# CHAPTER 4

# TEMPO-QUANTUM AND PERIOD-COHORT INTERPLAY IN FERTILITY CHANGES IN EUROPE:
## Evidence from the Czech Republic, Italy, the Netherlands and Sweden*

*Using detailed data on period and cohort fertility in four European countries, this chapter evaluates different indicators of period fertility, including indicators adjusted for changes in fertility timing. The 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 conventional total fertility rate (TFR). This pattern of differential period-cohort approximation widely varies by birth order. While the TFR constitutes a distorted, potentially misleading indicator of fertility, each of its alternative counterparts also has shortcomings, and none of them represents an unambiguous measure of fertility quantum. Despite these shortcomings, the alternatives to the conventional TFR provide valuable insights and may serve for the assessment of tempo distortions as well as projections of period and cohort fertility.*

## 4.1 INTRODUCTION

The most commonly used indicators of period fertility are sensitive to changes in the timing of childbearing. During timing shifts in the fertility schedule—whether the postponement or advancement of births—period fertility measures reflect the interplay of both the *quantum* (level) and *tempo* (timing) components. Since the early 1970s, postponement of childbearing has become one of the most prominent features of European fertility trends (see Chapter 3). The ongoing fertility postponement has 'deflated' the most usual indicator of period fertility, the total fertility rate (TFR), which has declined in many countries to extremely low levels (see Chapter 6). For instance, the *TFR* for birth order 1 declined below the level of 0.60 in Spain (1995-98), the Czech Republic (1995-2002), Hungary (1997-2000) and Latvia (1997-99). Such values do not indicate an unprecedented increase in childlessness, but rather a distinct deferment of births, which has been most intensive in these countries (see also Chapter 5). They also illustrate that due to fertility postponement the TFR has lost its descriptive power as an indicator of period fertility quantum.

Widespread use of total fertility rates often leads to the misinterpretation of fertility trends, resulting in exaggerated assessments concerning the current level of period fertility as

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well as 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 are either free of the distortions present in the TFR or provide an adjustment for these distortions. Although alternatives to the TFR are known and occasionally used (see e.g. Barkalov and Dorbritz 1996; Rallu and Toulemon 1994 and subsequent comments in Population 1994), extensive discussion of these indicators did not start until 1998, when Bongaarts and Feeney proposed a simple adjustment of the total fertility rate, which aims to remove the tempo changes.

This chapter 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 may be formulated as follows: 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 period fertility indicators: Do they adequately represent the period trends? Is it possible to make inferences or projections concerning cohort fertility based on current period fertility measures? Does the use of adjusted fertility indicators improve our understanding of fertility change?

The goals of this chapter are formulated as follows:

1. To discuss specific issues connected with the use of synthetic cohort indicators of period fertility.
2. To analyse trends in period fertility with the use of indicators that are free of some of the 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 the specific advantages and disadvantages of this approach.
4. To illustrate the potential benefits of the use of adjusted period fertility measures.

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[1] There are many examples of overly simplistic assumptions concerning 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 until 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 total fertility rates and is not related to the real experience of any birth cohort of women. The misreading of period fertility indicators may be even more serious with respect to order-specific TFR. Rychtaříková and Akkerman (2003: 235) interpreted the decline in first-order TFR in the Czech Republic to the level around 0.52 in the late 1990s as an "unprecedented rise in the percentage of childless women, from virtual nil in the early 1970s to almost 50% in the 1990s."

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

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 provided separately for birth orders 1, 2, and 3+ and for total fertility.

The chapter is divided into ten sections. The Introduction is followed by a theoretical discussion of period fertility indicators (Section 4.2). Section 4.3 provides a description of methods and indicators used, while Section 4.4 gives an overview of the data. A brief account of recent trends in period and cohort fertility in the four analysed countries is given in Section 4.5. Section 4.6 presents a comparison of period and cohort fertility indicators; further criteria on the use of various period indicators are proposed in Section 4.7. Section 4.8 discusses the tempo-quantum and period-cohort interaction, focusing on age-parity birth probabilities. Section 4.9 illustrates new insights obtained from the use of the adjusted period fertility indicators. The subsequent section concludes this chapter.

## 4.2 PERIOD FERTILITY INDICATORS: THEORETICAL CONSIDERATIONS

### 4.2.1 Indicators of period fertility

Generally, four basic approaches to measuring the level of period fertility may be distinguished. The first is a simple indicator of birth rate, the second and third are based on 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 vital statistics and surveys (for analysis of survey data see Wunsch 1999). However, national statistical offices usually do not collect the 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* (*incidence rates*, or *reduced rates,* also known as *central birth rates, frequencies*, and *rates of the second kind*), which relate the number of births among women in a given age group to all women in that age group. The terms 'incidence rates' and 'reduced rates' are used throughout this study. 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 (*CTFR*). 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 age structure of the female population. 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 ASFRs are subjected to distortions in fertility timing—postponement or advancement of births and changes in the shape of the fertility schedule. When the data on births by birth order are available, the ASFRs and the TFR can be 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 $ASFR_i$ do 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[3] composition of the female population and its changes over time (see Chapter 3, Sections 3.3.2 and 3.5.1).

(3) Age and parity-specific childbearing *probabilities* and *intensities* (also known as *occurrence-exposure rates* or *hazard 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.[4] A summary index, analogous to the *TFR,* has been termed as the *parity-adjusted TFR* (Park 1976), *age-parity specific TFR* (Schoen 2003), or *index controlling for parity and age* (*PATFR*; Rallu and Toulemon 1994: 65-67). A specific variant of this indicator is Yamaguchi and Beppu's (2004) parity-specific *TFR*, which employs an exposure rate that defines the population at risk as all women who have not experienced a birth of a given order.[5] Childbearing *probabilities* and *intensities* may be organised within the framework of multistate fertility tables, depicting the 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)). Using the example of the Czech Republic in 2002, Chapter 3 (Section 3.3.1) gives an illustration of the construction and main functions of a fertility table of birth order 1. Various indicators of fertility tables are discussed by Park (1976), Chiang (1984), Willekens (1991a) and Ortega

[3] 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, including those when different period indicators are compared with each other and with the cohort fertility, the term 'birth order' is used.

[4] Barkalov and Dorbritz (1996: 469) and Barkalov (1999: 31) compiled a list of studies which provide country-specific time series of parity-progression indicators.

[5] Differently from standard parity-progression calculations, where only women at parity *i-1* are exposed to childbirth of order *i*, Yamaguchi and Beppu's (2004) fertility index allows each woman at any parity less than *i* to be exposed to childbirth of order *i*.

and Kohler (2002); the construction of general increment-decrement life tables is described in Schoen (1975). The use of the PATFR concept, illustrated in Section 3.3.2, is limited by the inadequate availability of data on the distribution of women by parity and age. Although the PATFR eliminates the bias, present in the order-specific TFR and ASFR, of relating births specified by birth order to all women of a given age, 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 the number of births of a particular birth order. Several researchers (e.g. Ní Bhrolcháin 1992: 614; Hobcraft 1993: 450) suggested that duration since the previous birth should also be included in period fertility indicators. Feeney (1983: 76) 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), or specified as a function of age, identical with the PATFR concept (see *PDTFR* in Rallu and Toulemon 1994).

Other indicators of period fertility have been proposed as well. A specific case is '*average cohort fertility'* (Schoen 2004), a period fertility indicator derived from the completed cohort fertility. A more detailed overview of different fertility indicators is provided in Rallu and Toulemon (1994) and Ortega and Kohler (2002). The discussion and analysis in this study focuses on fertility indicators based on incidence rates and age-parity birth probabilities. Owing to a lack of data, the indicators based on duration were not included in the analysis.

### 4.2.2 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 is by far the most common indicator of period fertility, most attempts have been made to adjust the TFR for tempo distortions. Brass (1991) calculated estimates of 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 order-specific total fertility rates and annual changes in the order-specific mean age at childbearing.

The BF adjustment has stimulated 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; UN 2003; Yamaguchi and Beppu 2004; Sobotka 2004). Nevertheless, controversy surrounded both the idea of adjustment and the meaning of adjusted indicators. Van Imhoff and Keilman (2000), Kim and Schoen (2000), Kohler and Philipov (2001), Schoen (2004), and Yamaguchi and Beppu (2004) emphasise the inadequacies of the BF adjustment. Two major deficiencies of the Bongaarts-Feeney approach may be 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 which assumes that the shape of the fertility schedule remains constant. (2) The BF adjusted TFR as well as the conventional TFR may be distorted by changes in the distribution of women by parity (see also Chapter 3, Section 3.5).

Consequently, efforts have been made to improve the adjustment indicators. Kohler and Philipov (2001, hereafter referred to as KP) proposed an extension of the adjusted TFR to allow for variance effects, thus eliminating 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 occurrence-exposure rates (*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). A different approach has been taken by Yamaguchi and Beppu (2004), who have made the distinction between *'spurious tempo bias'* (the distortion of the conventional TFR as compared with their TFR index) and *'genuine tempo bias'*, which is addressed by the proposed adjustment to their TFR index.

### 4.2.3 The meaning of adjusted fertility indicators

Do adjusted measures really provide useful information about period fertility? The fact that synthetic cohort indicators are subjected to timing distortions is widely recognised among demographers. Some of them proposed 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)

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? The largest controversy surrounds the Bongaarts-Feeney indicator, which has become the best known alternative to the conventional TFR. 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 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 an "additional and very useful measure for analysing fertility patterns, especially when fertility is subject to strong and fluctuating tempo effects." On the other hand, quite a few researchers remain sceptical about the usefulness of the Bongaarts-Feeney approach and other adjusted indicators, pointing out that these indicators are not able to represent the pure quantum of period fertility, owing to their unrealistic assumptions and volatility (e.g. Van Imhoff and Keilman 2000, Van Imhoff 2001, Schoen 2004).

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 the cohort fertility of women at 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. Besides Schoen's (2004) period indicator of '*average cohort fertility*,' an explicit link to cohort fertility has been also drawn by Yamaguchi and Beppu (2004: 26), who propose that their TFR index, by removing the main portion of the tempo bias, increases the association between the period TFR and cohort CTFR.

