.55	1947	1.99
1990	2.13	2.24	2.13	2.29	2.19	28.57	1948	1.99
1991	2.11	2.37	2.11	2.41	2.26	28.72	1949	2.00
1992	2.09	2.39	2.08	2.39	2.27	28.85	1950	2.01
1993	1.99	2.31	2.00	2.32	2.21	28.97	1951	2.00
1994	1.88	2.16	1.90	2.10	2.10	29.13	1952	*2.01*
1995	1.73	2.05	1.76	1.97	2.01	29.22	1953	*2.02*
1996	1.60	1.91	1.66	1.83	1.89	29.36	1954	*2.02*
1997	1.52	1.92	1.59	1.83	1.85	29.47	1955	*2.03*
1998	1.50	1.88	1.58	1.81	1.85	29.72	1956	*2.04*
1999	1.50	1.68	1.57	1.63	1.71	29.79	1957	*2.05*
2000	1.54		1.63			29.85	1958	*2.05*
							1959	*2.04*
							1960	*2.05*
							1961	*2.02*
							1962	*2.02*
							1963	*2.00*
							1964	*1.98*

MAB - mean age of mother at childbearing (computed from the age-specific fertility rates).
Estimates of completed cohort fertility for birth cohorts who did not complete their reproduction are shown in italic.

ITALY

Year	TFR	adj TFR	PATFR	adj PATFR	com TFR	MAB	Cohort fertility: birth cohort	CTFR
1965	2.66	2.53				28.68	1933	2.33
1966	2.63	2.45				28.67	1934	2.33
1967	2.53	2.34				28.54	1935	2.31
1968	2.49	2.51				28.44	1936	2.27
1969	2.51	2.49				28.45	1937	2.25
1970	2.42	2.26				28.27	1938	2.23
1971	2.41	2.31				28.17	1939	2.20
1972	2.36	2.24				27.99	1940	2.17
1973	2.34	2.24				27.87	1941	2.16
1974	2.33	2.23				27.75	1942	2.14
1975	2.21	2.09				27.60	1943	2.13
1976	2.11	2.10				27.52	1944	2.11
1977	1.98	2.04				27.48	1945	2.09
1978	1.87	1.93				27.47	1946	2.06
1979	1.76	1.92				27.43	1947	2.00
1980	1.64	1.85	1.69			27.48	1948	1.95
1981	1.58	1.76	1.64	1.69	1.78	27.55	1949	1.92
1982	1.56	1.79	1.62	1.72	1.78	27.66	1950	*1.90*
1983	1.51	1.79	1.57	1.72	1.77	27.78	1951	*1.87*
1984	1.46	1.76	1.52	1.68	1.73	27.90	1952	*1.85*
1985	1.42	1.71	1.48	1.79	1.74	28.07	1953	*1.84*
1986	1.34	1.64	1.41	1.68	1.68	28.28	1954	*1.83*
1987	1.32	1.69	1.38	1.59	1.65	28.47	1955	*1.81*
1988	1.35	1.73	1.41	1.61	1.66	28.61	1956	*1.78*
1989	1.32	1.61	1.38	1.46	1.57	28.69	1957	*1.75*
1990	1.33	1.51	1.40	1.44	1.53	28.87	1958	*1.72*
1991	1.30	1.58	1.37	1.54	1.57	29.00	1959	*1.70*
1992	1.30	1.62	1.37	1.56	1.59	29.22	1960	*1.67*
1993	1.25	1.52	1.32	1.47	1.51	29.31		
1994	1.20	1.62	1.27	1.54	1.56	29.51		
1995	1.18	1.64	1.25	1.55	1.56	29.64		
1996	1.19	1.82	1.25	1.64	1.63	29.92		
1997	1.20		1.26			30.38		

