Postponement and Recuperation in Cohort Fertility: New Analytical and Projection Methods and their Application

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Abstract

A number of studies have analysed cohort fertility developments in Europe among women born after World War II. These cohorts have seen a shift of childbearing towards later ages and a concomitant decline in fertility level. This broad trend has been studied using the notions of fertility *postponement* (fertility decline across younger ages) and subsequent *recuperation* (a compensatory fertility increase at higher reproductive ages). We apply order-specific data and extend and elaborate on two broad approaches to this process: 1) a basic benchmark model extensively used by Tomas Frejka and his colleagues and 2) a relational model proposed by Ron Lesthaeghe (2001). Our work, illustrated with examples for selected European countries and the United States, is based on a simple set of organising rules that aim to be flexible enough to capture subtle trends in the ongoing transformation of cohort fertility. We also illustrate the usefulness of these two approaches for constructing projection scenarios of completed cohort fertility among women of reproductive age.

Using three key indicators of the postponement transition—initial fertility level, absolute fertility decline at younger ages, and the relative degree of fertility 'recuperation' at older ages—we demonstrate that each of these components is salient for explaining contemporary differences in cohort fertility. Differential recuperation is especially important, but also parity-specific: whereas all the analysed countries have experienced relatively vigorous recovery of delayed first births, pronounced cross-country differentials are observed with regard to the recuperation of second and particularly of third and later births. In line with these differentials, projected values of completed fertility in four European countries vary widely for the cohorts born in the early 1980s, ranging from 1.3 in the lowest scenario for Spain up to 1.9 in the highest scenario for the Czech Republic. Thus, considerable variation in low fertility across the developed countries is likely to continue or even increase further.

CONTENTS

1 INTRODUCTION

1.1 Period and cohort analyses of the "postponement" process

Since the 1970s, fertility trends in Europe, Australia, Japan, the United States and some other developed countries have been dominated by two intertwined developments: childbearing has been shifted to ever later ages and fertility rates have declined, especially among women with two or more children (e.g., Frejka and Sardon 2007). The shift towards later childbearing, often described as childbearing "postponement" constitutes a potential complication when studying period fertility change as the intensity with which births are being shifted to later ages has a temporary depressing effect on period fertility rates. Consequently, it is not easy to distinguish in a period perspective between a 'real' decline in fertility (i.e., the change in fertility level or fertility quantum) and a temporary depressing effect of the shifting timing of childbearing (tempo effect). Considerable debate ensued around the methods that were proposed to estimate these two components and about period fertility measurement in general (see e.g., Bongaarts and Feeney 1998, Lesthaeghe and Willems 1999, Philipov and Kohler 2001, van Imhof 2001, Ortega and Kohler 2002, Schoen 2004, Sobotka 2004, Bongaarts and Feeney 2006, Ní Bhrolcháin 2008, Sobotka and Lutz 2009, Bongaarts and Sobotka 2011). A systematic analysis of a recent shift in period fertility timing has been provided first by Kohler, Billari and Ortega (2002), who coined the term postponement transition. This concept has been later elaborated by Goldstein, Sobotka and Jasilioniene (2009a) and Frejka (2010).[1]

[1] While the term 'postponement transition' was initially used in the context of period fertility analysis, we use it interchangeably with the term 'postponement and recuperation process' to denote cohort fertility changes.

Period fertility analysis provides one perspective on fertility change over time. We argue that a cohort perspective, which is often neglected, provides an equally valuable contribution and that looking at one of these two dimensions only can lead to partial and distorted conclusions. In contrast to period fertility trends, the measurement of the *quantum* and *tempo* changes in cohort fertility is straightforward. The cohort approach does not need any recourse to statistical constructs such as a synthetic cohort, and consequently, it does not have to cope with the avalanche of problems related to it. While each birth cohort can shift births to younger or older ages, its completed cohort fertility rate (*CTFR*), conventionally measured at age 50, gives an unbiased measure of the cohort fertility level. Changes in both cohort fertility level and timing can be analysed from the observed data on age-specific cohort fertility rates and cumulated fertility rates at selected ages. Considering the time and effort that period analysts have spent on correcting tempo distortions in period indicators, the obvious layman's question would be why they have often abandoned the real cohort view to start with. Obviously, the main obstacle in analysing cohort fertility lies in the long 'waiting time' until the cohort completes its reproductive history. While age 40 is frequently used as a safe threshold for making assessments about the completed fertility, there are still many years left before an almost complete fertility history of each cohort currently of reproductive age can be observed. For instance, the completed fertility of the cohort of 1980, which as of 2010 is in its prime reproductive age, can be measured reliably only around 2020. However, cohort analysis is well-suited for studying long-term shifts in fertility tempo and quantum and the ongoing *postponement transition* constitutes such a case. In many Western countries, this process has been initiated by women born in 1945-1950, who are at present well past their reproductive ages and whose fertility trajectories can be compared with those of the younger cohorts.

Two key terms are frequently used to characterise the process of fertility ageing across age and time dimensions: *postponement* refers to a life stage when fertility rates are declining and *recuperation* (*recovery*, also termed *catching-up*) refers to subsequent ages when fertility rates are increasing. However, this terminology is also subjective and ambiguous, since at the time when *postponement* starts, it is unclear whether any *recovery* will eventually take place and, if so, what portion of presumably *postponed* births will be *recovered* (see Ní Bhrolcháin and Toulemon 2005 for a critical assessment). Similarly, analysts are divided between those who argue that period-driven changes, induced by social, cultural, or economic trends in a given period, are the main driving force of the observed fertility developments (a "period paramount view" advocated by Ní Bhrolcháin 1992) and those who reckon that cohort effects are at least as important in driving observed fertility trends (Lesthaeghe 2001). One reason underpinning the cohort component is that changes in family formation at later stages of reproductive span are also conditioned by ideational factors that, in tandem with education, tend to follow cohort dynamics (Lesthaeghe and Surkyn 1988).

A cohort approach has the great advantage of following life events as they unfold sequentially over time and occurring to the same group of people amalgamated on the basis of a relevant criterion. In contrast to a classic Markov-chain, where probabilities of transitions at any time t are independent on the transitions that occurred earlier and are only conditioned by period-specific events, the cohort view studies such transitions as interconnected. Period approaches in demography are best suited for studying single transitions and trend reversals in response to exogenous shocks (economic crisis, inventions, legal and political changes and upheavals etc), but they rarely interconnect sequential transitions over a life time. As Ryder (1951:117) noted, "regardless of the level of specificity for which fertility is studied from period to period, the interdependency of the reproductive experience […] of the same cohort of people in successive periods" must be respected. In other words, the cohort approach respects life course history, whereas the period mode does not.

Because the current *postponement transition* has evolved over long time periods of up to four decades and across many cohorts, it is particularly useful to analyse a cohort dynamics of this process. For our purpose, it is essential to link differential fertility *postponement* (by country, age, and birth order) with the subsequent progression of differential fertility *recuperation*. In the cohort view postponement and recuperation are interconnected and both embedded in the complex unfolding of the life cycle. They are both subject to period effects since postponement and recuperation phases occur at different times, but these respective period impulses may not explain the entire picture. In other words, it remains both wise and prudent at the onset not to a priori cut up individuals' life histories in unrelated vertical period slices. Since cohort analyses in demography use just the same data arrays as cross-sectional analyses with fictitious or synthetic cohorts, there is no additional data problem: our exercise can also be seen as an analytic and descriptive framework that would be equally valid even if the observed change in fertility were entirely period-driven. Therefore we do not argue about causality or supremacy of the cohort analysis in this study.

1.2 Concepts and terminology, goals of this study

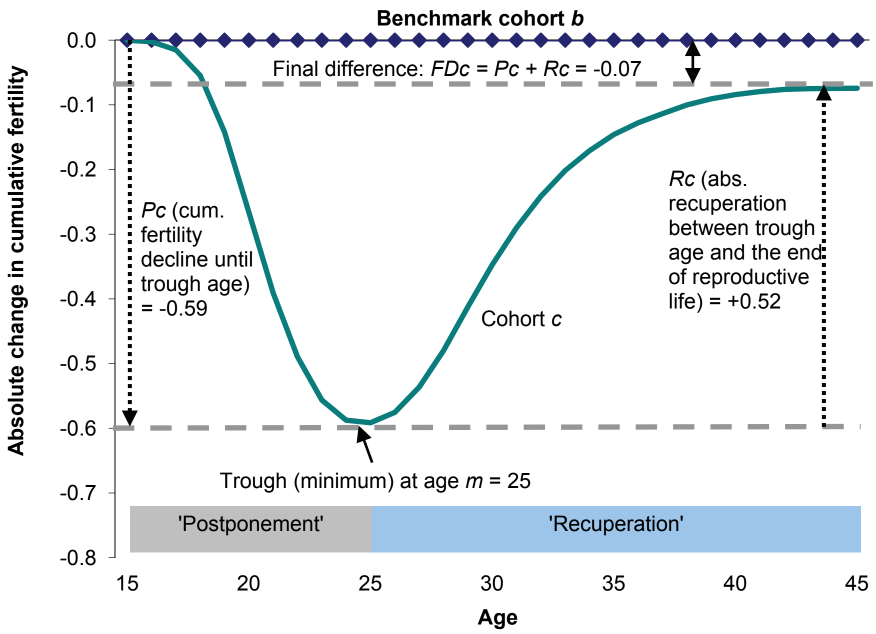
The cohort analysis of the *postponement transition*, using the basic benchmark model, has been pioneered in numerous studies conducted by Tomas Frejka and his colleagues (see Frejka and Calot 2001, and especially Frejka and Sardon 2004), by Bosveld (1996) and by Lesthaeghe (2001).[2] In a cohort fertility analysis, the concept of fertility *postponement* and *recuperation* has a different meaning than in the period approach. Both *postponement* and *recuperation* can be measured by age for any cohort of interest, which is compared with an older *reference cohort* (*benchmark cohort,* labelled here as *b*). Usually, *postponement* is measured by cumulating absolute or relative fertility declines across all ages when fertility has fallen, while *recuperation* is measured by cumulating absolute or relative

[2] Here and elsewhere, our contribution focuses on birth cohorts, defined by the year of birth. However, many concepts discussed can also be applied for other cohorts, such as parity cohorts, marriage cohorts, education cohorts, etc.

fertility increases across all ages when fertility has increased relative to the reference cohort. This is illustrated using hypothetical cohorts *b* and *c* in Figure 1. This approach can be effectively employed only when the process of long-term fertility change during the *postponement transition* indeed follows a regular pattern, marked by continuous fertility declines at younger ages and subsequent compensatory increases at older ages. As in the period analysis, a large portion of what is measured as a *postponement* may actually represent a decline in fertility *quantum* that has not been offset later in life. But, unlike in the period analysis, the cohort approach allows a precise delineation of what part of fertility decline at younger ages (termed as *fertility deficit* in the analysis by Frejka and Calot (2001) and Frejka and Sardon (2004) and denoted as P_c in Figure 1) has eventually been *recuperated* later in life (*fertility surplus* in Frejka and Sardon's terminology, denoted as R_c in Figure 1) and what part of that decline turned out to be permanent. Two basic indicators can be computed. First, the 'permanent decline' (FD_c), as compared to benchmark cohort *b*, is simply computed as an absolute difference between fertility decline at younger ages and fertility rise at higher ages $FD_c = P_c + R_c$. Second, a recuperation index, RI_c, shows the relative degree of fertility recuperation at later reproductive ages: $RI_c = R_c / (-P_c)$ and can be expressed in per cent (see also Section 4.3).