### 4.2.4 Focus of the chapter: 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 on how to judge the performance of the adjusted measures. Should they fluctuate or should they depict a stable pattern? Should they resemble 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 occasionally been performed using visual inspection of period and cohort fertility indicators. Bongaarts (2002: 430) 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 CTFR 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 CTFR and suggested that relatively little is gained from the more elaborate KP and KO adjustments.

Inspired by the discussion on the meaning of adjustment methods, this chapter aims to explore whether some period fertility indicators are systematically closer to cohort fertility measures. The rationale behind this exploration may be formulated as follows: given that the postponement of childbearing tends to depress total fertility rates well below the level that would otherwise be recorded, the adjustment for tempo effects, which provides an estimate of the 'pure quantum' of period fertility, is also likely to reflect better 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 completed cohort fertility.

Is it useful to know which indicator of period fertility approximates better the completed fertility of birth cohorts realising births in a given period? Should we not look at 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 fertility postponement, 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 fertility postponement, 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 CTFR, they may offer better insight into the following questions: At what level will period fertility—and consequently also 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 at the ages of highest fertility?

### 4.2.5 Timing effects in period fertility: An illustration

The post-communist countries of Central and Eastern Europe constitute the last group of countries experiencing the onset of fertility postponement (see Chapters 3 and 7). 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. The increasingly common phenomenon of very low TFR levels 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; Caldwell and Schindlmayer 2003; Morgan 2003; Voas 2003; Billari and Kohler 2004; Billari et al. 2004). Kohler, Billari and Ortega (2002) have used the term 'lowest-low fertility' (defined as TFR below 1.30) to highlight a special situation within a widespread 'low fertility' pattern. The 'lowest-low fertility' is typically associated with a marked postponement of childbearing. Although it may persist for a relatively long period of time, it appears to be a temporary phenomenon which does not lead to similarly low cohort fertility (see Chapter 6). Table 4.1 provides an illustration of such a situation. Suppose a country experiences a shift from early to late childbearing. This shift takes 35 years, during which the mean age of the fertility schedule (MAB) increases annually by 0.2 years of age. Over the whole period, the TFR remains at a low level of 1.35. One might expect a decline in cohort fertility towards the level of the period TFR over such a long period and, more generally, convergence between cohort and period TFR.

Nevertheless, sustained low TFR persisting over two or three decades does not necessarily induce decline in cohort fertility to similarly low levels, provided that the postponement of births does not come to an end. Continuous postponement, as shown in Table 4.1, 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*). Even if such an example may seem unrealistic, implying delay in childbearing among women by seven years over a period of 35 years, the various fertility schedules shown in the table correspond to the schedules experienced in European countries over the 1990s. The 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 to the fertility schedule in the Netherlands in 1999 (although the TFR of 1.65 was considerably higher there; MAB=30.3). While 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 clearly shows that the TFR may give misleading signals about trends in cohort fertility for a long period of time.

***Table 4.1.*** An illustration of tempo effects: cumulative age-specific fertility rates, period and cohort fertility indicators in a country with stable TFR (1.35) and ongoing postponement of births

| Age group | Year 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** |

## 4.3 METHODS

### 4.3.1 Linking period and cohort fertility

The core of this 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[6] 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 the 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 $Y = t - MAB_i$, where $MAB_i$ is the mean age of the fertility schedule computed from age-specific fertility rates (incidence 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 completed fertility are taken into account (see Table 4.2 for an overview of birth cohorts included in the analysis). The completed cohort fertility of women who have not reached age 50 was estimated assuming they would realise the remaining part of their fertility according to the schedule of the ASFR for the last available year. Although the use of exposure-based indicators would be more appropriate, the estimate deals only with a small fraction of ultimate fertility realised at relatively high ages. This is a conservative estimate of completed fertility, assuming no further 'recovery' of fertility among women approaching the end of their reproductive age.

Differences between period and cohort indicators are compared separately for each birth order (see Section 4.6). 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 4.2 below). 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 this comparative analysis. The average values of annual absolute differences between the period TFR and the ultimate cohort fertility serve as a benchmark, establishing how much more closely the other period fertility indicators approximate the CTFR. Visual inspection of the figures comparing the trends of various fertility indicators adds another dimension to the evaluation of their performance over time. Selected additional criteria, such as fluctuations in period fertility measures, the occurrence of 'impossible' values, performance in 'extreme situations,' and the analysis of period-cohort fertility differences during the periods of rapid postponement are discussed in Section 4.7.

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[6] 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.

### 4.3.2 Indicators of period fertility used in the analysis

The following indicators of period fertility are compared in the analysis:

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

$$TFR = \sum_i TFR_i = \sum_i \sum_a ASFR_i(a) = \sum_i \sum_a \frac{B_i(a)}{P_F(a, T = July1)} \tag{4.1}$$

where *a* is age, *B* number of live births, *T=July 1* denotes mid-year estimate for the year *t*, and $P_F$ female population.

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

$$adjTFR_i(t) = TFR_i(t) / (1-r_i(t)) \tag{4.2}$$

where $r_i(t)$ is the change in the mean age at childbearing of birth order *i* between the beginning and the end of year *t*. Bongaarts and Feeney (2000: 563, fn. 1) recommend that $r_i(t)$ be estimated as $r_i(t) =[MAB_i(t+1) - MAB_i(t-1)] / 2,$ where $MAB_i(t)$ is the mean age of fertility schedule of order *i*, calculated from incidence rates ($ASFR_i(t)$). This computation is followed in the analysis. Alternatively, as suggested by Zeng Yi and Land (2001: 19, fn. 7), the change in median age may be used. Although they found median age less sensitive to random fluctuations, in the case of the four countries analysed in this chapter, the change in the median age depicted slightly wider fluctuations than the change in the mean age, particularly in the case of Sweden in 1990-1993. Analogous to the *TFR*, the tempo-adjusted total fertility rate for all birth orders is computed as the sum of the adjusted order-specific total fertility rates.

**(3) Period fertility indicator derived from parity-specific birth probabilities (*PATFR(i)*)**.

Age-specific and parity-specific birth probabilities $q_i(a)$ serve as an input of the multistate (increment-decrement) fertility table, treating each birth order separately (for the classification of life tables see, Willekens 1991a). Following Rallu and Toulemon (1994: 66), birth probabilities are estimated directly from the data on births combined with the parity and age structure of the female population (see also Chapter 3, Section 3.3.1):

$$q_i(a) = B_i(a) / P_{F,i-1}(a,T=January\ 1) \tag{4.3}$$

Equation 4.3 expresses the probability that a woman aged *a* and having *i-1* children will give birth during year *t*. Different from the $ASFR_i(a)$ calculation in Equation 4.1, the denominator is the parity-specific female population at the beginning of year *t*.

The concept of a fertility table for constructing the indicators of fertility tempo was introduced in Chapter 3, Section 3.3.1. Here, an illustration of the fertility quantum computation is also provided for parity 1. Consider a population of 10,000 women entering a fertility table of parity 1 at age 12: $P'_{F,0}(12)$ = 10,000. All women are initially childless. The apostrophe distinguishes table population *P'* from the real population *P*. The number of women still remaining childless at age *y* ($y \geq 13$) is given as (see Rallu and Toulemon 1994: 66, Eq. 2):

$$P'_{F,0}(y) = P'_{F,0}(12) \prod_{12 \leq a < y} \left(1 - q_1(a)\right) \tag{4.4}$$

and the number of ultimately childless women is equal to the table number of childless women at age 50 ($P'_{F,0}(50)$). 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):

$$PATFR_1 = P'_{F,i \geq 1}(50) \,/\, P'_{F,0}(12) = [P'_{F,0}(12) - P'_{F,0}(50)] \,/\, P'_{F,0}(12) \tag{4.5}$$

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 eventually give birth to 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 from 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:

$$PATFR_2 = P'_{F,i \geq 2}(50) \,/\, P'_{F,0}(12) = [(P'_{F,0}(12) - P'_{F,0}(50) - P'_{F,1}(50)] \,/\, P'_{F,0}(12) \tag{4.6}$$

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). Fertility tables also provide the parity distribution of women by age, as implied by the set of age-parity 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; and 5+ in the Czech Republic), were estimated as an open-ended category, depicting the probability of another birth among women with at least *U-1* children:

$$q_{i \geq U}(a) = B_{i \geq U}(a) \,/\, P_{F,i \geq U-1}(a, T = January\ 1);\ U > 0 \tag{4.7}$$

**(4) Tempo-adjusted and variance-adjusted period fertility indicator derived from parity-specific birth probabilities (*adjPATFR$_i$*).**

Kohler and Ortega (2002a) proposed an indicator derived from exposure-based indicators of age-parity specific fertility (birth probabilities and occurrence-exposure rates) which provides adjustment for both tempo and variance effects. Their method enables an estimation of 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 the fertility schedule. This is an analogy of the method developed earlier by Kohler and Philipov (2001) for an adjustment of incidence rates (see also Section 4.2.2). 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 study.[7] For each parity and single age group, parity-specific tempo change $r_i(a,t)$ was computed following Kohler and Philipov (2001: 8, Eq. 11): $r_i(a) = \gamma_i + \delta_i (a - \bar{a}_i)$, where $\gamma_i$ is the annual change in the mean age[8] of the fertility schedule (here represented by birth probabilities) at parity $i$, $\delta$ is the annual increase in the standard deviation of the schedule, and $\bar{a}$ is the mean age of the schedule. In this framework, fertility postponement, manifested by an increase in the mean age by $\gamma_i$, is directly translated into an increase of age-specific tempo change $r_i(a)$. However, an increase in the variance of the schedule, reflected by positive values of $\delta_i$, has a disproportional impact on tempo change $r_i(a)$ at different ages: it lowers the size of the tempo change at ages below the mean age $\bar{a}_i$ and increases the size of the tempo change at ages above this mean age (see Kohler and Philipov 2001: 8). Indicator $\gamma_i$ was estimated from the mean age of the probability schedule in a similar manner as the Bongaarts-Feeney estimate of $r_i$ above. The estimation of $\delta$ was based directly on an estimate in Result 12 in Kohler and Philipov (2001: 10), without performing the iterative procedure described in Result 13. Further details of this adjustment are elaborated in Kohler and Philipov (2001), Ortega and Kohler (2002), and Kohler and Ortega (2002a).