The NETHERLANDS

Year	TFR	adj TFR	PATFR	adj PATFR	com TFR	MAB	Cohort fertility: birth cohort	CTFR
1965	3.04	2.96				28.97	1930	2.64
1966	2.90	2.81				28.75	1931	2.68
1967	2.81	2.65				28.54	1932	2.59
1968	2.72	2.48				28.36	1933	2.60
1969	2.75	2.60				28.25	1934	2.53
1970	2.57	2.50				28.19	1935	2.50
1971	2.36	2.29				27.97	1936	2.43
1972	2.15	2.19				27.70	1937	2.41
1973	1.90	1.95				27.53	1938	2.32
1974	1.77	1.86				27.37	1939	2.27
1975	1.66	1.77				27.36	1940	2.21
1976	1.63	1.73				27.36	1941	2.18
1977	1.58	1.71				27.45	1942	2.12
1978	1.58	1.72				27.50	1943	2.08
1979	1.56	1.69				27.59	1944	2.05
1980	1.60	1.73	1.64			27.69	1945	2.00
1981	1.56	1.75	1.60	1.69	1.76	27.82	1946	1.95
1982	1.50	1.73	1.52	1.67	1.73	27.96	1947	1.92
1983	1.47	1.73	1.50	1.66	1.71	28.07	1948	1.92
1984	1.49	1.82	1.53	1.76	1.76	28.19	1949	1.89
1985	1.51	1.91	1.54	1.87	1.85	28.41	1950	1.90
1986	1.55	1.98	1.57	1.94	1.89	28.62	1951	1.88
1987	1.56	1.94	1.58	1.88	1.85	28.83	1952	1.87
1988	1.54	1.86	1.58	1.82	1.81	28.97	1953	*1.86*
1989	1.55	1.88	1.59	1.85	1.81	29.15	1954	*1.86*
1990	1.62	1.97	1.66	1.95	1.88	29.30	1955	*1.85*
1991	1.61	1.93	1.66	1.97	1.91	29.46	1956	*1.85*
1992	1.59	1.90	1.62	1.93	1.88	29.66	1957	*1.84*
1993	1.57	1.83	1.61	1.79	1.79	29.81	1958	*1.84*
1994	1.57	1.90	1.61	1.77	1.78	29.89	1959	*1.83*
1995	1.53	1.92	1.57	1.77	1.76	30.03	1960	*1.83*
1996	1.53	1.72	1.57	1.67	1.69	30.14	1961	*1.80*
1997	1.56	1.71	1.61	1.68	1.70	30.18	1962	*1.80*
1998	1.63	1.71	1.67	1.70	1.71	30.24	1963	*1.78*
1999	1.65	1.67	1.68	1.67	1.66	30.26	1964	*1.76*
2000	1.72	1.83	1.75	1.81	1.76	30.28	1965	

MAB - mean age of mother at childbearing (computed from the age-specific fertility rates).
Estimates of completed cohort fertility for birth cohorts who did not complete their reproduction are shown in italic.

2. Indicators for births of birth order 1

CZECH REPUBLIC

Year	TFR_1	adj TFR_1	$PATFR_1$	adj $PATFR_1$	MAB_1
1965	0.92	0.85	0.95		22.68
1966	0.88	0.80	0.93	0.91	22.56
1967	0.87	0.86	0.93	0.93	22.49
1968	0.87	0.86	0.93	0.92	22.53
1969	0.89	0.86	0.92	0.91	22.47
1970	0.91	0.97	0.92	0.95	22.46
1971	0.92	1.00	0.93	0.96	22.60
1972	0.93	0.95	0.94	0.94	22.62
1973	0.95	0.94	0.94	0.94	22.64
1974	1.01	0.95	0.95	0.94	22.60
1975	1.01	0.96	0.95	0.94	22.51
1976	1.00	0.98	0.95	0.95	22.50
1977	0.99	0.97	0.95	0.94	22.48
1978	1.00	0.97	0.95	0.94	22.45
1979	0.98	0.94	0.95	0.95	22.42
1980	0.94	0.92	0.94	0.96	22.37
1981	0.90	0.89	0.94	0.95	22.39
1982	0.90	0.87	0.94	0.93	22.36
1983	0.90	0.88	0.94	0.93	22.32
1984	0.92	0.93	0.94	0.94	22.32
1985	0.92	0.96	0.94	0.95	22.35
1986	0.91	0.95	0.94	0.94	22.40
1987	0.90	0.92	0.94	0.94	22.44
1988	0.91	0.93	0.94	0.94	22.44
1989	0.89	0.90	0.93	0.92	22.48
1990	0.90	0.87	0.93	0.93	22.47
1991	0.91	0.93	0.93	0.94	22.43
1992	0.82	0.90	0.91	0.94	22.51
1993	0.76	0.96	0.89	0.97	22.61
1994	0.64	1.00	0.85	0.98	22.92
1995	0.56	0.90	0.81	0.94	23.32
1996	0.52	0.81	0.79	0.93	23.68
1997	0.53	0.79	0.79	0.91	24.04
1998	0.53	0.73	0.78	0.85	24.35
1999	0.53	0.75	0.77	0.85	24.59
2000	0.54		0.77		24.94