Lesthaeghe (2001) focuses on the dynamics in cohort *postponement* and *recuperation* from the onset of the postponement process, looking how these two factors evolve over many subsequent cohorts. To do so, he proposes a simple relational model based on the trajectories of the first three 5-year cohorts that delayed childbearing, using these trajectories as a yardstick (termed *national standard schedule*) for measuring the subsequent dynamics of the *postponement and recuperation process*. This analysis also allows projecting completed fertility in cohorts with incomplete trajectories, which was the original aim of the author. However, the method does not lend itself so well to cross-national comparisons since the *national standard deviation schedules* differ from country to country and the initial levels of fertility among the *benchmark cohorts* further complicate the interpretation of results.

Figure 1 A simplified scheme of cohort "postponement" and "recuperation"



While the graphical and statistical analysis of cohort fertility *postponement* and *recuperation* has been employed in a variety of studies, there has been surprisingly little effort to further advance or elaborate this methodology. Simple graphical representations have been extended in some studies (e.g., Tu and Zhang 2004, Neels 2006, Caltabiano 2008, Frejka et al. 2010); also a more elaborate statistical analysis of the cycle of *postponement* and *recuperation* has been pursued (Neels 2010, Sánchez-Barricarte et al. 2007). However, only a few studies discussed the premises, methods and terminology of these approaches or attempted to add other dimensions, like education, into the study of cohort fertility change during the *postponement transition* (Neels 2010). In addition, Caltabiano et al. (2009) used

Lesthaeghe's model to analyse fertility recuperation in three broad regions of Italy and draw some international comparisons.

Billari and Kohler (2004) have criticised the basic benchmark model employed by Frejka and Calot (2001) on two counts: First, with respect to terminology, they perceive the notion of *fertility deficit* and *fertility surplus* as "unfortunate since it tends to imply that the reference cohort reflects a 'correct' or 'desirable' fertility pattern" (p. 166). Their second and more important critique pertains to the choice of the reference cohorts, which may have widely different fertility levels and timing patterns in the analysed countries, obscuring thus the results of cross-country comparisons. In a different vain, Ní Bhrolcháin and Toulemon (2005) criticise the notion of *postponement* and argue that the declines in fertility rates at younger ages may be unrelated to the parallel increases in fertility rates at older ages. Finally, most of the initial analyses studied cohort fertility for all birth orders combined, ignoring the huge variability in parity-specific patterns of the 'recuperation' process.

Despite these criticisms, we consider the existing methods useful for describing the ongoing process of cohort change in the developed countries, but also see a need for their further development, addressing the criticisms and broadening the debate on their merits and weaknesses. The goal of this contribution is to elaborate on both approaches discussed above: Building upon the work of Tomas Frejka, Gérard Calot, and Jean-Paul Sardon, we propose an extended analysis of cohort *postponement* and *recuperation*, based on a set of simple rules, expanded graphical representations and selected summary indicators. We also experiment with the relational model proposed by Ron Lesthaeghe. In addition, we examine potential usefulness of both approaches for fertility projections. We use illustrations for selected European countries with good quality data on parity-specific fertility, namely Austria, the Czech Republic, the Netherlands, and Spain. Following our methodological proposals, we employ our new approaches to analyse cohort fertility transformations in selected countries of Europe and the United States. We pay attention to the diversity in fertility *recuperation*, which has become a critical determinant for the overall cohort fertility trends and cross-country differences in Europe, and which has been relatively weak in the three German-speaking countries. In conclusion, we highlight main advantages and new insights that can be gained by using our expanded methodology.

2 OVERLAPPING COHORTS AND PERIOD FERTILITY CHANGE

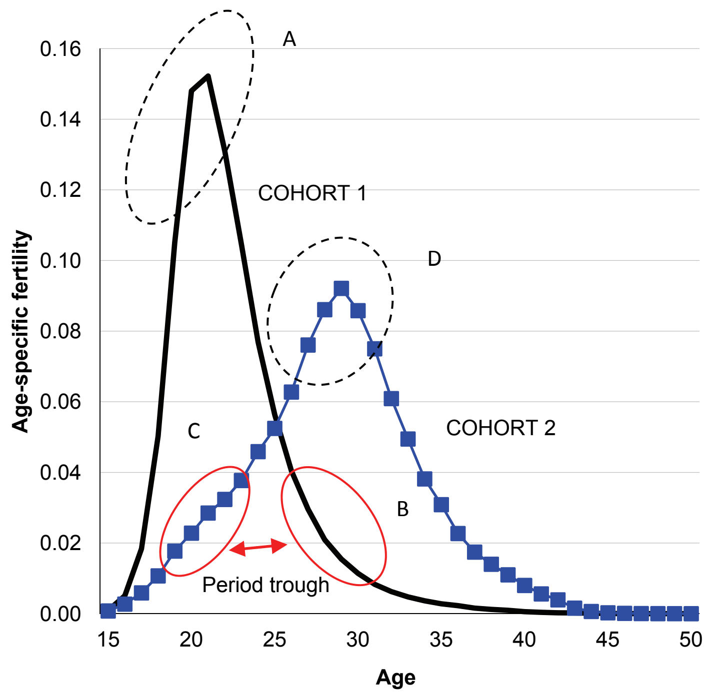
The rapid changes in fertility level and tempo during the last four decades have often been described primarily from a period perspective. But they can be equally well captured through the lenses of transforming cohort fertility patterns, which may in turn be translated to the observed period fertility shifts. Because cohorts with very different childbearing trajectories overlap during the same period of time, period fertility ups and downs may also be seen as an outcome of different stages of cohort fertility transformations.[3] This process has been analysed in detail by Tomas Frejka (2010); here we briefly sketch its dynamics and refer for more details to Frejka's study.

Consider a rapid change in cohort timing as depicted in Figure 2, which shows, in a stylised fashion, a shift in first birth fertility schedules from a very early childbearing pattern (Cohort 1, roughly corresponding to first birth schedule of the 1960 cohort in the Czech Republic) to a late pattern (Cohort 2, approximately corresponding to the first birth schedule among the 1970 cohort in the Netherlands). Both schedules are normalised with the sum of age-specific rates by age equal to 1. If cohort fertility patterns remained stable, according to the schedule of Cohort 1, period fertility rates would also remain stable, combining very high fertility at

[3] However, since we are not attempting to test whether the observed changes were period- or cohort-driven, we focus on describing fertility dynamics from a cohort perspective during the *postponement transition* rather than making causal statements about recent fertility trends.

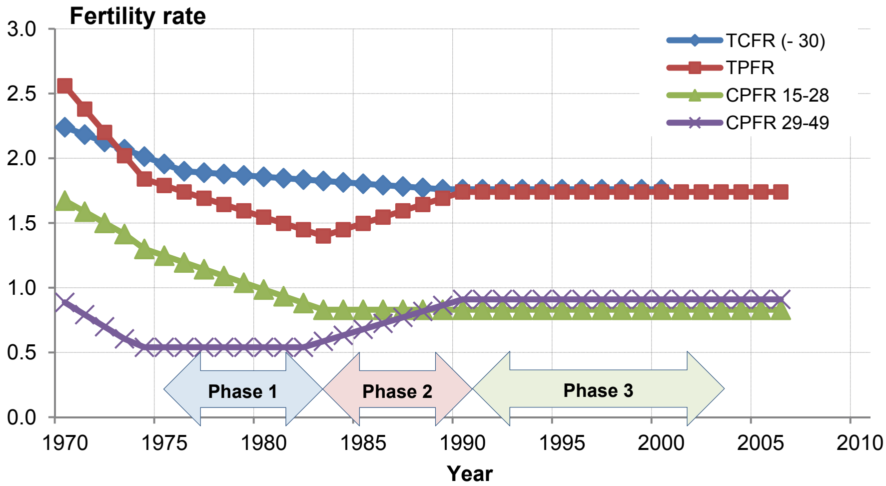
young ages (oval A for ages 19-23, capturing almost two thirds of realised fertility) with a marginal fertility at later ages (oval B for ages 27-31). Similarly, if fertility patterns were stable and fixed according to the schedule of Cohort 2, the combination of very low fertility at young ages (oval C) with high fertility at older ages (oval D) would be translated into a stable and equal level of period fertility, reaching the value of 1. When, however, a rapid change in cohort fertility timing takes place, the very low fertility at younger ages among the Cohort 2 may overlap with a very low fertility at higher ages among the older Cohort 1, producing temporarily an extreme low level of period fertility (a combination of ovals C and B), a "period trough."

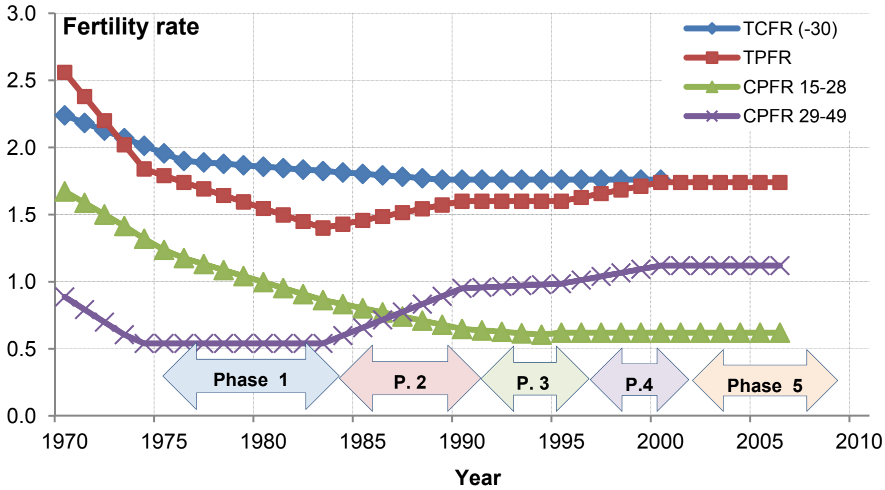
Figure 2 Fertility schedules of two cohorts with radically different first birth patterns, overlapping in one period of time



In most countries fertility rates have declined in the course of the *postponement transition*. Frejka (2010) provides an empirical investigation of cohort and period transformations of fertility across all developed countries with available data and outlines two actual patterns, a simple one with three phases and a complex one, consisting of five phases. These two models reproduced here (Figures 3a and 3b) capture in a stylised fashion the transformation of fertility in the regions with an early onset of childbearing postponement, especially in Western, Northern and parts of Southern Europe. They contain two important findings. First, usually there is only a brief period when the period TFR bottoms out (a period fertility trough), without staying for long at these record-low levels. Second, the stage of period fertility 'recuperation' is often interrupted by a spell of relatively stable fertility, followed by a renewed increase in the period TFR (Figure 3b). However, there are many exceptions and idiosyncratic trends to this general pattern, which are described in detail in Frejka's (2010) study.

Figure 3a and 3b Observed period and cohort fertility rates during the course of the postponement in cohort childbearing patterns: a simple model with three stages and an extended model with five stages





Source: Reproduced from Frejka (2010): Figure 4.

Notes: Completed cohort fertility rate, denoted TCFR, is lagged by 30 years. Period TFR is denoted as TPFR and cumulated period fertility rates at ages 15-28 and 29-49 are labelled as CPFR.

3 DATA

Throughout this study we use detailed order-specific cohort fertility data by age of mother for selected countries of Europe. These data were collected from different sources and databases, which are briefly listed here.

Data for the **Czech Republic**, the **Netherlands**, **Sweden,** and the **United States** originate from the Human Fertility Database (*www.humanfertility.org*, last accessed in July 2010), which also provides their detailed documentation.

Data for **Spain** were computed by combining cohort order-specific fertility rates by age realised until 1997 that were formerly available in Eurostat *New Cronos Database* (2003) with the period fertility data on births by birth order and age of mother and female population by age, downloaded from Eurostat (2009). In some years, the statistics of births by birth order in Spain were not entirely reliable (Devolder and Ortiz 2010), but such irregularities should not have a large impact on our computations.