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

[8] In this case, mean age may be seen as a structural indicator related to the shape of the first birth probabilities schedule rather than an indicator of fertility timing in any real or synthetic population. To calculate the latter within the framework of birth probabilities or occurrence-exposure rates, the mean age should be based on the age distribution of births derived from the fertility table (see also Fn. 4 in Chapter 3 and Section 3.3.1).

## 4.4 DATA

Period and cohort fertility data were obtained from the sources listed in Appendix 1. Table 4.2 provides an overview of the primary data and derived incidence rates and age-parity birth probabilities for each country analysed. It further shows for which periods various summary indicators were estimated.

The series of incidence rates generally covers 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 combined with the age and parity structure of the female population, following Equation 4.3 above. All births were organised in a 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 perspective: $B_i(a) = [B_i(x-1) + B_i(x)] / 2$ , where $a$ is age reached during the year (cohort age) and $x$ is age in completed years at the time of birth $B$.

The cohort fertility was reconstructed by combining various data sources. The most recent reliable 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 the computation of age-parity specific birth probabilities $q_i(a)$. These time series were obtained by combining the initial cumulative cohort fertility distribution and period incidence rates prior to and after the year for which they were available. This method assumes that migration and mortality do not affect cohort fertility, that is, the distribution by

***Table 4.2.*** Overview of period and cohort fertility data used in the analysis

| | Czech Republic | Italy | The Netherlands | Sweden |
|---|---|---|---|---|
| Primary data | $B_i(a)$, $P_F(a)$ | $B_i(a)$, $P_F(a)$ (1980-85, 1990-97); $ASFR_i(a)$ (1965-79, 1985-89) | $B_i(a)$, $P_F(a)$ | $B_i(a)$, $P_F(a)$ |
| 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: | | | | |
| $ASFR_i(a)$, $TFR_i$ | 1965-2000 | 1964-1997 | 1964-2001 | 1974-2000 |
| $AdjTFR_i$ | 1966-1999 | 1965-1996 | 1965-2000 | 1975-1999 |
| Probabilities $q_i(a)$ and $PATFR_i$ | 1965-2000 | 1980-1997 | 1980-2001 | 1980-2000 |
| $AdjPATFR_i$ | 1966-1999 | 1981-1996 | 1981-2000 | 1981-1999 |
| Corresponding cohort fertility indicators are compared with period fertility measures for a given period: | | | | |
| | 1966-92 | 1965-89 | 1965-94 | 1975-93 |
| Cohort CTFR | C1916-87 | C1933-83 | C1930-87 | C1930-86 |
| Period for which CTFR estimated [1)] | 1965-2001 | 1980-98 | 1980-2002 | 1980-2001 |

NOTES:
1) Period for which cumulative cohort fertility by parity was reconstructed for all women of reproductive age.
OBSERVATION PERSPECTIVE:
AP age-period perspective (births organised by age of mother in completed years)
PC period-cohort perspective (births organised by the year of birth of mother)
See the List of acronyms and symbols for an overview of symbols for various fertility indicators.

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 4.2; a detailed description of data sources and estimates of cohort fertility is given in Appendix 1.

## 4.5 FOUR COUNTRIES, FOUR FERTILITY HISTORIES

Four countries, 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 distinct fertility histories.

The Netherlands is a country with relatively small fluctuations in total fertility (Figure 4.1a). A rather high-fertility regime prevailing until the mid-1960s was replaced after a decade of intensive fertility decline (1965-1975) 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 the slow-down and subsequent ending of the fertility postponement (Figure 4.2; see also Chapter 6). The TFR value of 1.72 reached in 2000 was the highest since 1974. In Sweden, fertility declined after the moderate baby boom in the mid-1960s, in line with trends in Italy and the Netherlands. However, starting in 1986 Sweden experienced a distinct baby-boom period culminating in 1990 (TFR 2.13), followed by a downturn with a trough in 1999 (TFR 1.49). 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 for paid parental leave for mothers in 1986. This measure 'accelerated' the births of second and third 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 often contrasted with the other three countries. A gradual decline in the TFR during the 1950s and 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 population policy measures (Frejka 1980, Koubek 1990). The 1980s were characterised by a relatively stable level of the TFR around 2.0; the sharp decline started in 1992, hand in hand with the increase in the mean age at childbearing. By the year 2000, the Czech Republic was—as measured by the TFR, which declined to 1.14—among the countries with the lowest period fertility in the world.

***Figure 4.1a.*** TFR in the Czech Republic, Italy, the Netherlands, and Sweden, 1960-2002

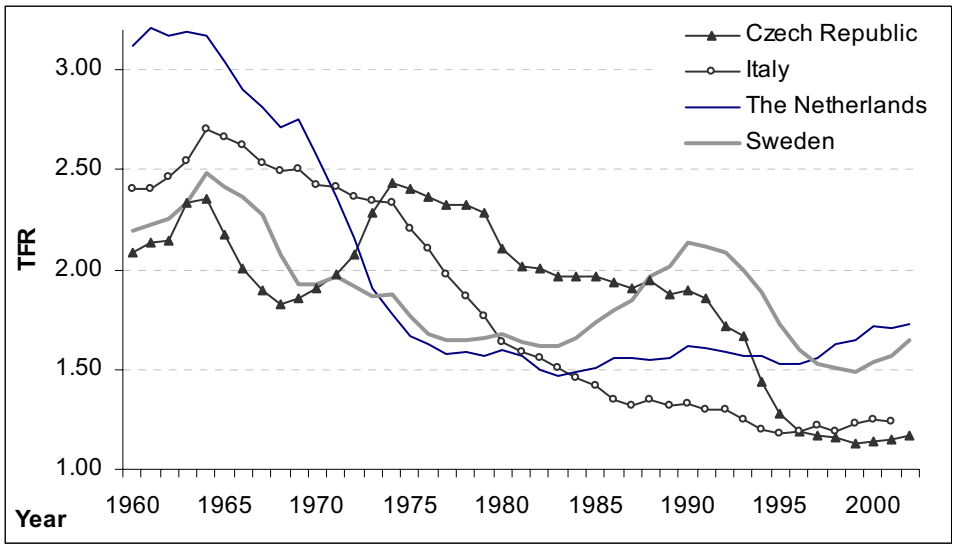
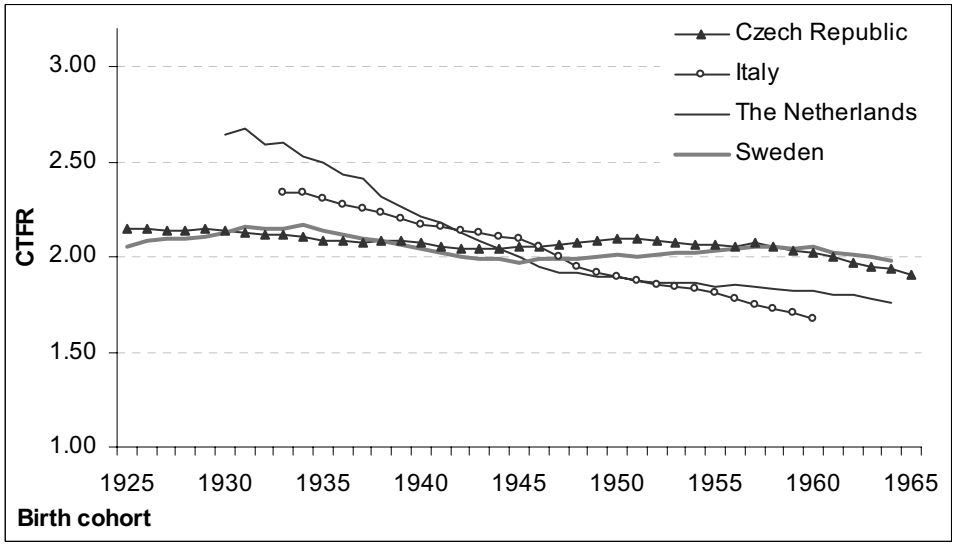



***Figure 4.1b.*** Completed fertility among women in the Czech Republic, Italy, the Netherlands, and Sweden (birth cohorts 1925 to 1965 (1960))



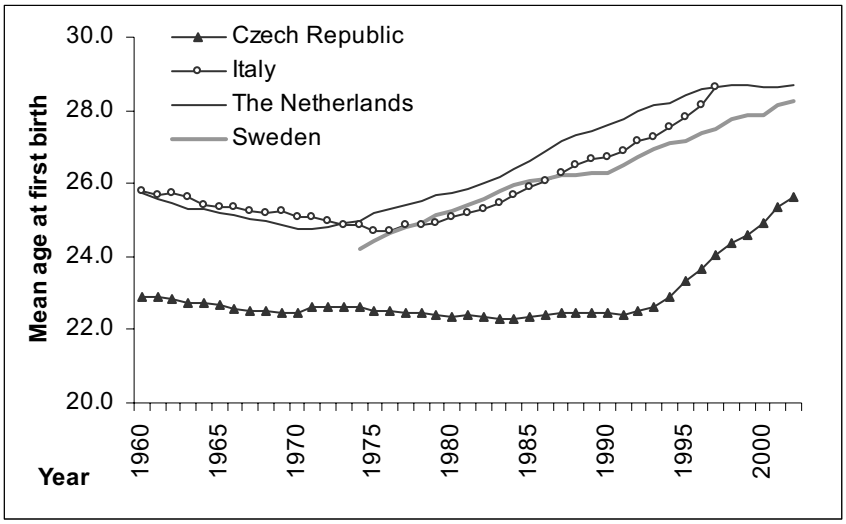

DATA SOURCES: Author's calculations based on data specified in Appendix 1; Council of Europe (2003)

Cohort fertility in these countries was characterised by considerable stability, as the ups and downs of period fertility affected cohort values to a much smaller degree (Figure 4.1b). The cohort fertility of women in Sweden and the Czech Republic showed a stable level around or somewhat above 2.0 children per woman among the cohorts born until the early 1960s. The cohort fertility of Dutch and Italian women was gradually decreasing, more rapidly (and from higher levels) among Dutch women born in the 1930s and 1940s and among Italian women born in the 1950s. Cohorts of women born around 1945 had on average around two children in all four countries (between 1.95 in the Netherlands and 2.06 in Italy).