Cohort fertility

birth cohort	$CTFR_1$
1932	0.94
1933	0.94
1934	0.94
1935	0.94
1936	0.94
1937	0.94
1938	0.94
1939	0.95
1940	0.94
1941	0.94
1942	0.94
1943	0.94
1944	0.94
1945	0.94
1946	0.94
1947	0.94
1948	0.94
1949	0.94
1950	0.94
1951	0.94
1952	0.94
1953	0.95
1954	0.94
1955	*0.95*
1956	*0.95*
1957	*0.95*
1958	*0.95*
1959	*0.94*
1960	*0.94*
1961	*0.93*
1962	*0.93*
1963	*0.93*
1964	*0.93*
1965	*0.92*
1966	*0.92*
1967	*0.91*
1968	*0.90*
1969	*0.89*

SWEDEN

Year	TFR_1	adj TFR_1	$PATFR_1$	adj $PATFR_1$	MAB_1
1974	0.84				24.21
1975	0.81	1.05			24.45
1976	0.77	0.92			24.66
1977	0.73	0.84			24.79
1978	0.68	0.82			24.92
1979	0.70	0.84			25.11
1980	0.72	0.84	0.82		25.25
1981	0.69	0.82	0.81	0.86	25.39
1982	0.68	0.84	0.80	0.86	25.55
1983	0.67	0.84	0.79	0.85	25.78
1984	0.68	0.79	0.79	0.83	25.97
1985	0.71	0.78	0.81	0.84	26.06
1986	0.75	0.83	0.82	0.84	26.13
1987	0.78	0.82	0.83	0.84	26.24
1988	0.83	0.85	0.84	0.85	26.24
1989	0.86	0.88	0.85	0.87	26.29
1990	0.90	1.01	0.87	0.91	26.30
1991	0.88	1.10	0.87	0.93	26.50
1992	0.85	1.10	0.87	0.94	26.71
1993	0.82	1.01	0.86	0.93	26.94
1994	0.75	0.85	0.84	0.89	27.09
1995	0.70	0.80	0.82	0.88	27.17
1996	0.66	0.77	0.80	0.85	27.36
1997	0.64	0.78	0.78	0.85	27.46
1998	0.63	0.79	0.78	0.86	27.74
1999	0.64	0.69	0.78	0.80	27.87
2000	0.69		0.80		27.87

Cohort fertility

birth cohort	$CTFR_1$
1940	0.87
1941	0.87
1942	0.87
1943	0.87
1944	0.88
1945	0.88
1946	0.88
1947	0.88
1948	0.88
1949	0.87
1950	0.87
1951	0.87
1952	0.87
1953	0.87
1954	*0.87*
1955	*0.87*
1956	*0.87*
1957	*0.87*
1958	*0.87*
1959	*0.87*
1960	*0.87*
1961	*0.86*
1962	*0.86*
1963	*0.86*
1964	*0.86*
1965	*0.86*
1966	*0.85*

MAB_1 - mean age of mother at birth of first child (computed from the age-specific fertility rates).
Estimates of completed cohort fertility for birth cohorts who did not complete their reproduction are shown in italic.

ITALY

Year	TFR_1	adj TFR_1	$PATFR_1$	adj $PATFR_1$	MAB_1
1965	1.01	0.97			25.36
1966	0.97	0.93			25.34
1967	0.94	0.88			25.27
1968	0.93	0.91			25.22
1969	0.94	0.89			25.23
1970	0.94	0.86			25.10
1971	0.96	0.89			25.06
1972	0.97	0.88			24.95
1973	0.98	0.93			24.85
1974	1.00	0.93			24.86
1975	0.95	0.89			24.70
1976	0.92	0.98			24.72
1977	0.87	0.94			24.84
1978	0.82	0.87			24.87
1979	0.79	0.89			24.94
1980	0.76	0.86	0.86		25.09
1981	0.72	0.81	0.84	0.88	25.19
1982	0.72	0.84	0.84	0.88	25.30
1983	0.70	0.85	0.83	0.89	25.48
1984	0.67	0.85	0.82	0.88	25.66
1985	0.66	0.82	0.81	0.87	25.89
1986	0.64	0.78	0.79	0.85	26.05
1987	0.63	0.80	0.79	0.86	26.26
1988	0.65	0.81	0.79	0.86	26.48
1989	0.64	0.74	0.78	0.85	26.66
1990	0.65	0.72	0.78	0.84	26.75
1991	0.64	0.80	0.77	0.83	26.87
1992	0.65	0.81	0.78	0.84	27.15
1993	0.63	0.78	0.76	0.82	27.27
1994	0.61	0.85	0.74	0.84	27.53
1995	0.60	0.86	0.74	0.85	27.84
1996	0.61	0.99	0.74	0.87	28.13
1997	0.60		0.74		28.61