Cohort fertility data for **Austria** were assembled by combining two datasets: 1) Vital statistics data in 1984-2009, provided by Statistics Austria (and also displayed in the *Human Fertility Database*) and 2) estimates of age-specific fertility rates by birth order in 1952-1983, compiled by Anna Šťastná and Tomáš Sobotka (unpublished dataset, 2008). This latter dataset was mostly based on retrospective distribution of births, using the question on the dates of birth of the first four live-born children that was asked to all resident women aged 15+ in the Austrian census of 1981 (Statistics Austria 1989). In addition, data on live births by age of mother and birth order within marriage in that period as well as the records on total numbers of live births by age of mother were used in order to adjust the estimates to the total number of live births by age of mother in that period.

Data for **Switzerland** were estimated by Marion Burkimsher from the vital statistics data published by the Swiss Federal Statistical Office and kindly provided by her (see also Kreyenfeld et al. 2011). Cohort fertility histories by birth order and age of mother for the women born since 1950 were reconstructed by estimating data on live births by biological birth order and age of mother in 1969-1997 from the dataset on birth order within marriage and the subsequent data on biological birth order in 1998-2008. In addition, a portion of data with unknown birth order in 1998-2004 had to be redistributed as well. Because of these estimations and redistributions, Swiss data should be treated as 'best estimates' that may contain some inaccuracies in order-specific indicators.

Data for **Germany,** including those for **East Germany (former GDR)** and **West Germany (former FRG)**, were reconstructed from the vital statistics records and accessed from the *Human Fertility Database* (accessed in October 2010). Because of administrative changes, the data pertaining to the period after 2001 exclude the territory of Berlin. For the period through 2001 data for East Berlin were included in the dataset for East Germany and the data for West Berlin were part of the West German dataset (see more details in the country documentation file in the *Human Fertility Database*).

4 Basic Benchmark Model: New Graphical Approaches and Summary Indicators

4.1 Graphical approaches and main organizing principles

Relatively simple graphical illustrations can provide many insights about cohort fertility changes during the *postponement transition* and serve for comparing its trajectory across different countries, cohorts and birth orders. However, this type of analysis depends critically on the choice of the benchmark cohort (Billari and Kohler 2004) and also on order-specific fertility trends, as the cohort *recuperation* is hugely differentiated by birth order. In this section we provide a critical discussion of the existing approaches, propose an expanded set of graphical illustrations and analytical indexes and demonstrate their application for selected countries. This analysis is based on a simple set of organising rules that aim to be flexible enough to capture subtle trends in the ongoing transformation of cohort fertility patterns

As in the case of period fertility, the design of cohort fertility analysis should reflect analyst's purposes and aims (Ní Bhrolcháin 2008). To overcome some deficiencies in the existing approaches, we have formulated the following organising principles of cohort analysis, which are particularly suitable for studying the cohort fertility transformation since the 1970s.

1) The choice of a benchmark cohort should reflect aims of the analysis

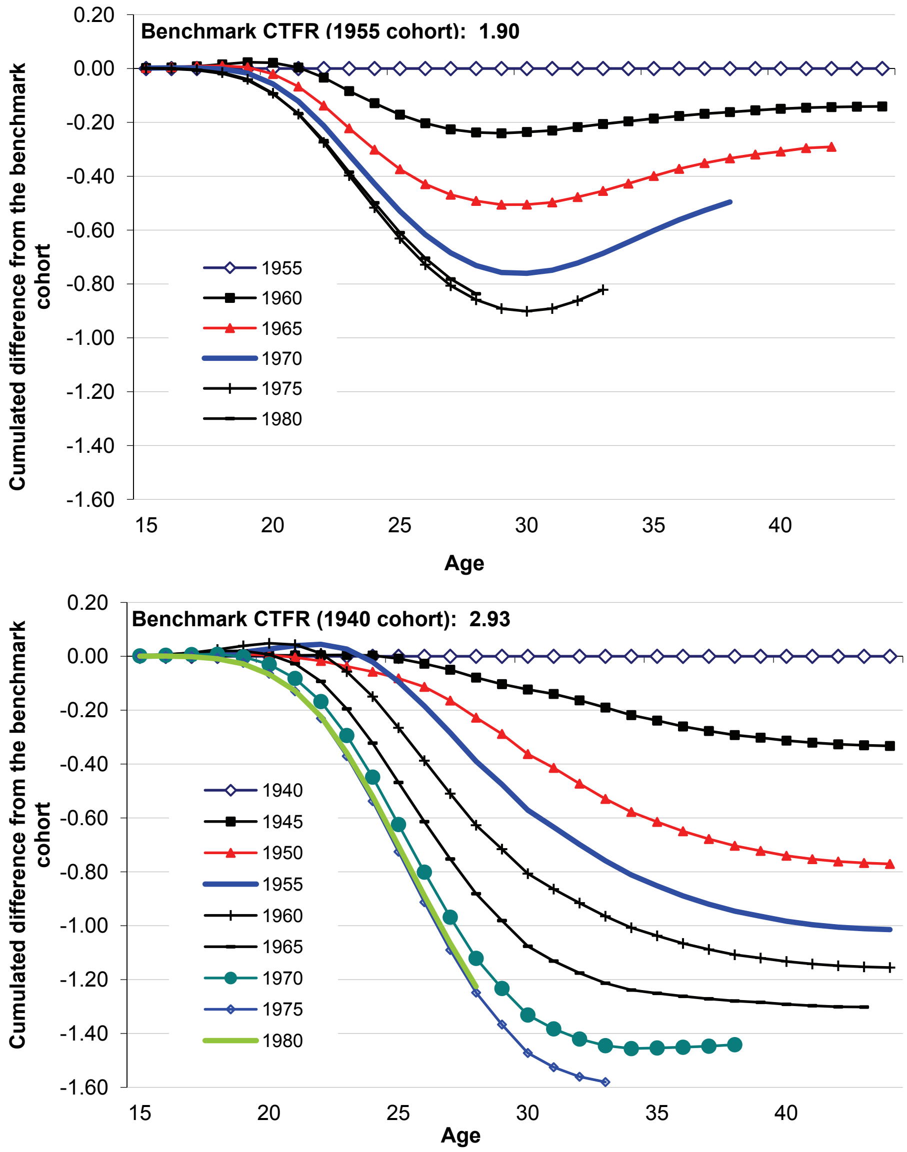
The choice of a reference cohort may critically influence the outcome of the analysis. This is illustrated on the example of Spain in Figure 4a, where anchoring the cohort analysis to the 1940 cohort with a high completed fertility rate (*CTFR*) of 2.93 gives an impression of a massive decline in fertility rates among all subsequent cohorts, in which any *recuperation* at older ages is practically absent. If, however, a later reference cohort with lower fertility is chosen as the benchmark, the decline is obviously much smaller and a limited recuperation can be observed, especially for the 1970 cohort (see Figure 4b with the benchmark cohort of 1955 that had a *CTFR* of 1.90). For the purpose of analysing contemporary developed countries, it is preferable to anchor the analysis with the cohort that does not have a fertility rate far above 2, i.e., above a level that is not to be expected to be reached in any rich society (with the notable exception of Israel).

Since our focus is on the dynamics of fertility *postponement* and *recuperation*, we propose to anchor our study in the cohorts that have initiated this trend. We choose one of the cohorts that first experienced an onset of the increase in the mean age at first birth that spanned over at least five consecutive cohorts. Therefore, the reference cohorts are allowed to vary by country, depending on the start of the *postponement transition*. Although this flexible definition does not completely eliminate differences in the initial *CTFR* levels, we see this as a more objective criterion than using the same *benchmark cohort* for all countries.

2) Focus on order-specific differences

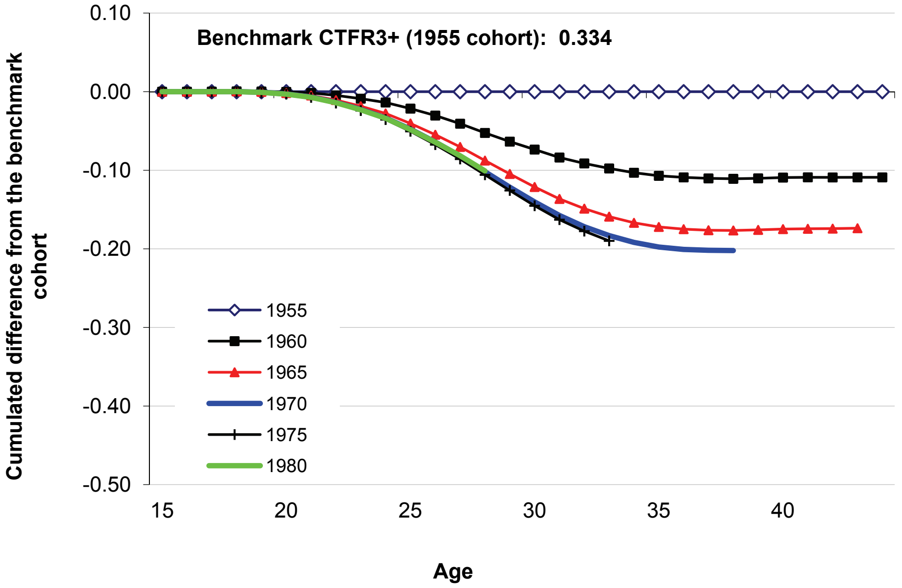
Many countries experience pronounced differentials in cohort fertility trends by birth order. Ignoring these differentials may lead to erroneous reading of the overall trends for total birth orders. Whenever data allow, we advocate performing order-specific analysis. We expect that most of the presumably *postponed* first births will be *recuperated*, while the decline in third and higher-order births is often likely to become permanent. This hypothesis is perfectly consistent with the observed trend in Spain, portrayed in Figure 5. Most, albeit not all, of the massive decline in first birth rates below the age of 27 among the cohorts of 1960-1975 has been compensated by a strong increase after that age. However, there has been no traceable recovery in third and higher-order birth rates that progressively declined until ages 35-40 among the women born until around 1970. Because similar contrasts are often found for other countries, we decompose the overall cohort fertility change into three order-specific components: 1, 2, and 3+. Such decomposition can also be depicted for one selected cohort, compared with the benchmark cohort, as in the case of the 1970 cohort in Spain, which is related to the 1955 cohort in Figure 6. Very different trajectories of the *postponement* and *recuperation* by birth order are clearly illustrated: an earlier decline and a stronger recovery for first births and a later decline with a modest recovery for the second births contrast with the perpetual decline with no recovery for third and later births. Summing up these three components would give a trajectory for total birth orders, as shown in Figure 4b above.

Figures 4a and 4b Cumulated cohort fertility compared to the reference cohort, Spain, benchmark cohorts 1940 and 1955



Data sources: Own computations based on Eurostat (2009) and INE (2010).