Among younger cohorts, however, the differences increased again: in Italy and Sweden women born in 1960 have on average less than 1.7 children and 2.05 children, respectively.

Figure 4.2 shows the extent of first birth postponement as captured by the increase in the period mean age of first-time mothers. In Italy, the postponement started in 1977—several years later than in Sweden and the Netherlands. Subsequently, these three societies experienced very similar trends of fertility delay until the late 1990s, when the increase in the mean age at first birth stopped, at least temporarily, in the Netherlands. During this period, the mean age of first-time mothers increased by four years (see Chapter 3, Table 3.3). In the Czech Republic postponement started much later, in 1992. By then, Czech women were bearing children at an early age, in line with the pattern in other post-communist European countries. Since then, the postponement of first births has been proceeding much faster there than in the other three countries under discussion.

***Figure 4.2.*** Mean age of mother at birth of first child in the Czech Republic, Italy, the Netherlands, and in Sweden, 1960-2002




DATA SOURCES: Author's calculations based on data specified in Appendix 1.

## 4.6 COMPARISON OF PERIOD AND COHORT FERTILITY BY BIRTH ORDER

### 4.6.1 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, a divergence between fertility measures adjusted for tempo changes and the conventional TFR could be expected especially in the case of order 1 (see also Chapter 3, Section 3.5).

All of the analysed alternative indicators provide better approximation of cohort fertility than the $TFR_1$.[9] Only in the case of the Czech Republic, the Bongaarts-Feeney adjTFR did not provide a closer approximation of the cohort CTFR. During most of the analysed period (1966-1992), the timing of first births was very stable there and tempo effects were absent. It is worth mentioning that under these conditions the PATFR indicators based on the fertility table showed substantially higher stability than the TFR and displayed only a negligible difference from the cohort CTFR (see Figure 4.3). 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, indicators based on birth probabilities show that the increase in the $TFR_1$ was dominantly driven by 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 intensive fertility delay, characterised by the strongest differences between the period $TFR_1$ and the cohort $CTFR_1$, all alternative indicators came considerably closer to the $CTFR_1$. 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. Fertility table indicator $adjPATFR_1$ for the same period reached levels of 0.85-0.93, which do not imply a dramatic increase in cohort childlessness in the future.

Table 4.3 summarises the performance of fertility indicators of birth order 1 for all countries combined. The indicators based on age-parity birth probabilities, the PATFR and particularly its adjusted version, provide the closest approximation of the cohort $CTFR_1$. The adjPATFR comes closer to the cohort fertility in 81% of the cases (non-adjusted PATFR even in 89% of the cases) and reduces the difference between $TFR_1$ and $CTFR_1$ by three-quarters on average (see *index of improvement in approximation*).

Figure 4.3 displays period and cohort fertility for 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 CTFR than the ordinary TFR. However, it also shows

[9] Country-specific comparative tables of results can be consulted in Appendix 2 and 3 in Sobotka (2003).

***Figure 4.3***. Period and cohort fertility indicators of birth order 1 in the Czech Republic, Italy, the Netherlands, and Sweden

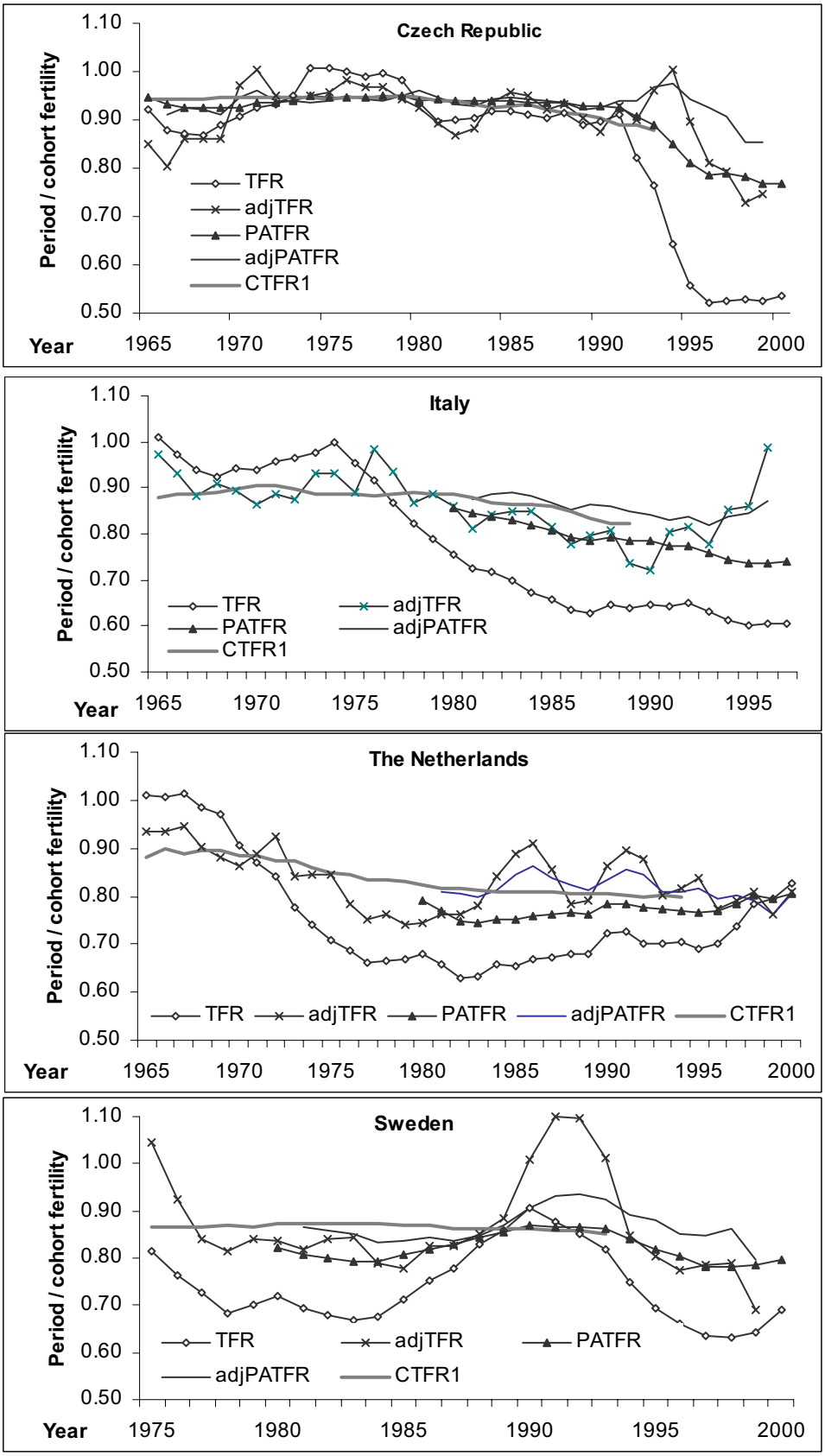


***Table 4.3***. Summary table for birth order 1. Degree to which the period fertility indicators approximate completed cohort fertility in comparison with the TFR

| | | **adjTFR** | **PATFR** | **adjPATFR** |
|---|---|---|---|---|
| (1) | Total years of observation | 101 | 63 | 63 |
| (2) | Of which years with better approximation than $TFR_1$ | 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 $TFR_1$ (%) | 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** |