Cohort fertility

birth cohort	$CTFR_1$
1933	0.88
1934	0.88
1935	0.87
1936	0.87
1937	0.87
1938	0.87
1939	0.87
1940	0.88
1941	0.88
1942	0.89
1943	0.89
1944	0.90
1945	0.90
1946	0.90
1947	0.90
1948	0.89
1949	0.89
1950	*0.89*
1951	*0.88*
1952	*0.89*
1953	*0.89*
1954	*0.89*
1955	*0.88*
1956	*0.88*
1957	*0.87*
1958	*0.86*
1959	*0.86*
1960	*0.85*
1961	*0.83*
1962	*0.82*

The NETHERLANDS

Year	TFR_1	adj TFR_1	$PATFR_1$	adj $PATFR_1$	MAB_1
1965	1.01	0.93			25.18
1966	1.01	0.94			25.12
1967	1.01	0.95			25.03
1968	0.98	0.90			24.97
1969	0.97	0.88			24.85
1970	0.91	0.86			24.78
1971	0.87	0.89			24.75
1972	0.84	0.92			24.81
1973	0.78	0.84			24.92
1974	0.74	0.84			24.96
1975	0.71	0.84			25.16
1976	0.69	0.78			25.28
1977	0.66	0.75			25.41
1978	0.67	0.76			25.52
1979	0.67	0.74			25.66
1980	0.68	0.75	0.79		25.72
1981	0.66	0.76	0.77	0.81	25.84
1982	0.63	0.76	0.75	0.81	25.99
1983	0.63	0.78	0.74	0.80	26.19
1984	0.66	0.84	0.75	0.81	26.37
1985	0.65	0.89	0.75	0.85	26.63
1986	0.67	0.91	0.76	0.86	26.89
1987	0.67	0.85	0.76	0.84	27.16
1988	0.68	0.79	0.76	0.82	27.32
1989	0.68	0.79	0.76	0.81	27.43
1990	0.72	0.86	0.78	0.83	27.59
1991	0.73	0.89	0.78	0.86	27.75
1992	0.70	0.88	0.77	0.85	27.96
1993	0.70	0.80	0.77	0.81	28.15
1994	0.70	0.82	0.77	0.81	28.22
1995	0.69	0.84	0.76	0.82	28.42
1996	0.70	0.77	0.77	0.80	28.57
1997	0.74	0.79	0.78	0.80	28.61
1998	0.78	0.81	0.80	0.79	28.71
1999	0.79	0.76	0.79	0.76	28.67
2000	0.83	0.81	0.81	0.81	28.62

Cohort fertility

birth cohort	$CTFR_1$
1935	0.88
1936	0.88
1937	0.90
1938	0.88
1939	0.88
1940	0.88
1941	0.90
1942	0.89
1943	0.90
1944	0.89
1945	0.88
1946	0.88
1947	0.87
1948	0.87
1949	0.86
1950	0.85
1951	0.85
1952	0.83
1953	0.83
1954	*0.82*
1955	*0.82*
1956	*0.82*
1957	*0.81*
1958	*0.81*
1959	*0.81*
1960	*0.81*
1961	*0.81*
1962	*0.81*
1963	*0.80*
1964	*0.80*
1965	*0.80*
1966	*0.80*

MAB_1 - mean age of mother at birth of first child (computed from the age-specific fertility rates).
Estimates of completed cohort fertility for birth cohorts who did not complete their reproduction are shown in italic.