Figures 5a and 5b Cumulated cohort fertility compared to the reference cohort. Spain, benchmark cohort 1955, first births and third and higher-order births



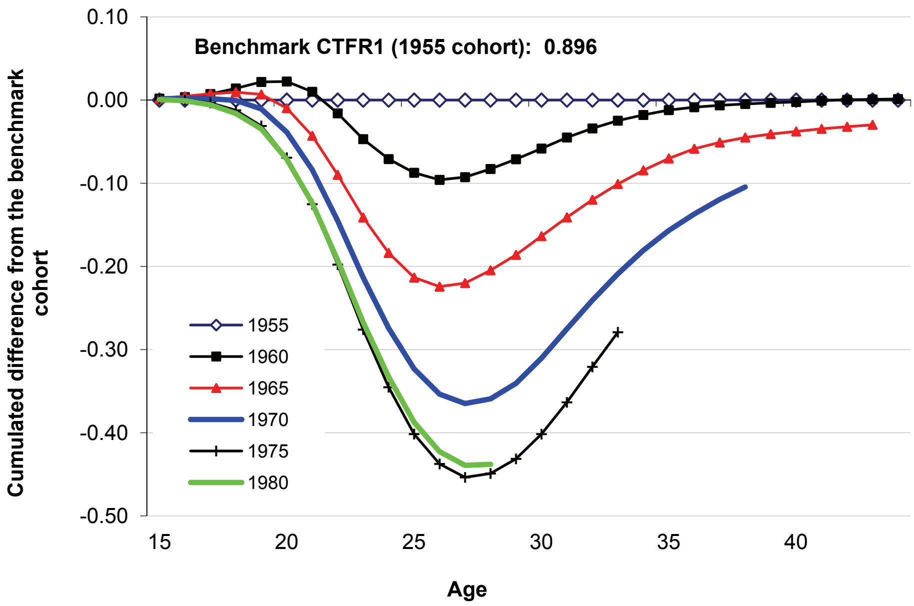
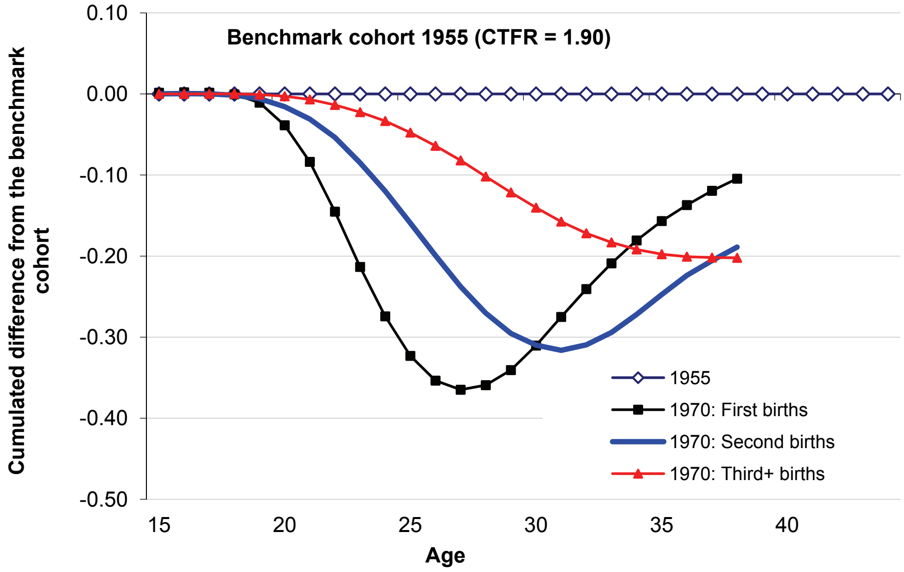


Figure 6 Cumulated cohort fertility by birth order compared to the reference cohort: Spain, 1970 cohort as compared to the cohort of 1955



Data sources: Own computations based on Eurostat (2009) and INE (2010)

3) Specifying age at maximum cumulative fertility decline

Most of the past studies used a fixed age delineating the *postponement* and *recuperation* phases of fertility. Frejka and Sardon (2004 and other studies) repeatedly used age 27, whereas Lesthaeghe, working with 5-year age groups, chose age 30 as a boundary. Rather than using a fixed age category, we specify for each cohort and birth order the age of the maximum cumulative fertility decline and measure the actual size of this decline from our detailed dataset, allowing thus the age at maximum decline to vary in line with the observed trend.

This more precise approach prevents us from underestimating the degree of recuperation from the point when the trough has been reached, which often happens when using the fixed age approach. For instance, when analysing data for total birth orders for Spain related to the 1955 cohort, the age at maximum cumulated fertility 'gap' for the most recent cohort reaching age 40 in our dataset, 1968, was 30 years. When analysed correctly at age 30, the maximum decline reaches -0.66, and subsequently narrows down to -0.40 by age 40, indicating that 40% (= 0.26 / 0.66) of the decline has subsequently been offset by rising fertility at ages 31 to 40. However, when measured by age 27, the estimated maximum gap would be smaller, -0.60, suggesting a weaker subsequent *recuperation*, with only 33% of the fertility decline at younger ages subsequently 'made up' later in life.

4.2 Moving benchmark cohort: studying the postponement process in detail

The relatively simple graphical analyses and analytical 'rules' discussed above can be further elaborated. This sub-section discusses one possible extension, focusing on the dynamics of the *postponement transition*. Another potentially useful extension, not illustrated here, involves shifting the benchmark from the initial cohorts, which display different initial levels of completed fertility across countries, to a 'target' value of completed fertility, such as the population replacement level (around 2.07 in contemporary Europe) or to a lower fertility level that can be sustainable in combination with moderate immigration (e.g., 1.75, representing approximately annual rate of intrinsic population decline of 0.5% in the absence of immigration).

The course of the *postponement transition* can be relatively steady, with each new cohort experiencing a progressively deeper fall in fertility at younger ages and a comparable increase at later reproductive ages, or it may depend on the stage of the postponement process, period influences and country-specific effects. Clearly, the intercohort dynamics cannot always be effectively studied with the schemes relating all cohorts to one initial cohort, as the sheer fall in fertility among the earlier cohorts often conceals subtle changes in fertility behaviour among the youngest cohorts – as is the case of Spain in Figure 4a above. In order to study the intercohort dynamics, we analyse cumulated cohort fertility by age using a set of flexible benchmark cohorts rather than one fixed reference cohort. Specifically, we compare the fertility trajectory for each *quinquennial* cohort *C* with that of a cohort born five years earlier (*C-5*). At the same time, each cohort *C* becomes a benchmark for studying fertility change in a subsequent cohort *C+5*.

We illustrate this approach looking at Spanish cohort fertility transformation (Figure 7) and at cohort first birth *postponement* and *recuperation* among women in Austria, the Czech Republic, the Netherlands, and Spain (Figure 8). Figure 7 nicely illustrates the advantage of 'dissecting' cohort changes into smaller slices. The comparison of fertility dynamics between two neighbouring *quinquennial* cohorts shows how the postponement and recuperation evolved. Cohorts born between 1955 and 1970 all saw a vigorous fall in fertility up to around age 30, after which a modest recovery took place, reducing the size of the cumulative fertility "gap" at age 30 from about 0.25 to around 0.15 at age 40. Thereafter, the cohorts born in 1970-75 show less vigorous fall in fertility at younger ages and for the cohorts born after 1975, a turnaround is observed, with a slight rise of fertility at younger ages—arguably linked to rising numbers of migrant women with early childbearing pattern (Goldstein et al. 2009b)—marking the end or at least an interruption of the *postponement transition* in the country.

Figure 8 illustrates huge cross-country differences in Europe in the dynamics of cohort first birth *postponement* process. The first benchmark cohort differs for each country and is chosen just at or before the start of the *postponement*: 1945 for the Netherlands, 1950 for Austria, 1955 for Spain, and 1960 for the Czech Republic. In all four countries, a vast portion of initial first birth decline has been 'offset' by an increase at later ages. In Austria, the pattern of first births has changed relatively smoothly and gradually, without any cohort standing out. A more dynamic change is observed in the Netherlands: the most pronounced shift took place among the 1950-55 cohorts, with the women born thereafter showing a diminishing pace of the postponement, which ceased completely for the post-1970 cohorts. Yet more rapid shifts in cohort first birth timing unfolded in the Czech Republic and Spain, with both countries being characterised by an abrupt change among the women born in the 1960s in Spain and in the 1970s in the Czech Republic.

Figure 7 Cumulated cohort fertility rates in Spain during the *postponement transition* using moving benchmark cohort; women born in 1955-85

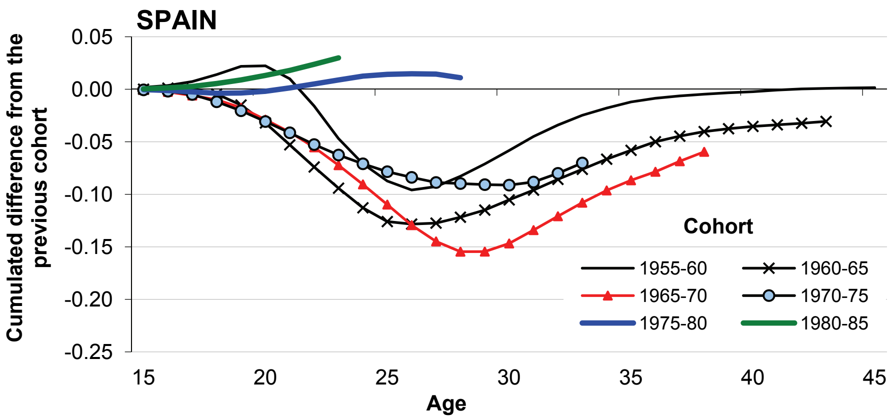


Figure 8 Cumulated cohort first birth rates during the *postponement transition* using moving benchmark cohort (Austria, Czech Republic, the Netherlands, and Spain)