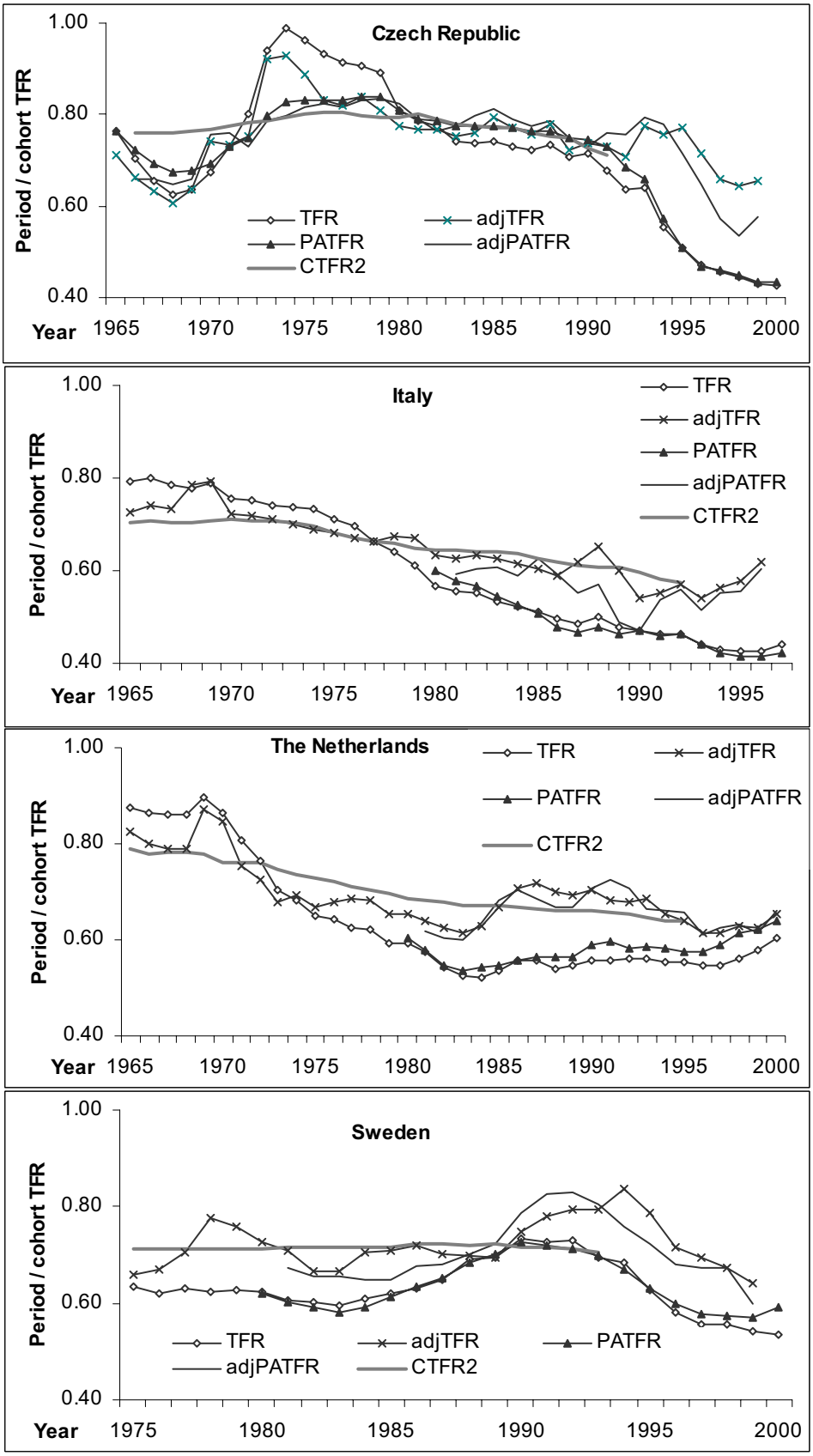
considerable fluctuations with peaks and troughs that are difficult to interpret. It can also reach absurd values of first-order TFR over 1.0, for instance in Sweden in 1975 and in 1990-1993 (see Section 4.7.3 below and Chapter 3, Section 3.5). The indicators based on birth probabilities are more stable and, by definition, remain within the theoretically possible range of cohort fertility distributions. The PATFR shows high stability and very good correspondence with cohort fertility during periods with no changes in fertility timing, such as in the Czech Republic before 1992. On the other hand, due to tempo distortions it displays systematically lower values than the corresponding cohort CTFR during periods of first birth postponement. Adjusted $adjPATFR_1$ comes close to the completed cohort fertility in most cases shown in the graphs and approximates the $CTFR_1$ particularly well in the case of Italy, where trends in period fertility seem to be relatively smooth and without sudden shifts.

One 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—most pronounced in the case of Sweden in 1991-94 when the TFR and the PATFR actually came close to the cohort CTFR and the adjusted measures reached extremely high values—reveal their limitations. Such sudden fertility swings cannot be easily adjusted for even when changes in the variance of fertility schedule are taken into account.

### 4.6.2 Fertility of birth order 2

In most cases, the 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. However, there were considerable swings 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. 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 4.4). Clearly, timing effects influence the fertility table measures of second

***Figure 4.4***. Period and cohort fertility indicators of birth order 2 in the Czech Republic, Italy, the Netherlands, and Sweden



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 shifts in fertility timing.

Although the fertility table indicators are more elaborate than the measures based on incidence 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$_2$. Whereas 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 CTFR of parity 2 by slightly more than 50% (Table 4.4). The adjPATFR for parity 2 was also characterised by larger fluctuations than for parity 1.

***Table 4.4.*** 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** |

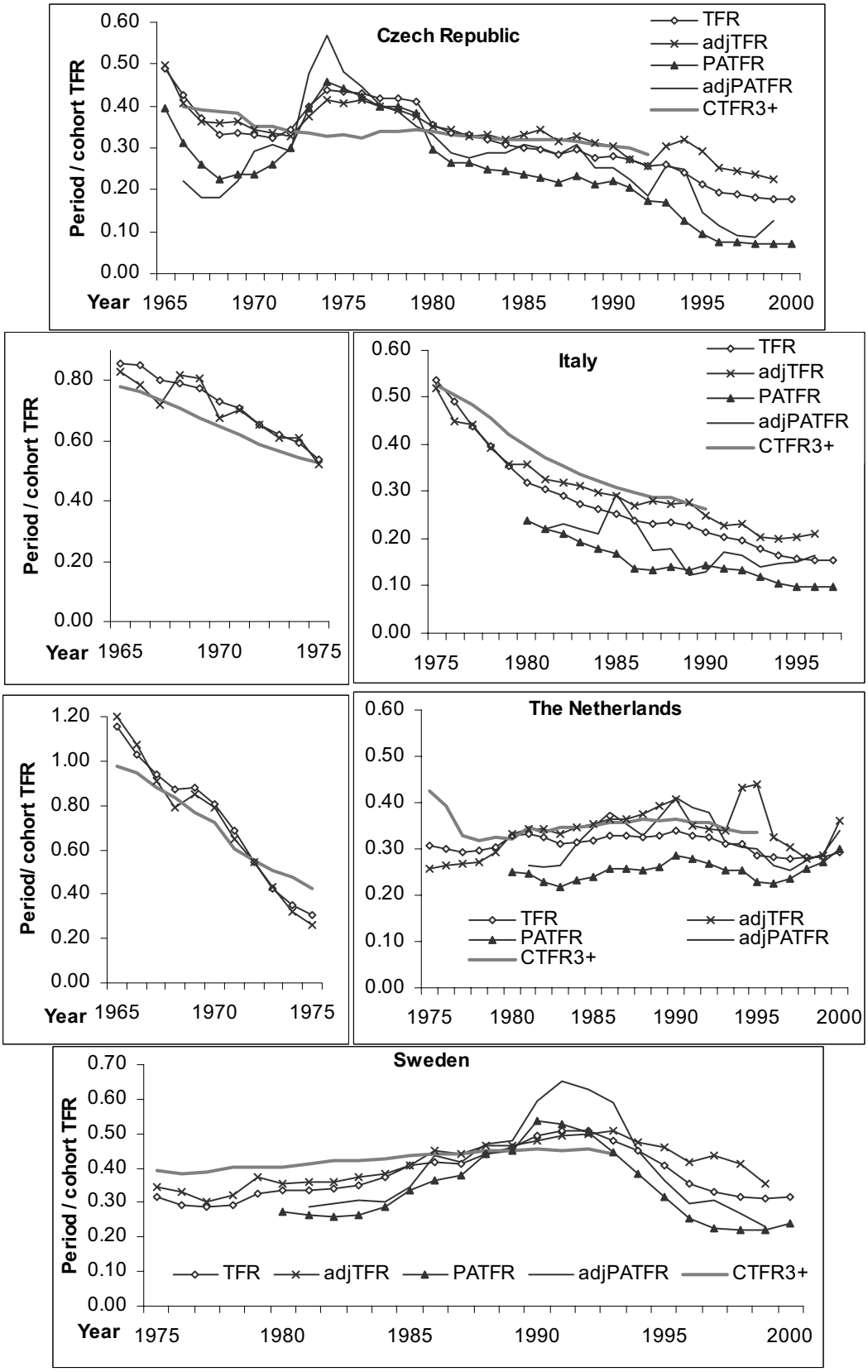
### 4.6.3 Fertility of birth order 3 and higher

The alternative period fertility indicators do not improve the approximation of completed cohort fertility of birth order 3 and higher. The fertility table indicator ($PATFR_{3+}$) usually displays values not only well below the cohort CTFR, but also below the period $TFR_{3+}$, showing worse approximation of cohort fertility in all compared situations (Table 4.5 and Figure 4.5). The adjusted $adjPATFR_{3+}$ eliminates part of the differences between the $PATFR_{3+}$ and the cohort $CTFR_{3+}$. However, it still provides poorer approximation of cohort fertility than the ordinary $TFR_{3+}$.

***Table 4.5.*** 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 4.5***. Period and cohort fertility indicators of birth order 3+ in the Czech Republic, Italy, the Netherlands, and Sweden



Of all the indicators considered, only the Bongaarts-Feeney $adjTFR_{3+}$ provides a slightly better approximation of the cohort $CTFR_{3+}$. Still, the improvement is very modest: although it comes closer to the $CTFR_{3+}$ in 77% cases as compared with the $TFR_{3+}$, it reduces the difference on average only by 23%. Thus, the performance of the *adjTFR* for birth order 3+ is also considerably worse than for the lower birth orders. Relatively slower postponement of third and later births (as compared with first and second births) as well as fluctuations in the mean age of the mother at birth orders 3+ negatively influenced 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 4.8.