APPENDIX 3: Comparison of period and cohort fertility, country results

Average annual differences between completed cohort fertility by birth order and corresponding period fertility indicators (%)

Table A: *Birth order 1*

	Czech Republic			**Italy**		
period	1966-71	1972-79	1980-92	1965-80	1981-89	
TFR	5.71	4.30	2.50	7.88	21.48	
adj TFR	6.26	1.50	2.92	3.78	4.92	
PATFR	1.77	0.45	1.45		4.83	
adj PATFR	2.28	0.55	2.11		2.13	
	The Netherlands			**Sweden**		
period	1965-80	1981-1994		1975-80	1981-90	1991-93
TFR	12.58	15.96		15.29	13.94	2.26
adj TFR	4.87	6.11		7.33	6.37	24.82
PATFR		5.26			5.53	1.02
adj PATFR		2.95			2.68	8.66

Table B: *Birth order 2*

	Czech Republic			**Italy**		
period	1966-71	1972-79	1980-92	1965-80	1981-89	
TFR	12.24	15.04	4.89	7.29	17.69	
adj TFR	12.49	7.31	2.30	3.13	3.09	
PATFR	8.71	3.67	0.98		18.29	
adj PATFR	9.67	2.61	2.86		7.35	
	The Netherlands			**Sweden**		
period	1965-80	1981-1994		1975-80	1981-90	1991-93
TFR	10.22	17.20		11.96	10.96	1.73
adj TFR	5.31	5.32		5.39	3.27	10.81
PATFR		14.53			11.50	0.54
adj PATFR		5.65			6.60	15.17

Table C: *Birth order 3+*

	Czech Republic			Italy		
period	1966-71	1972-79	1980-92	1965-80	1981-89	
TFR	8.91	22.71	22.71	10.85	18.64	
adj TFR	4.82	16.69	16.69	9.40	7.04	
PATFR	32.40	22.19	22.19		46.64	
adj PATFR	37.82	30.90	30.90		33.16	
	The Netherlands			**Sweden**		
period	1965-80	1981-1994		1975-80	1981-90	1991-93
TFR	12.30	8.11		22.12	9.70	10.80
adj TFR	13.89	4.92		14.37	6.92	11.19
PATFR		28.23			21.47	9.26
adj PATFR		10.08			18.24	38.59

Table D: *Total fertility*

	Czech Republic			Italy		
period	1966-71	1972-79	1980-92	1965-80	1981-89	
TFR	6.50	11.20	2.75	11.60	18.67	
adj TFR	6.50	5.86	2.36	7.63	2.39	
PATFR	8.16	4.96	2.61		15.17	
adj PATFR	9.47	5.71	2.13		5.95	
com TFR	3.74	4.36	2.34		2.88	
	The Netherlands			**Sweden**		
period	1965-80	1981-1994		1975-80	1981-90	1991-93
TFR	16.46	15.00		16.20	12.70	3.30
adj TFR	11.38	5.36		4.20	5.62	17.98
PATFR		13.17			11.89	3.40
adj PATFR		5.15			7.95	18.77
com TFR		3.32			6.33	12.52

APPENDIX 4: List of abbreviations and symbols used in the paper

***a* –** age

***adjPATFR* –** tempo-adjusted and variance-adjusted index of total fertility, computed from the parity-specific birth probabilities

***adjTFR* –** Bongaarts-Feeney tempo-adjusted total fertility rate

***AP* –** age-period perspective (events of interest sorted by age in completed years)

***ASFR* –** age-specific fertility rates (reduced rates), computed for 1-year age groups of women

***B* –** number of births

***BF* –** Bongaarts-Feeney

***C* –** birth cohort

***CFR* –** completed cohort fertility

***i* –** parity (birth order) of a child

***F* –** females

***KO* –** Kohler-Ortega

***KP* –** Kohler-Philipov

***MAB* –** period mean age of mother at childbearing computed from the age-specific fertility rates

***P* –** population size

***PATFR* –** index of total fertility computed from the parity-specific birth probabilities using fertility tables

***PC* –** period-cohort perspective (period events of interest sorted by year of birth of a given birth cohort)

PPR_i – period parity-progression ratio (period probability that a woman having i-1 children will have another one during her reproductive life)

q – age-specific and parity-specific birth probability

***r* –** change in the mean age of mother at childbearing (*MAB*)

***t* –** year

***TFR* –** period total fertility rate