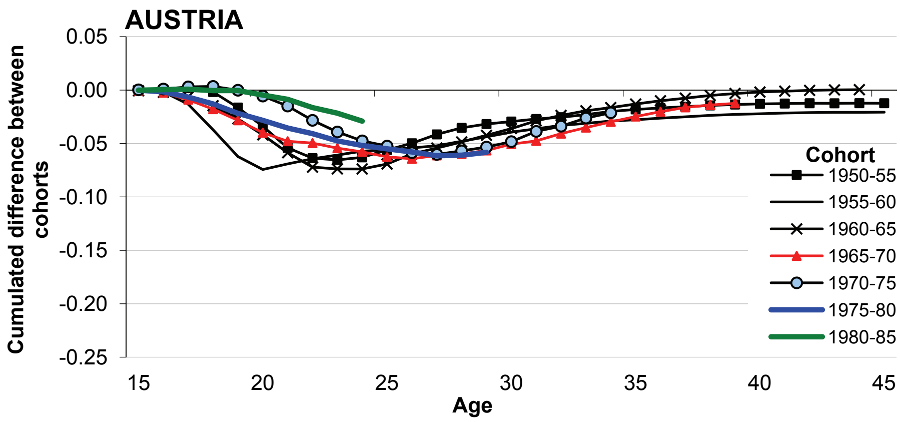


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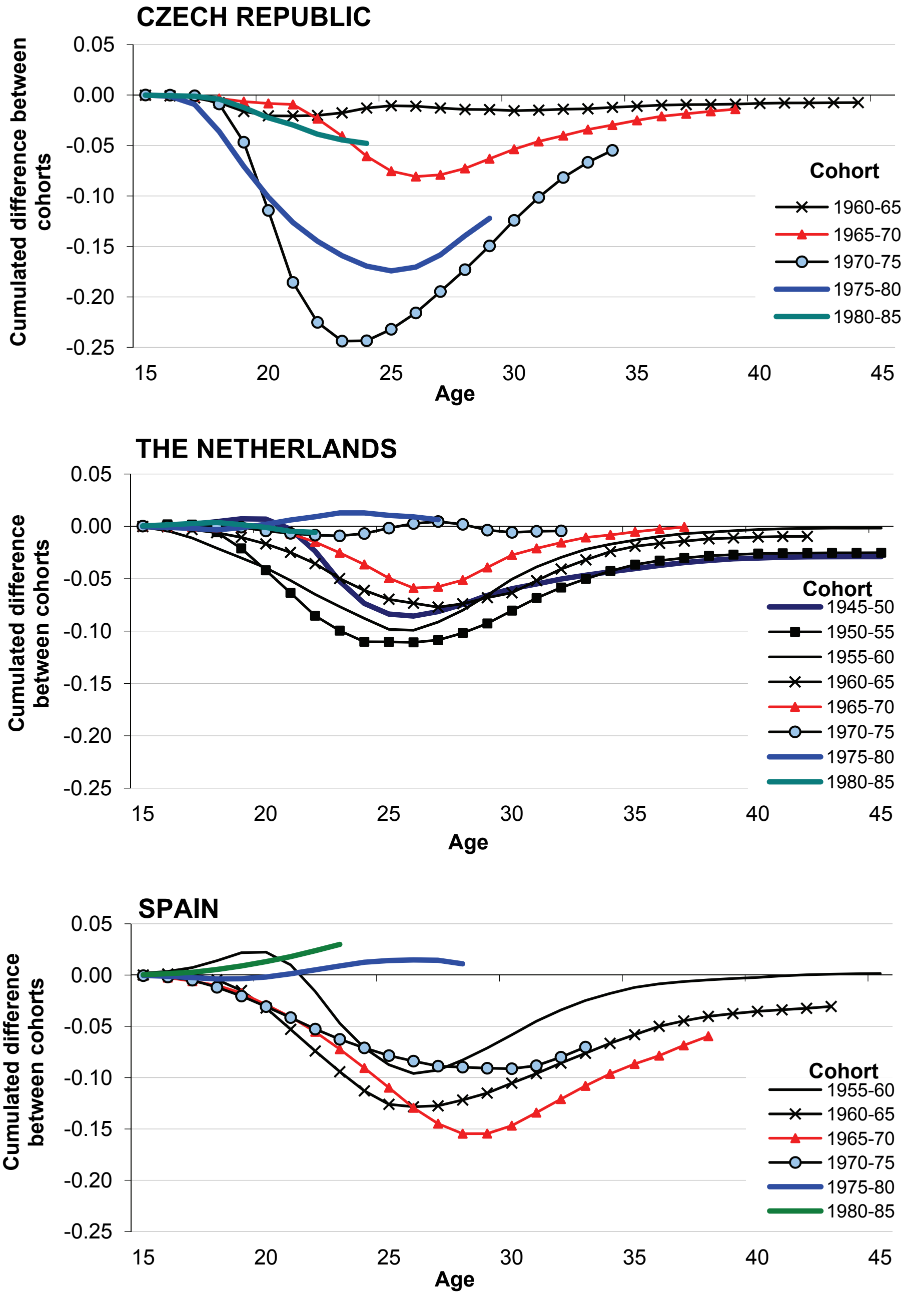
Figure 8 continued



4.3 Postponement transition in a nutshell: Summary graphs and indicators

As the previous sections have demonstrated, a vast number of graphs and empirical results can be amassed to analyse different features of cohort fertility change by parity and age. To condense and summarise this information, we propose using a set of graphs specified by birth order (1, 2, and 3+), which track major indicators of cohort fertility change during the *postponement transition*. Specifically, we aim to identify and show the following indicators side by side, starting with some of the cohorts immediately preceding the onset of the *postponement*:

b: *Benchmark cohort*; the first cohort that experienced an increase in the mean age at first birth that continued for at least five cohorts. For practical purposes, the nearest *quinquennial* cohort (i.e., a cohort ending with 0 or 5) is chosen as the benchmark. Thus, when the *postponement* trend is initiated by a cohort born in 1948 or 1951, the cohort of 1950 is selected as the benchmark.

$F_c(x)$ is the *cumulated fertility rate* (number of births per woman) up to age *x* in any cohort *c* $F_c(x) = \sum_{x=12}^{x-1} f_c(x)$ where *$f_c(x)$* is the age-specific fertility rate of cohort *c* at age *x*.

m is the age at which the gap between the cumulated fertility rate of the benchmark cohort and of the observed cohort reaches a maximum. We refer to it as a 'trough age' (see Figure 1).

$F_c(m)$ is the cumulated fertility in cohort *c* up to age *m* of the trough.

P_c: Decline in cumulated cohort fertility of cohort *c* compared to that of the *benchmark cohort b* at the trough age *m*. P_c thus measures the maximal difference in cumulated fertility between the benchmark and the observed cohort. It measures the "depth" of the trough, and can be labelled as the *postponement measure* of cohort *c* (hence, P_c):

$$P_c = \sum_{x=12}^{m} [f_c(x) - f_b(x)] = F_c(m) - F_b(m) \qquad [1]$$

R_c: *Recuperation measure* or the absolute increase in cohort fertility, as compared to the *benchmark cohort b*, between the *trough* age *m*, and the end of the reproductive period:

$$R_c = \sum_{x=m}^{50} [f_c(x) - f_b(x)] = CTFR_c - CTFR_b - P_c \qquad [2]$$

In this study, we often use age 40 as a simplified endpoint for our cohort fertility analysis;

FD_c: *Final difference*: permanent difference, usually decline, in fertility between the benchmark cohort and the cohort of interest, computed as $FD_c = P_c + R_c = CTFR_c - CTFR_b$. It can also be computed as a non-recuperated portion of the 'postponed' fertility, using the recuperation index specified below: $FD_c = P_c \cdot (1 - RI_c)$;

RI_c: *Recuperation Index* [4], measuring the degree of *recuperation* relative to the fertility *decline* at younger ages: $RI_c = (R_c / - P_c)$. [3]

It can also be expressed as a percentage, ranging from 0 (no recuperation) to 100 % (full recuperation) or even above ('over-compensation').

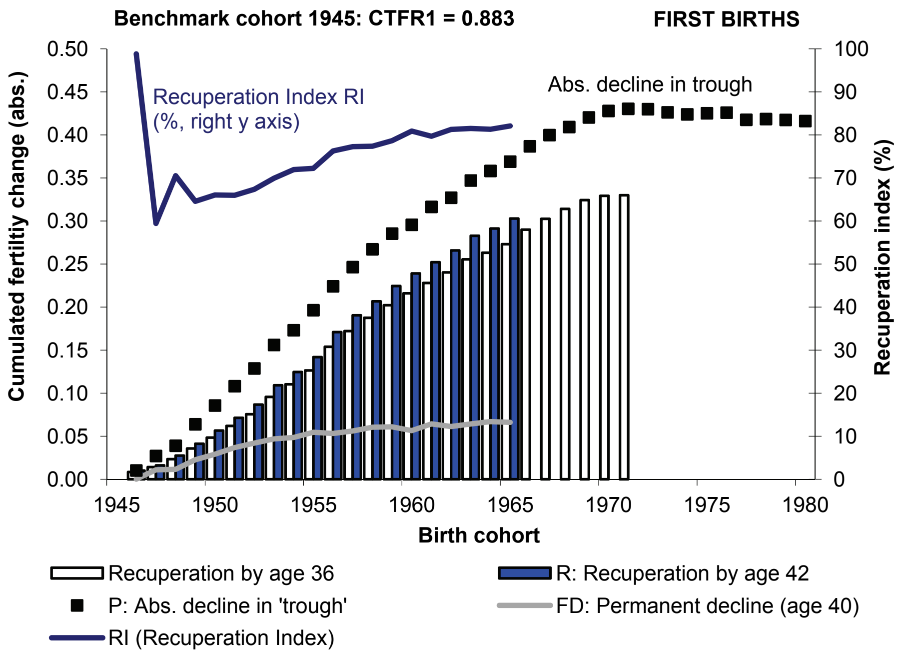
Each of these indicators can be specified by birth order *i*. The *Recuperation Index* is most informative when shown alongside with the initial fertility level of the benchmark cohort and the absolute value of fertility decline at the trough, P_c, since this index can easily reach very high, very low or unstable values when the absolute change in fertility is minor.

Figure 9 shows all the essential indicators of the *postponement transition* for first births in the Netherlands, starting with the women born in 1945. It features each single birth cohort through 1980 and thus gives a finer picture of cohort trends than the graphs for quinquennial cohorts above. It shows the absolute *recuperation* and the *Recuperation Index* by age 42 as well as the absolute degree of *recuperation* at age 36, which gives a

[4] The *Recuperation Index* was first employed by Frejka et al. (2010). A similar index, called *DR* (*Degree of Recuperation*) has been introduced in the study on fertility in Hong Kong and Taiwan by Tu and Zhang (2004).

'preview' of the progressing recuperation among the relatively younger birth cohorts. The portrait of first-birth dynamics is very transparent: it shows a regular pattern of fertility fall at younger ages before the trough was reached (which occurred at age 26 for most cohorts) and then a steady pattern of *recuperation*, with the *RI* surpassing 80% for the early 1960s cohorts. The postponement transition comes to an end for the cohorts born around 1970, which do not display an additional decline in first birth rates at younger ages. *Postponement* and *recuperation* are much less regular for third and higher-order births, where the RI reaches 100% for the mid-1950s cohorts and then falls rapidly thereafter (not displayed here). Also in this case, the cohorts born after 1970 do not display any additional *postponement.*

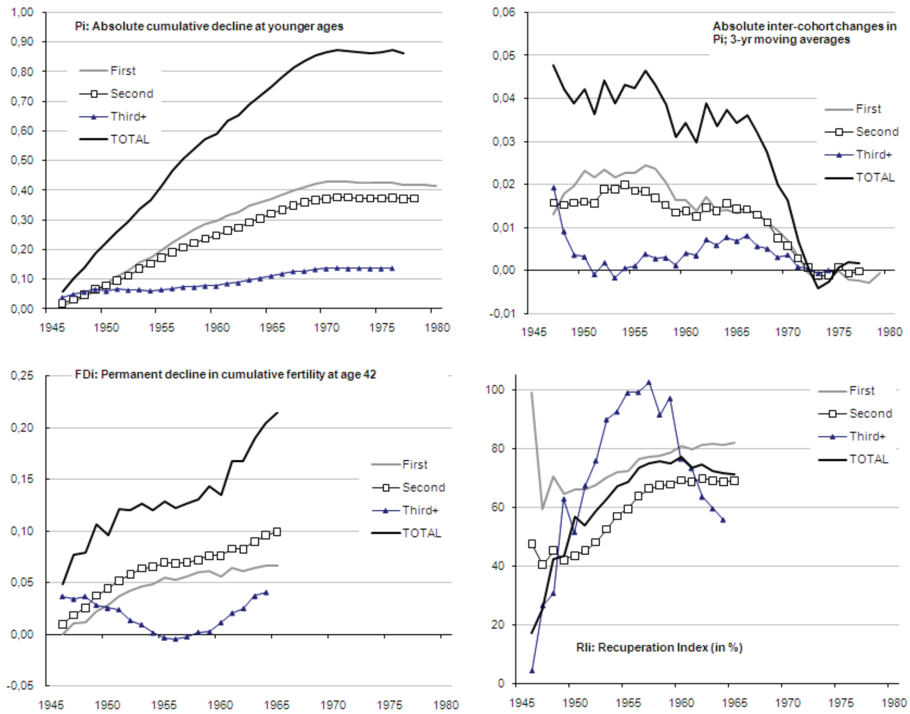
Figure 9 Graphical summary of the postponement and recuperation process, first births in the Netherlands among the women born since 1945



Obviously, it is also possible to compare different indicators by birth order, as it is done in Figure 10 for the Netherlands. Indicators P_c and FD_c decompose the change in cohort fertility for total birth orders into its order-specific components and show that first births were more important in the postponement process, but second births somewhat dominated the final decline in completed fertility (*FD*) due to a lower degree of recuperation in second birth rates (see the *RI* index). Trends in first and second birth *postponement* show a very similar development across cohorts (top right panel), dissipating rapidly among the women born in 1965-70. The indicators *P* or *FD* for all birth orders combined often differ from a simple summation of order-specific indicators P^i and FD^i because of diverse age-specific trajectories of declines and increases and different *trough* ages m_i in order-specific indicators. Thus, two sets of indicators for total birth orders can be derived: One, based on the observed data for total birth orders (as shown in Figure 10), and the other, derived from the order-specific indicators, either by summation (e.g., $P_c = \sum P_c^i$) or, in the case of the recuperation index, as a model value $RI_c^{*\ i}$ derived by weighting order-specific results with the completed fertility rate by birth order, $CTFR_c^i$:

$$RI_c^* = \frac{RI_c^1 \cdot CTFR_c^1 + RI_c^2 \cdot CTFR_c^2 + RI_c^{3+} \cdot CTFR_c^{3+}}{CTFR_c} \qquad [4]$$

Figure 10 Major indicators of postponement and recuperation in the Netherlands by birth order, cohorts born in 1945-1980



Note: The completed fertility rate in the benchmark cohort of 1945 is estimated as follows: CTFR = 1.997, $CTFR^1 = 0.883$, $CTFR^2 = 0.747$; $CTFR^{3+} = 0.367$.