### 4.6.4 All births combined: Period indicators of total fertility

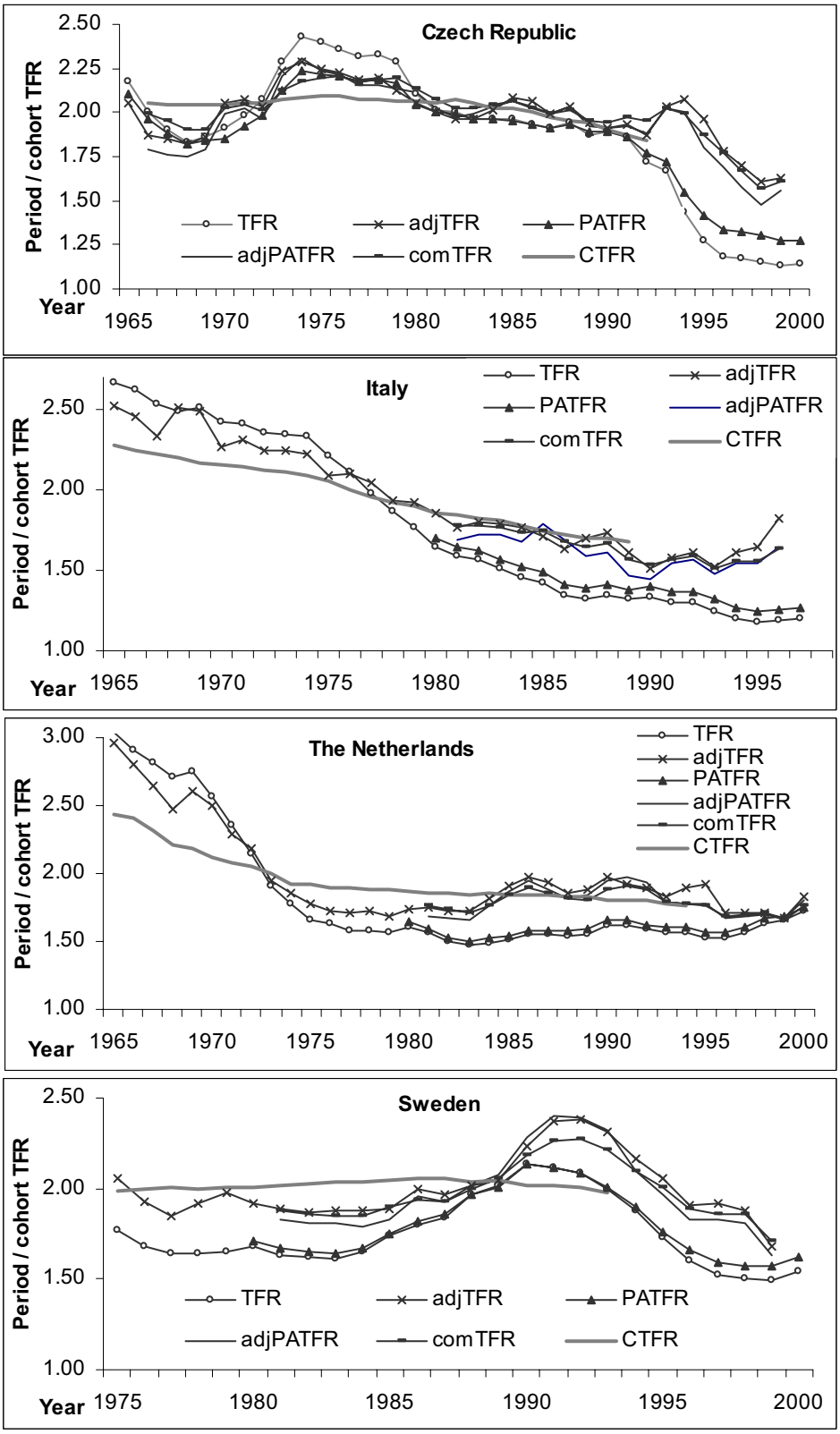
Table 4.6 and Figure 4.6 provide an overview of the approximation of cohort fertility using different indicators of period fertility for all birth orders. One additional indicator is introduced here: the hybrid indicator (*comTFR*) which combines the adjPATFR indicator for parity 1 and 2 with the TFR for birth order 3+. The rationale for this additional indicator is to combine indicators that best approximate the cohort fertility at each birth order. For birth order 3 and higher, the TFR was chosen instead of the adjTFR due to the stronger year-to-year fluctuations in the latter measure.

Among the analysed indicators, the PATFR does not come much closer to the cohort CTFR. During periods of shifts in fertility timing, the PATFR gives similar results to the TFR (see Figure 4.6). 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 4.6); the adjPATFR and adjTFR reduce, on average, less than half of the difference between the TFR and the CTFR. Derived from 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 reduces 62% of the differences between the TFR and CTFR. However, it is a measure computed in an inconsistent way, combining two different indicators, and thus it is also the most difficult to interpret. Worth pointing out is the notable

***Table 4.6.*** 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 (improvement in approximation) | **0.46** | **0.16** | **0.42** | **0.62** |

***Figure 4.6***. Period and cohort fertility indicators (all parities) in the Czech Republic, Italy, the Netherlands, and Sweden



convergence of all the analysed indicators in the Netherlands in the late 1990s after the fertility postponement stopped. This finding, notable also for the order-specific indicators and further supported by the evidence from the Czech Republic in the 1980s, indicates that when fertility tempo remains stable, different period indicators usually converge to the same level.

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

(1) 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 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+).

(2) 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.), while others seem to be the artificial results of applying a particular adjustment method or using particular indicators of period fertility. The fluctuation in fertility indicators is further addressed in Section 4.7.2.

(3) There appears to be consistency in the degree to which various period fertility indicators approximate cohort fertility. Measures based on fertility tables, particularly the adjusted ones, are consistently closer to the CTFR 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 CTFR. On the other hand, none of the analysed period measures comes considerably closer to the CTFR of parity 3+ than the TFR, and the fertility table indicators even display much larger differences.

## 4.7 ADDITIONAL CRITERIA TO ANALYSE THE PERFORMANCE OF PERIOD FERTILITY INDICATORS

### 4.7.1 Approximation of cohort fertility during periods of intensive postponement

So far this chapter has discussed 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 the fertility quantum in periods when the TFR is influenced by 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 annually and for which all compared indicators were estimated. This illustration comprises the evidence for 26 calendar years: for

***Table 4.7.*** 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** |
|---|---|---|---|---|
| (1) Total years of observation | 26 | 26 | 26 | 26 |
| (2) Of which years with better approximation than TFR | 26 | 26 | 26 | 26 |
| (3) Proportion of years with better approximation, % (2/1) | **100** | **100** | **100** | **100** |
| Average absolute differences from completed cohort fertility values | | | | |
| (4) Average abs. difference of TFR (%) | 17.13 | 17.13 | 17.13 | 17.13 |
| (5) Average abs. difference of alternative measure (%) | 4.53 | 14.80 | 6.45 | 4.02 |
| (6) INDEX (4-5)/4 (improvement in approximation) | **0.74** | **0.14** | **0.62** | **0.77** |

the Netherlands between 1981 and 1993, for Italy between 1981 and 1989 and for Sweden between 1981 and 1984. The summary table (Table 4.7) documents that 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 cohort fertility in all the years of observation. While the PATFR reduced the TFR-CTFR 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 CTFR, which was 17%, has shrunk to only a 4% distance between the comTFR and the CTFR. 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 shifts in fertility tempo, thus enabling inferences about the 'underlying' levels of cohort fertility and better reflecting the period fertility quantum.

While the TFR and the PATFR provide systematically lower values than the cohort CTFR once the delay of motherhood takes place, we may ask 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 rising infertility after age 35—actually never 'catch up,' adjusted indicators could be expected to show higher values on average than the ultimate cohort fertility. Table 4.8 indicates, however, that the opposite is true. Although only slightly, the adjTFR, adjPATFR, as well as the comTFR still indicated lower values on average than the completed cohort fertility of women giving births during the observed periods. This

***Table 4.8.*** Average relative differences between period fertility indicators and the corresponding completed cohort fertility (CTFR), in %

| | **The Netherlands** | **Italy** | **Sweden** | **Total** |
|---|---|---|---|---|
| Period | 1981-1993 | 1981-1989 | 1981-1984 | |
| 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 |

underestimation was smallest in the adjTFR (-0.9%), which also showed a slight overestimation (+1.8%) in the case of the Netherlands, and was more pronounced in the *comTFR* (-2.6%) and the *adjPATFR* (-3.5%).

In sum, adjusted indicators do not seem to provide overly 'optimistic' (i.e., high) approximations of cohort fertility. Moreover, smoothing or averaging values for longer periods erases some fluctuations, further reducing period-cohort fertility differences.

### 4.7.2 Fluctuations in fertility indicators

Period fertility indicators are characterised by less stability than 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, the 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 cannot be explained by any underlying causes.

To look at this volatility in a more systematic way, the annual absolute change in all indicators considered was analysed. Table 4.9 shows the average annual fluctuations as well as relative fluctuations with respect to the TFR and CTFR. It depicts substantial differences by birth order. Period indicators are characterised by considerably more intensive annual changes than the cohort CTFR. 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 a fertility table 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

***Table 4.9.*** Average 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** | **CTFR** |
| 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 CTFR (Average fluctuations in CTFR = 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** |

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, which may be related to the methodological shortcomings of these indicators.

### 4.7.3 'Impossible' cases

It is a well-known fact that the TFR may reach levels that cannot occur in real birth cohorts, such as a first-order TFR higher than 1.0, suggesting the absurd situation of more than 100% of women in a synthetic cohort having a first child. Such cases do not occur in multiplicative measures, where women are not exposed to birth of a given parity more than once. The impossible values depicted occasionally by the TFR may still be acceptable as indicators of 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 a total of 127 observations, the $TFR_1$ exceeded the level of 1.0 in six cases (4.7%)—in the Czech Republic in 1974-75, in the Netherlands in 1965-67 and in Italy in 1965. The adjusted $TFR_1$ in all these cases was below 1.0, indicating that the TFR was 'exaggerated' due to tempo effects, namely the advancement of births. However, the $adjTFR_1$ exceeded unity in seven other cases: in Sweden in 1975 and 1990-1993, and in the Czech Republic in 1971 and 1994. Apparently, the tempo-adjusted TFR by birth order is a problematic indicator of fertility quantum and should not be used for projections of cohort fertility trends unless extreme caution is exercised.

### 4.7.4 Performance in 'extreme' situations

Zeng 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; Van Imhoff 2001; Yamaguchi and Beppu 2004). However, according to Zeng 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 interquartile range of the fertility schedule exceeding 0.10 years were proposed as such instances (Zeng and Land 2001: 23).

Among the countries included in this analysis, such cases of fertility timing changes were not unusual. For instance, the mean age of the fertility schedule of birth order 1 based on incidence rates changed by more than 0.25 years in 16 out of 131 cases (12%), and the

interquartile range of age-specific reduced rates (ASFR) of order 1 changed by more than 0.10 years in 25 cases (19%). A rapid increase in the mean age is typical of countries experiencing an intensive postponement of births in the 1990s, particularly Italy and the Czech Republic. The Czech Republic after 1993 is a model case of 'extreme' situations: the mean age of the 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 the year 2000.