5 Lesthaeghe's Relational Model and its Extentions

Lesthaeghe's model of cohort fertility postponement and recuperation was first formulated in a 2001 working paper for an IUSSP seminar (Lesthaeghe 2001), but since it has not been widely circulated, we first summarise its main ideas.

The paper proposed a relational model of cohort cumulative fertility deviations relative to the schedule of a benchmark cohort, using two scalars to manipulate a standard deviation schedule before and after the age of 30.

The benchmark cohort is chosen as the one at the very beginning of the postponement trend, which in Lesthaeghe's examples for Western European countries were cohorts born around 1942-48. The analysis proceeds with the differences $d_c(x)$ in cumulative fertility $F_c(x)$ between the observed cohort c and the benchmark cohort b (i.e., $F_c(x) - F_b(x)$). The schedule of these differences by age was referred to as the "deficit function" of values of $d_c(x)$ for each cohort c. Subsequently, a standard deficit schedule is chosen for each country, namely $d_n(x)$, which is taken as representative for the underlying age pattern in all d_c(x) schedules. The observed $d_c(x)$ and the national standard $d_n(x)$schedules are related to each other by two parameters only. The postponement scalar PR_c manipulates (accelerates or decelerates) the degree of postponement as defined in the national standard d_n for all ages below 30, and the recuperation scalar, RR_c, determines the degree of fertility deficit reduction (i.e., "recuperation") above age 30. The model is a very parsimonious one, but crucially hinges on the stability of the shape of the national standard deficit function $d_n(x)$. If that condition is met, then the model can be used profitably for completing cumulative fertility schedules of cohorts between ages 30 and 50.

The original formulation was conditioned by data limitations and could only make use of fertility rates by five year age groups as then published in the Council of Europe's publications. The availability of single year data obviously offers several opportunities for improvement. The other major limitation of the original was the lack of parity specificity, but the philosophy of the relational model can readily be applied to parity specific schedules as well, as we shall demonstrate here.

5.1 Relational model of fertility postponement: basic formulas, notations and indicators

Before we begin elaborating on Lesthaeghe's relational model, we first summarise main formulas, notations, concepts and indicators used. We build upon the basic concepts and indicators used in our descriptive analysis of fertility *postponement* and *recuperation* introduced in Figure 1 and in Sections 1.2 and 4.3.

Figure 11 illustrates two trajectories of cumulated fertility by age as related to the *benchmark cohort b*.[5] One trajectory depicts the national schedule of deviations, d_n, which is defined in our study as an average value over two cohorts: 1) the youngest cohort that reached the age of 40 at the time when most recent data were available (typically, this is a cohort born in 1968 or 1969) and 2) the cohort born five year earlier.[6] Age-specific fertility rates $f_n(x)$ of the "national standard schedule" can simply be derived as an average of the two cohorts used for its computation:

$$f_n(x) = \frac{f_{n1}(x) + f_{n2}(x)}{2} \quad \text{or} \quad F_n(x) = \frac{F_{n1}(x) + F_{n2}(x)}{2} \qquad [5]$$

Then, the 'national standard schedule of deviations' is computed as a difference between cumulated fertility of the national standard schedule *n* and benchmark cohort *b*:

$$d_n(x) = \sum_{12}^{x-1} [f_n(x) - f_b(x)] = F_n(x) - F_b(x) \qquad [6]$$

Analogically, for any cohort younger than the benchmark cohort *b*, its deviations from the fertility schedule of the benchmark cohort can be computed as follows:

$$d_c(x) = \sum_{12}^{x-1} [f_c(x) - f_b(x)] = F_c(x) - F_b(x) \qquad [7]$$

By definition, the deviations of the benchmark cohort *b* at any age *x* are set to zero: $d_b(x) = 0$

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[5] The *benchmark cohort* is defined in the same way as in the descriptive approach introduced in Section 4.3 as a cohort experiencing the onset of first birth postponement (rounded to the nearest cohort ending with 0 or 5).

[6] Alternatively, only one recent cohort could be used to define the national schedule of deviations. While the results are likely to be similar in most cases, we expect that choosing two cohorts to define this standard schedule gives more stable results of the projections.

The *trough age m* in the national standard schedule is defined as an age when the absolute value of the deficit $d_n(x)$ reaches a maximum.[7] This does not necessarily mean that $d_c(x)$ for other cohorts also reaches a maximum at that age. For ages $x \geq m$ the absolute value of *recuperation* (i.e., fertility increase after age *m*), as compared to the benchmark cohort, can be computed for any cohort *c>b* (see Figure 11 for graphical illustration):

$$r_c(x) = \sum_{m}^{x-1} \left[[f_c(x) - f_b(x)] - [f_c(m) - f_b(m)] \right] = d_c(x) - d_c(m) \quad [8]$$

Analogously, the absolute recuperation can also be derived for the national standard schedule:

$$r_n(x) = \sum_{m}^{x-1} \left[[f_n(x) - f_b(x)] - [f_n(m) - f_b(m)] \right] = d_n(x) - d_n(m) \quad [9]$$

By definition, recuperation is nil at age *m*: $r_n(m) = 0; r_c(m) = 0$

Two essential indicators that show progression in the pace of *postponement* and *recuperation* at different ages across cohorts, are called the 'postponement ratio' PR_c and the 'recuperation ratio' RR_c. Both are measured relative to the national standard schedule $d_n(x)$. The *postponement ratio* can either be measured at ages lower than the *trough* age *m*, when its trajectory reflects the evolving pace of fertility decline, or across all ages considered. In the latter case, its interpretation after the age *m* becomes ambiguous as it is affected by both the size of maximum decline $P_c(m)$ at age *m* and the subsequent development in the recuperation, D_c, after that age. In contrast, the recuperation ratio RR_c is measured only at ages x > m:

$$PR_c(x) = \frac{d_c(x)}{d_n(x)} = \frac{\sum_{12}^{x-1} [f_c(x) - f_b(x)]}{\sum_{12}^{x-1} [f_n(x) - f_b(x)]} = \frac{F_c(x) - F_b(x)}{F_n(x) - F_b(x)} \quad [10]$$

[7] The *trough* age, however, can not be identified in the absence of any *recuperation* at older ages. Such a pure quantum decline without any subsequent compensatory increase usually occurs at higher birth orders, e.g., among Spanish women having third or higher-order birth (Figure 5b).

for $x > m$:

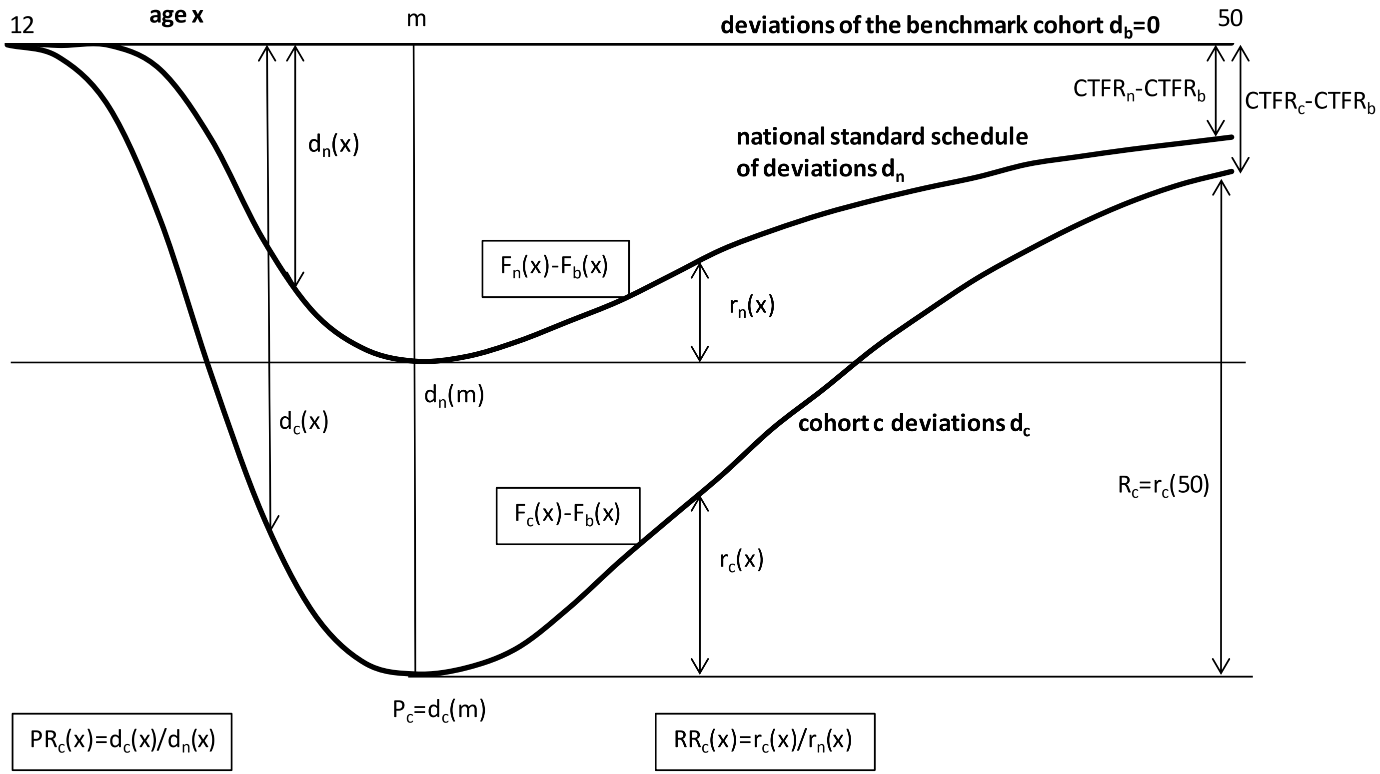
$$RR_c(x) = \frac{r_c(x)}{r_n(x)} = \frac{d_c(x) - d_c(m)}{d_n(x) - d_n(m)} = \frac{\sum_m^{x-1}[f_c(x) - f_b(x)]}{\sum_m^{x-1}[f_n(x) - f_b(x)]} \qquad [11]$$

By definition, both these ratios equal 0 in the benchmark cohort and are equal to 1 in the national standard schedule:

$$PR_n(x) = 1; PR_b(x) = 0; RR_n(x) = 1; RR_b(x) = 0 .$$

Since these two indexes portray trends in fertility *postponement* and *recuperation* relative to the national standard schedules, the developments in the absolute amount of fertility decline P_c and subsequent increase R_c (see Section 4.3) may considerably differ from these relative indexes. If, for instance, the pace of recuperation was only meagre in the national standard schedule, even a rapid increase in the RR_c index among the younger cohorts may not be enough to offset huge absolute declines in fertility at younger ages. Thus, it is always useful to inspect both the trends in absolute and relative measures of fertility *postponement* and *recuperation*.

Figure 11 Graphical illustration of the cohort postponement and recuperation as conceptualised in the relational model based on Lesthaeghe (2001)



5.2 Using the relational model to analyse trajectories of the cohort postponement and recuperation process

The relational model introduced above depicts the evolution of cohort *postponement* and *recuperation* as related to the degree of *postponement* and *recuperation* in the *national standard schedule* of deviations. This analysis is strongly affected by the choice of the cohorts for which this standard schedule is computed and for which the *postponement ratio PR* and the recuperation ratio *RR* is set by definition at 1.

In Figure 12 we use the example of first births in Austria to illustrate the analytical usefulness of this model. We select two recent cohorts whose first birth trajectory can be observed until age 40, specifically, 1963 and 1968, to define a national schedule of fertility deviations by age. This schedule reflects declines in cumulated fertility by age between the benchmark cohort of 1950 and the two selected national standard cohorts (an average value of cumulated fertility decline in these two cohorts is used). The standard schedule is then compared in graph 12a with the age-specific trajectories of cumulated fertility decline among selected older and younger cohorts. Figure 12b shows the schedules from another perspective, looking at selected ages only. Next, we show two different perspectives of analysing the postponement ratios PR_c, plotting their trends for selected cohorts across all ages through 40 (Figure 12c) and analysing them for all cohorts born since 1950 at selected ages (Figure 12d). For the cohorts born since 1970, the graphs show an acceleration of the postponement until about age 30, surpassing the value of 2, with a gradual decline in the postponement ratios thereafter. This signals that in comparison with the national standard schedules the cumulated fertility decline has further continued among the younger cohorts and into older ages, with a subsequent narrowing down of this ‘gap’ at ages above 30. Finally, graphs 12e and 12f track trends in the recuperation ratios and show that for the younger cohorts recuperation has been increasingly shifted into older ages, with sharply declining recuperation indexes below age 30. This pattern of cohort fertility changes signals that the age profile of the postponement and recuperation has shifted across cohorts. Especially the increasing concentration of the recuperation to later ages makes it more difficult to project completed fertility of cohorts that are currently in their prime reproductive ages. We provide a detailed elaboration of the use of the relational model for projection scenarios in Sections 6.3 and 6.4.

Figures 12a-f Relational model: indicators of cohort *postponement* and *recuperation* of first births in Austria by age and birth cohort

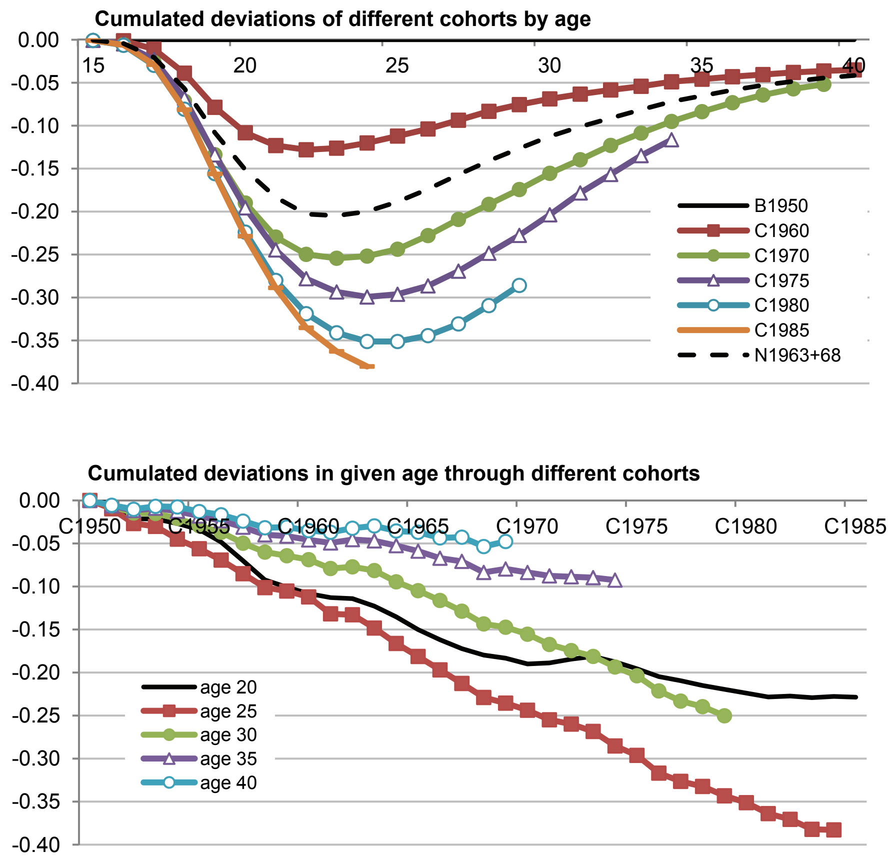


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Figure 12 continued

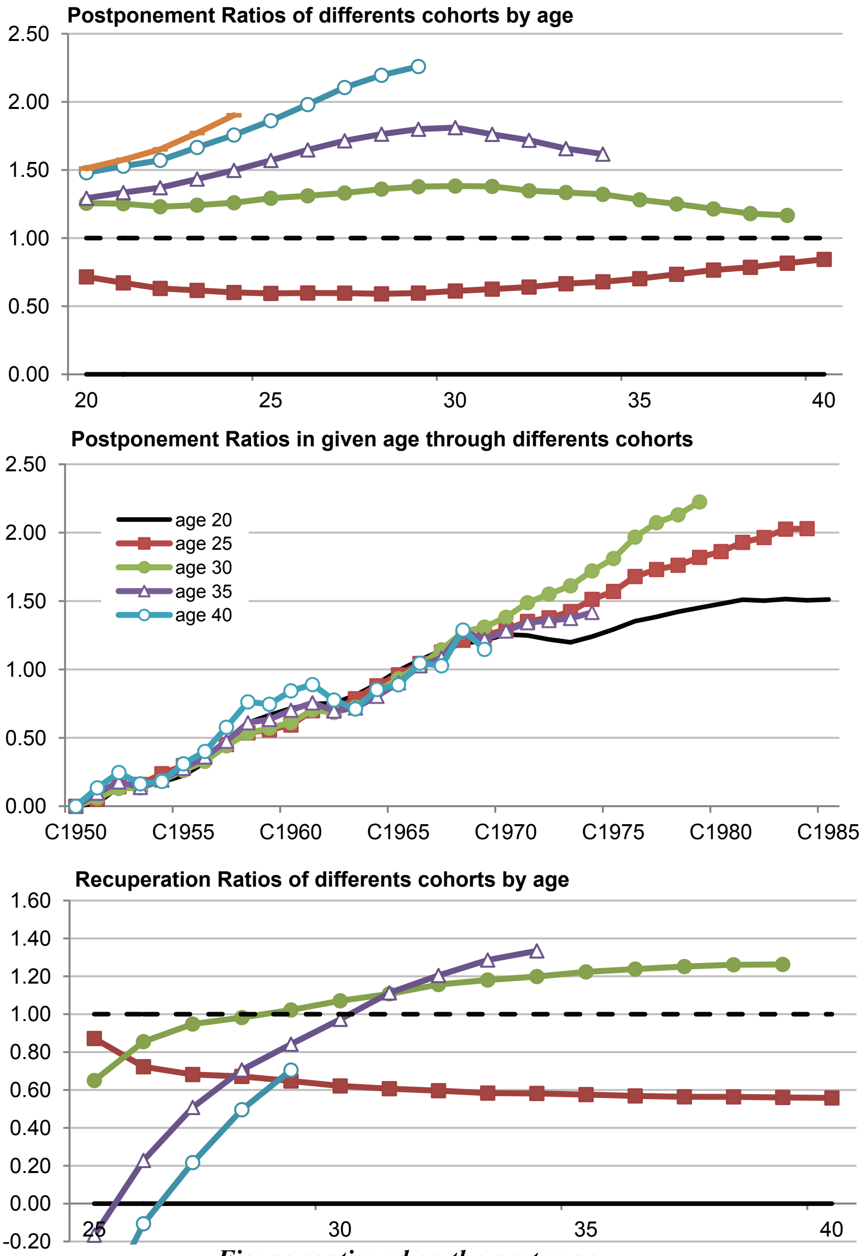

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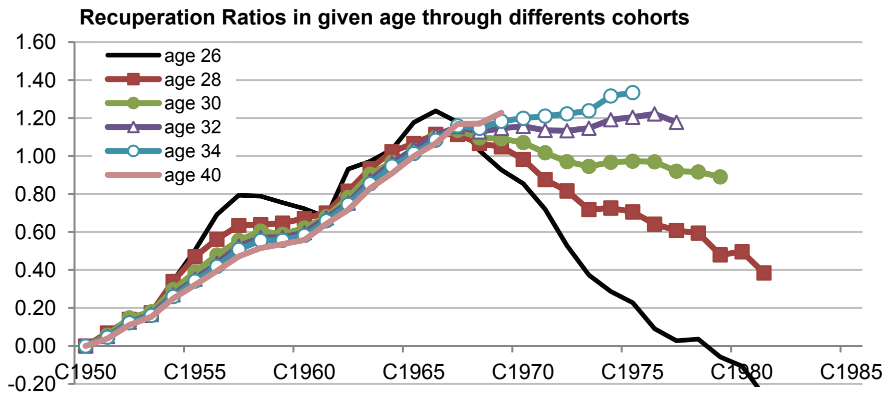
Figure 12 continued



6 Two Approaches for Projecting Cohort Fertility: Concepts and Illustrations

The real cohort view avoids the synthetic cohort distortions, but it faces the issue of incomplete schedules of cohorts that have not reached the end of their reproductive period. That brings analysts to explicitly formulating hypotheses and methods for forecasting cohort completion schedules. In other words, cohort analysis forces forecasters to be very explicit about the futures of each incomplete longitudinal set of life cycles. We address this issue illustrating projection scenarios based on the two broader analytical approaches to cohort fertility discussed above. Using the conventional Lexis diagram, the fertility rates in completed cohort schedules can also be read 'vertically' and translated into period measures that are consistent with the cohort ones. Projecting period rates only often leads to odd and even impossible outcomes when translated into the cohort format.

6.1 Approach 1: Using the basic benchmark model for projecting completed fertility among the cohorts of reproductive age

The key indicators from the basc benchmark model, discussed in Section 4, can be readily used for formulating cohort projection scenarios when the process of the *postponement transition* is underway. For any cohort of women, which has already reached the point of the maximum fertility decline relative to the *benchmark cohort*, the completed fertility rate *CTFR* at a given birth order *i* can be projected as follows (*p* stands for the projected values):

$$pCTFR_c^i = CTFR_b^i + P_c^i .(1 - pRI_c^i) \qquad [12]$$

where *b* represents the *benchmark cohort*, *RI* the recuperation index and *P* denotes maximum decline in cumulated fertility relative to the *benchmark cohort* (see Section 4.3). In this simple form, only the values of RI_c need to be projected, which puts the projection horizon at each birth order analysed to the last cohort that has reached the *trough* age. The projection of the completed fertility for all birth orders combined can either be obtained by a direct computation of the *pCTFR* using the formula 12 above, or, preferably, by summing up the results of order-specific projections:

$pCTFR_c = pCTFR_c^1 + pCTFR_c^2 + pCTFR_c^{3+}$. We argue that considering birth order improves the projection and its reliability by taking into account differential *postponement* and *recuperation* at each birth order. These order-specific trajectories may be hidden in the overall analysis for total birth orders when the parity distribution of births is changing across cohorts. When order-specific data are available, the two projection results for total birth orders can be readily derived and compared with each other.