The Bongaarts-Feeney adjustment of first-order fertility in the Czech Republic ($adjTFR_1$, see Figure 4.3) does not—with the exception of a brief upward fluctuation in 1992-1994—seem to show exaggerated values in the 1990s as would be suggested by Zeng and Land's (2001) findings. Generally, when a rapid increase in the mean age or intensive changes in the interquartile range take place, adjusted indicators do not show stronger fluctuations or larger differences from cohort fertility. Many fluctuations appear to occur because of random influences or non-systematic changes, such as large and time-varying changes in the tempo and shape of the schedule (Zeng and Land 2001: 23). This applies also to the adjustment for variance effects, which often generates additional fluctuations.[10]

### 4.7.5 Calculating period fertility indicators

There are two major sources of difficulties in deriving 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 the wider acceptance and more extensive use of the indicators analysed.

In almost all European countries, data on births by age of mother, necessary for computing the TFR, are available. Nevertheless, some countries collect and publish data on birth order within current marriage, which is not a reliable indicator of birth distribution when the proportion of non-marital births is high (see Chapter 3, Section 3.2). The use of such data for inferring order-specific indicators should be avoided. In addition, the calculation of exposure-based indicators also requires data on the composition of the female population by parity, which are regularly published in only a small number of countries. Cohort indicators may be estimated on the basis of period data; nevertheless, time series covering sufficiently long periods are usually unavailable.

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[10] The analysis of Spanish fertility by Ortega and Kohler (2001, Appendix) is illustrative of such fluctuations. $TFR_1$ had been gradually declining between 1977 (0.98) and 1996 (0.57), with a short period of stabilisation around 1988 (0.69). Such low levels were obviously reached due to 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) indicates, however, even more pronounced fluctuations, with their adjusted $TFR_1$ 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.

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 unlikely that the latter indicators would become widespread and generally recognised alternatives to the TFR.

## 4.8 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? The very poor approximation provided by the indicators based on age-parity birth probabilities for parity 3 and higher is especially 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 4.9). The tempo effects have influenced the TFR at higher orders considerably less than at lower orders. One reason for this 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 who in their younger 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 births. Moreover, women having third or higher-order births form a 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 fertility table diverge so much both from the TFR and the completed CTFR in the case 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 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 the 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 previous years. Reduction 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 at a later stage display some recovery among older women, leading to a further increase in the mean age and higher CTFR 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 progressively higher ages. While this depicts real trend, the period probabilities of parity 2 and higher in the same year *t* still pertain to those 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 interest. The period calculation will therefore show an increasingly shorter exposure of the 'average' woman to higher-parity births, squeezed into higher ages and coupled with the unrealistically early fertility schedule pertaining to older birth cohorts, thus 'exaggerating' birth probabilities at young ages, while not accounting for 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 CTFR during the postponement are intensified by:

(1) increasing parity (the multiplicative effects of not accounting for the future recuperation of birth probabilities at higher ages);
(2) the length of birth intervals (longer birth intervals lead to an increasing time difference in experiencing higher-parity births between the period fertility table and the real cohort experience); and
(3) the intensity of postponement (more intensive delay of childbearing leads to stronger discrepancies between the period fertility table and the cohort fertility schedule, particularly at higher reproductive ages).

These features are specific to indicators based on the notion of sequential parity progression, that is, age-parity birth probabilities, occurrence-exposure rates, and the corresponding fertility table calculations. To a lesser extent, they also apply to the adjusted adjPATFR. The PATFR in fact reveals the consequences of current childbearing patterns under the hypothetical scenario of no future 'catch-up' effects. Many women may postpone first birth until such a late age that they will not be able to give birth again—an aspect which Kohler and Ortega (2002b) label as the '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 very low levels of fertility of third and higher parity, as currently indicated by the PATFR indicators.

## 4.9 USING ALTERNATIVE PERIOD FERTILITY INDICATORS: AN ILLUSTRATION

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

### 4.9.1 Estimating *tempo* and *quantum* components in period fertility change

The tempo-adjusted measures provide a framework which enables the estimation of the *tempo* and *quantum* components in fertility change and 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 quantum effects? Since fertility postponement in the Czech Republic started after 1990, I assume that the TFR in 1990 reflects the period quantum for that year.

Table 4.10 compares the *TFR* 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 tempo effect, temporarily depressing the TFR level.

The role of the tempo and quantum components varies by birth order. Decline in first-order TFR after 1990—more intensive than for other orders—was almost entirely driven by fertility postponement, with only 12% estimated as quantum effect. This is the most

***Table 4.10.*** 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 in 1990 | | 0.897 | 0.715 | 0.282 | 1.893 |
| (2) TFR in 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 |
| | | **Decomposition of fertility change 1990-1999:** | | | |
| (6) *Quantum* effect (abs.) | (5)-(1) | -0.044 | -0.137 | -0.055 | -0.285 |
| (7) *Tempo* effect (abs.) | (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 |

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 slightly prevailed (59%) in the decline of the TFR of orders 3 and higher. The postponement of childbearing had a prominent influence on overall TFR decline. While the TFR for 1999 reached the lowest recorded level, 1.13, the comTFR indicated a markedly higher level of 1.61, suggesting that only 38% of the TFR decline since 1990 (TFR 1.89) occurred because of 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. A similar approach to evaluating the extent of tempo distortions in recent fertility decline in Central and Eastern Europe is used in Chapter 7, whereas a more general framework for assessing the magnitude of tempo effects in European countries and regions is used in Chapter 6.

### 4.9.2 Implications of period fertility trends for cohort fertility

Cohort fertility scenarios and assessments of the implications of current period fertility for future cohort fertility, age structure, and family composition are often still formulated on the basis of the trends in the TFR. However, a very simplistic scenario which assumes that the most recently recorded incidence 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 current tempo and variance-adjusted age-parity birth probabilities will continue may offer rather more realistic estimates of 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 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 age and order-specific incidence rates (Scenario 1) and age-parity specific tempo-adjusted and variance-adjusted birth probabilities (Scenario 2). 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 the starting point of the analysis. Since then, women in Italy are assumed to experience order-specific incidence rates of 1997 (Scenario 1) and adjusted age-parity probabilities of 1995 (Scenario 2)[11]; women in the Czech Republic are assumed to experience incidence rates of 2000 (Scenario 1) and adjusted probabilities of 1999 (Scenario 2). While the computation of cohort scenarios is simple and straightforward in the case of the order-specific incidence rates, the multiplicative nature of birth probabilities makes the calculation

[11] The age-parity birth probabilities in Italy were estimated for the period until 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 the recent period.

of cohort scenarios more complex. For each age and parity category of women, the proportion of women experiencing 1, 2, 3, etc. additional births until the end of their reproductive life has to be calculated. The resulting age-specific table with all the lifetime transition probabilities between various parities (0-1, 0-2, 0-3, 0-4, 0-5+, 1-2, 1-3, 1-4 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 4.7, 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 completed cohort fertility ultimately stabilises

***Figure 4.7.*** Scenarios of the future cohort fertility in the Czech Republic and Italy based on the most recent incidence rates and adjusted age-parity probabilities

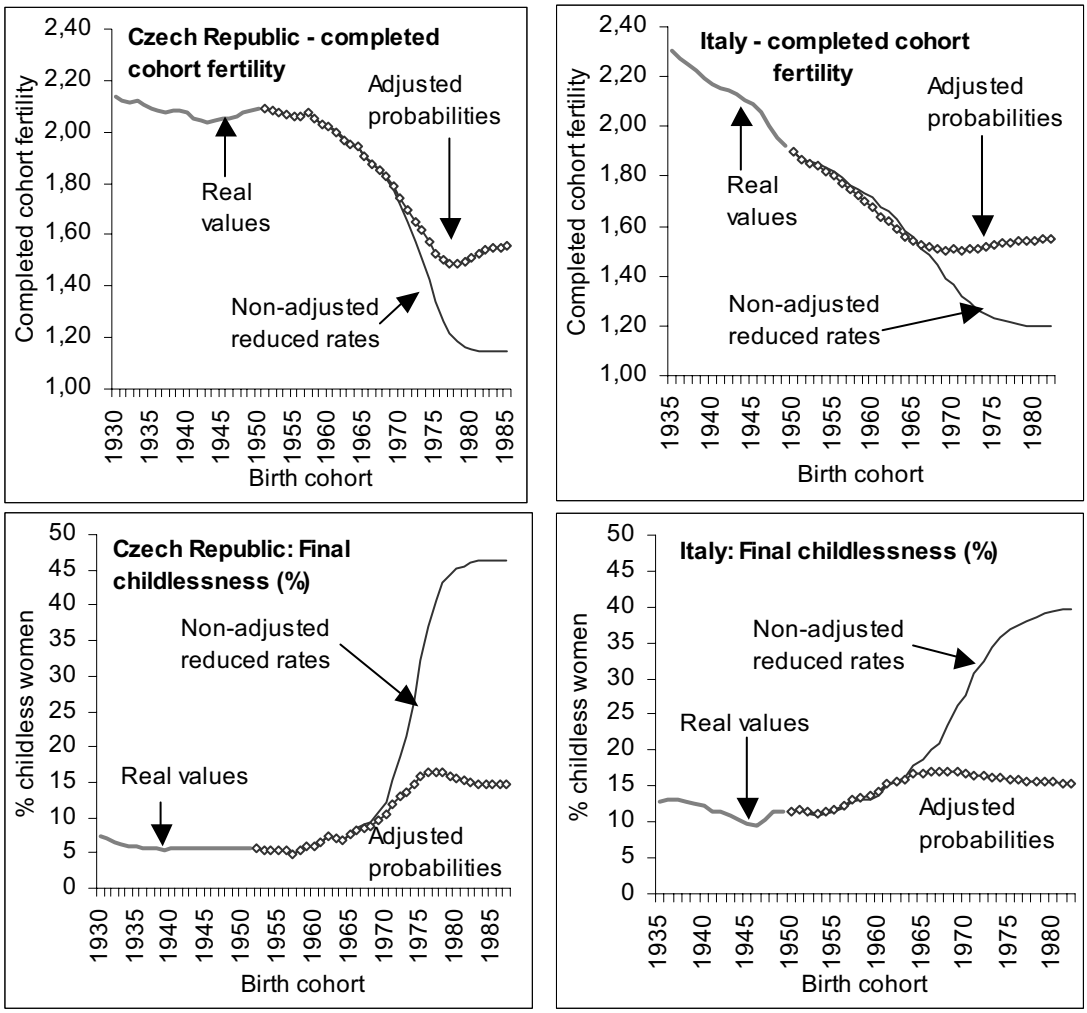
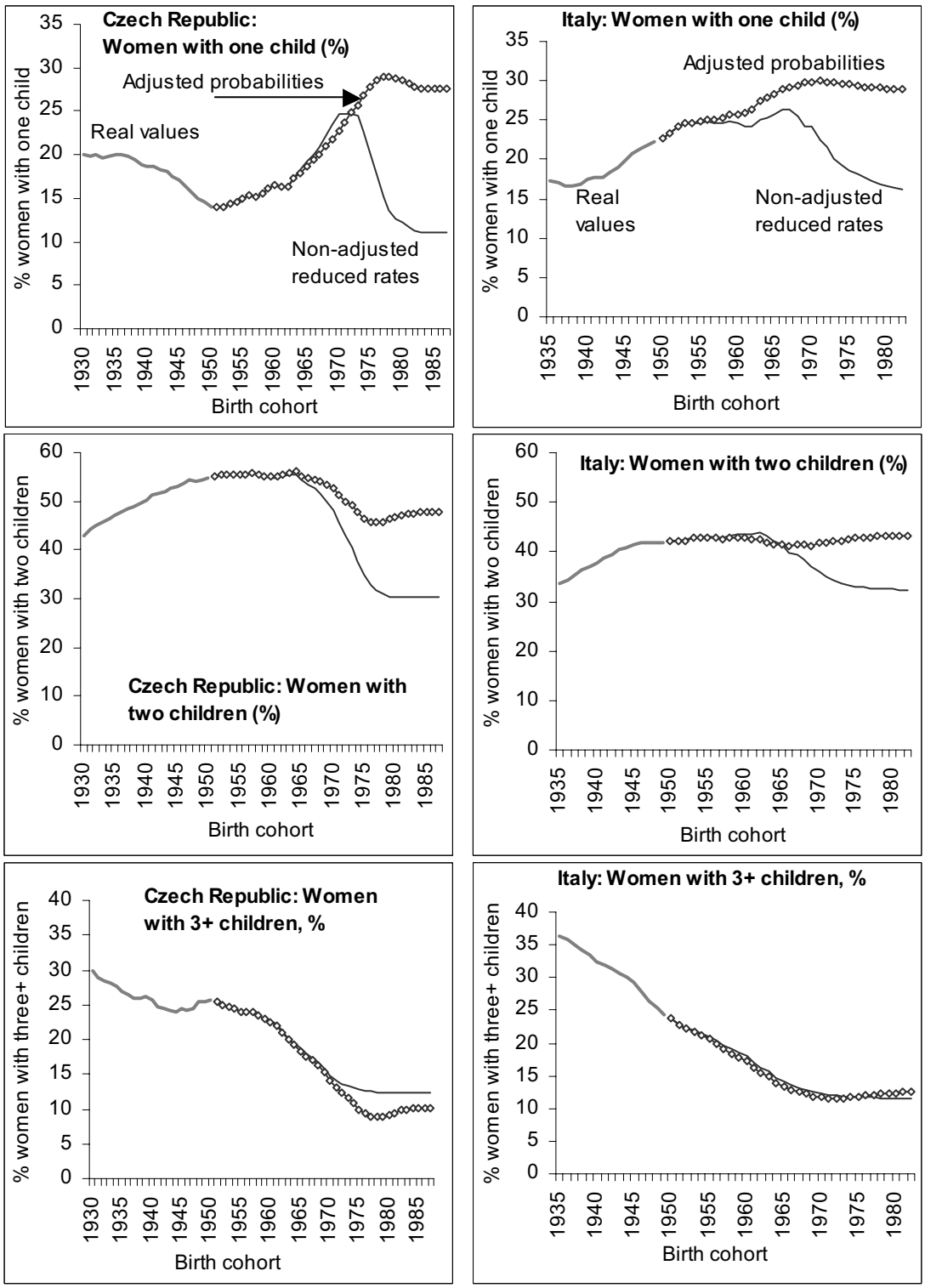


***Figure 4.7 (continued).*** Scenarios of the future cohort fertility in the Czech Republic and Italy based on the most recent incidence rates and adjusted age-parity probabilities



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 final childlessness: while the continuation of current reduced rates would imply a massive 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 incidence 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 ultimate family composition: 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 28% among women born after 1975 as compared with 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).

The two scenarios resemble each other only in the case of cohort fertility of parity 3+. In Italy, the long-lasting decline in higher-parity fertility would fade out among women born at the beginning of the 1970s, of which only 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 incidence rates clearly provide unrealistic results, such as a dramatic increase in childlessness. In comparison, the scenarios based on adjusted probabilities suggest trends that are 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. Elaborating upon this framework, adjusted and non-adjusted age-parity birth probabilities are used in final childlessness scenarios in 16 European countries and the United States in Chapter 5.

## 4.10 CONCLUSIONS

This chapter has discussed the fairly controversial issue of whether some indicators of period fertility come systematically closer to the corresponding completed cohort fertility than the total fertility rate does. All the indicators analysed were based on the 'synthetic cohort' approach, which despite some shortcomings, provides a convenient and intuitively understandable means of comparing period fertility. The indicators of period fertility analysed here are either adjusted for or free of one or more of the distortions present in the TFR, and therefore more closely depict the 'underlying' quantum of period fertility. This study focuses primarily on the distortions due to changes in fertility timing that are associated with very low TFR in many European countries. Detailed analysis of the period-cohort fertility differences reveals two major findings: firstly, some period indicators indeed come consistently closer to cohort fertility, particularly during intensive changes in fertility timing; secondly, this pattern of differential period-cohort approximation considerably varies by parity.

Table 4.11 summarises findings on the degree of the period-cohort fertility approximation and selected additional criteria concerning the indicators analysed. 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 cohort fertility, but also on the availability of data, the magnitude of random fluctuations, or the occurrence of 'impossible' values in the indicators derived from incidence rates.

Based on the data from four countries, the evidence encapsulated in Table 4.11 should be considered tentative. By no means does it give a definitive answer to the questions posed in the introductory part of this chapter; further research is necessary to provide support for these findings. Since this chapter focused on the periods marked by fertility postponement, it is possible that some conclusions concerning the proximity of period and cohort indicators may not equally apply in the case of fertility advancement. Keeping this in mind, the analysis has revealed that the approximation of cohort fertility was most successful with respect to birth order 1 and total fertility. Indicators based on birth probabilities have shown considerable reduction of the $TFR_1$-$CTFR_1$ differences: tempo-adjusted and variance-adjusted $adjPATFR_1$ reduced these differences on average by 76%.

The PATFR and adjPATFR are obviously much more suitable indicators of the long-term implications of current period fertility at birth order 1 than the TFR. For total fertility, the compound indicator comTFR came closest to the completed CTFR, reducing the TFR-CTFR difference on average by 62%. None of the indicators considered came systematically closer to cohort fertility of birth orders 3 and higher; the PATFR and adjPATFR even gave consistently poorer approximations than the TFR. A similar conclusion holds for the

***Table 4.11.*** Summary table comparing approximation of cohort fertility by various period fertility indicators and selected additional criteria for their evaluation

| | **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. |
| All 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 p. 3+ | small at par. 2 large at p. 3+ | small |
| 'Impossible' values | yes | yes | no | no | n.a. |
| Complexity of calculation | no | no | moderate | yes | yes |

NOTES: 1) during the periods of intensive postponement of first births
**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+%).

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 CTFR, when the comTFR reduced the TFR-CTFR difference on average by 77% and came closer to the CTFR 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 a better approximation of the overall cohort CTFR than the tempo and variance-adjusted adjPATFR, and in the phases of intensive postponement almost as good approximation as the combined indicator comTFR. An adjustment for the variance effects, which is relatively complex, does not significantly alter the values of the adjusted adjTFR and adjPATFR indicators. Additional analysis, not shown here, has revealed that in most cases the tempo-adjusted PATFR has been almost equal to the tempo and variance-adjusted adjPATFR and both have approximated the cohort CTFR to the same extent.

The data pertaining to four different European countries aptly illustrate the various advantages and disadvantages of the individual indicators of period fertility. The relatively smooth change in the fertility timing and level in Italy, and to a lesser extent also in the Netherlands, went hand in hand with a relatively close approximation of the cohort CTFR by the adjusted indicators. The very intensive postponement of childbearing in the Czech Republic since 1994 caused a large divergence between the TFR and PATFR indicators on one the side and the adjusted adjTFR and adjPATFR measures on the other side. The abrupt shifts in Swedish fertility during the first half of the 1990s, characterised by changes in the birth intervals and complex changes in the variance of the fertility schedule, coincided with very high values of adjusted indicators, diverting strongly from the cohort CTFR.

The Swedish example points out the limitations of the indicators analysed. Whereas the TFR clearly constitutes a distorted, potentially misleading indicator of fertility quantum, each of its alternative counterparts also has shortcomings, and none of them represents an unambiguous measure of fertility quantum. Their use for assessing the implications of current period fertility trends and projecting cohort fertility should be exercised with caution. Some deficiencies might be reduced or overcome by smoothing year-to-year fluctuations and inspecting trends over longer periods of time, or by comparing the values of several alternative indicators. Despite their shortcomings, the alternatives to the conventional TFR provide valuable insights and, as was shown in the cases of the Czech Republic and Italy, the straightforward use of the adjusted age-parity birth probabilities may provide rather realistic scenarios of future cohort fertility change. In this study, alternative indicators are extensively used to estimate final childlessness in European countries and the United States (Chapter 5), to evaluate the extent of tempo distortions in the total fertility rate in Europe (Chapter 6), and to provide an assessment on the role of tempo effects in fertility decline in Central and Eastern Europe (Chapter 7).