In practice, plenty of extensions and elaborations to this projection framework can be considered. First, there are different possibilities of projecting *RI*, starting from "freezing" the last observed values, through trend projections, up to different scenarios assuming various trajectories of *recuperation*, which may also serve as a sensitivity analysis for assessing the impact of different degrees of *recuperation* on completed fertility rates.

Second, the projection horizon can be extended by projecting the values of P_c for the cohorts that have not yet reached the *trough* age. Obviously, more assumptions are needed then, resulting in higher uncertainty about the projected values.

This projection framework has some drawbacks that should be taken into account, particularly when used for situations for which it was not designed. When based on the observed values of *P* and projected values of *RI*, the projection will not extend into the young birth cohorts of women in their early- to mid-20s and may not even capture women in their early 30s for the higher-order births (depending on the observed age at *trough*). The projection is designed for the countries that are still undergoing the *postponement transition* and will not work well for the countries without long-standing and systematic shift in the cohort timing of births. It also does not perform well in the early stages of the postponement shift, where none of the analysed cohorts has reached the later reproductive ages and hence the recuperation index *RI* cannot yet be computed. Finally, the order-specific projection is highly sensitive to data quality: Problems with proper birth order reporting or its changes over time may strongly affect the reliability of the main projection parameters and of the projection itself.

6.2 Empirical illustrations 1: Projecting completed fertility using the Recuperation Index RI_c

We formulate projection scenarios for four countries with a different history of the cohort postponement process: Austria, the Czech Republic, the Netherlands, and Spain. We compute the observed *Recuperation Index* at age 40 rather than at ages 45 or 50 in order to obtain this projection parameter for somewhat younger cohorts. At the same time, we recognize a rising importance of fertility after age 40 for the completed fertility rate (Sobotka, Kohler, and Billari 2007) and are aware that a small portion of the *recuperation* is being shifted beyond age 40 and thus not captured by our *Recuperation Index*. Therefore, we perform a separate trend projection of cohort fertility rates by birth order at ages 40+. Our projected $CTFR_i$ values are therefore computed using the observed values of the benchmark cohort's $CTFR_i$ at age 40 and the *RI*s at age 40 as follows:

$$pCTFR_c^{\,i} = CTFR_b^{\,i}(40) + P_c^i.(1 - pRI_c^{\,i}(40)) + pF_c^{\,i}(40+) \qquad [13]$$

where $pF^i(40+)$ represents projected fertility rates at order *i* at ages 40 and above. We compute two baseline scenarios: the first simply keeps the most recent observed *Recuperation Index* constant and the second extrapolates the *RI* trend observed among the cohorts recently reaching age 40, using linear extrapolation. Depending on individual country trajectories and analyst's needs, different extrapolation methods can be used as well. For each of these two baseline scenarios, we obtain two sub-scenarios of the completed *CTFR*, the first based on a direct computation for total birth orders and the second—which we prefer—based on summing up order-specific projection results.

All the projection parameters are listed in Tables 1 and 2 and in Figures A1-A4 in Appendix 1. Table 1 shows cohort fertility rates for the *benchmark cohorts*, to which all the indices among the subsequent cohorts are related. The analysed countries reached similar levels of below-replacement fertility among the reference cohorts, ranging from 1.86 in Austria to 2.00 in the Netherlands. This makes comparisons of different indicators more meaningful than if the initial fertility levels differed widely.

Appendix Figure A1 depicts differences in the cumulated fertility decline *P* when reaching the *trough age*, which shows the Czech Republic, the Netherlands and Spain witnessing rapid transitions and similar levels of cumulated declines among the cohorts born in the late 1970s. In the latter two countries, the fertility postponement as measured by this indicator, has come to an end, in the Netherlands among the cohorts born around 1970 and in Spain among the cohorts born around 1975. This cessation of the declining fertility rates at younger ages is clearly identifiable for the first and the second births as well as for the total birth orders. In contrast, childbearing postponement in Austria has progressed only gradually and in a very regular fashion (see also Figure 8 above) and so far there are no signs that this process is coming to the end among the youngest cohorts observed.

Also, in the Czech Republic childbearing postponement had not ceased. The observed and projected recuperation indexes *RI*s (Table 2 and Figure A2 in the Appendix) depict high degrees of first birth recuperation close to 80% in the late 1960s cohorts, somewhat lower second birth recuperation except in the Czech Republic (close to 70% in Austria and the Netherlands, but only 50% in Spain) and virtually no third birth recuperation in Austria and Spain.[8] These observed parity-specific differences in fertility recuperation provide key information for fertility projections. Finally, Appendix Figure A3 shows the rising fertility rates above age 40 (38 in the Czech Republic), which make up a growing fraction of completed fertility. The observed and projected trend in fertility at late childbearing ages is particularly strong in the Czech Republic and Spain.

In Spain, fertility rates at ages 40+ are projected to quadruple between the cohorts 1955 and 1985, from 0.03 to 0.12 in absolute terms, bringing their expected share on completed fertility from below 2% to more than 8%.

[8] Note, however, that the linear projection of the recuperation indexes, while simple, depends crucially on the choice of the cohorts used for establishing the cohort trend in the most recently observed RIs. We aimed choosing for each country and birth order different number of recent cohorts that give some stability and plausibility to the predicted trend. This was relatively easy for the countries with a long and rather stable pattern of birth postponement—Austria and the Netherlands (except for higher-order births)—but was difficult for countries with erratic trends such as Spain or with a very recent history of the postponement with only a short series of the observed RIs, such as the Czech Republic. Further details can be obtained from the first author upon request.

Table 1 Cumulated cohort fertility at age 40 and completed cohort fertility by birth order among the benchmark cohorts (BC) in Austria, Czech Republic, the Netherlands, and Spain

	Order 1	**Order 2**	**Order 3+**	**Total**
Cumulated *CFR*^{i} at age 40				
Austria (BC 1950)	0.829	0.608	0.401	1.838
Czech Republic (BC1965, age 38)	0.918	0.725	0.235	1.878
the Netherlands (BC 1945)	0.881	0.744	0.354	1.978
Spain (BC 1955)	0.887	0.667	0.320	1.873
Final *CTFR*^{i}				
Austria (BC 1950)	0.833	0.613	0.417	1.863
Czech Republic (BC1965)	0.925	0.735	0.271	1.931
the Netherlands (BC 1945)	0.883	0.747	0.367	1.997
Spain (BC 1955)	0.896	0.677	0.335	1.908

Note: Because of a late start of the cohort postponement, with the 'benchmark cohort' of 1965 reaching age 44 in 2009, when our most recent data were collected and also due to an overall earlier fertility schedule, we compute the scenarios and recuperation indexes for the Czech Republic at age 38 rather than 40.

Table 2 *Recuperation Index* (*RI*) in the most recent cohort reaching age 40 and the projected *RI* at age 40 for the *trend scenario* in the 1980 cohort (in %)

	Order 1	Order 2	Order 3+	Total
Observed RI^i at age 40 (%)				
Austria (BC 1969)	80.8	68.9	2.7	44.2
Czech Republic (age 38, BC1972)	77.3	64.3	41.0	62.7
the Netherlands (BC 1968)	83.1	67.5	45.6	69.4
Spain (BC 1968)	74.6	47.9	0.4	37.0
Projected RI^i at age 40, women born in 1980, trend scenario				
Austria	85.8	73.2	7.7	68.8
Czech Republic (age 38)	84.2	90.1	41.6	84.5
the Netherlands	93.4	72.1	8.3	68.4
Spain	60.1	40.3	0.5	49.8

Note: Observed and projected recuperation indexes for the Czech Republic are computed at age 38; see note below Table 1.

Table 3 gives a first glimpse on the projection results, concentrating on the 1980 cohort that was approaching age 30 at the start of the projection (2009 or 2010). The two approaches derived from order-specific projections—one using a stable *Recuperation Index* and the other *trend projection*—give identical results for Austria and the Netherlands and differ somewhat only in the case of Spain, which has the lowest projected completed fertility rate of 1.45 and 1.41, respectively. For the Czech Republic, the difference is considerable, however, since the cohorts for which the projection is computed experienced massive fertility declines at younger ages. The two scenarios derived for total birth orders combined (i.e., without taking into account fertility trajectories by birth order) show almost identical results for the Netherlands—a country with very stable and thus also quite 'predictable' cohort fertility—but depict noticeable differences for the other three countries. Overall, we have more confidence in order-specific scenarios, where we expect that the parity-specific analysis is likely to improve projection accuracy and reliability. For two countries, Austria and the Czech Republic, these scenarios give a considerably higher completed fertility than the simple projection based on keeping the observed age-specific fertility rates for 2008 constant.

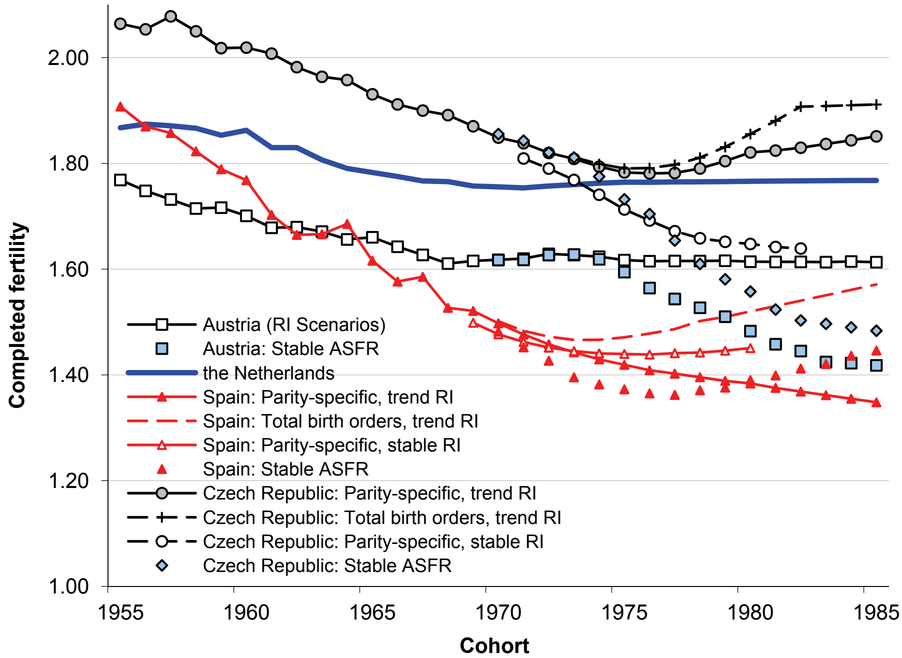
Table 3 Projected completed fertility rates among women born in 1980; scenarios based on the Recuperation Index (RI) as compared with the "stable age-specific rates" (ASFRs) scenario

	Derived from order-specific scenarios		**Computed for all birth orders combined**		**Keeping 2008 ASFRs constant**
	Stable RI	**Trend RI**	**Stable RI**	**Trend RI**	
Austria	1.60	1.61	1.51	1.63	1.48
Czech Republic	1.68	1.82	1.66	1.86	1.56
the Netherlands	1.77	1.77	1.78	1.76	1.76
Spain	1.45	1.41	1.38	1.52	1.39

Figure 13 summarises projection results for individual cohorts through 1985, based on different *Recuperation Index* scenarios and a simplistic scenario of constant age-specific fertility rates since 2008. For the Netherlands only the trend *RI* scenario is shown as it almost overlaps with all the other scenarios. For Austria, only two scenarios, the trend *RI* and a 'stable rates' scenario are used as all the scenarios based on the *Recuperation Index* show similar results. For both countries, a stabilization of completed fertility is projected for the women born after 1980, at a higher level in the Netherlands (just below 1.8) than in Austria (slightly above 1.6, except for the 'stable rates scenario', in which the completed fertility falls to the level close to 1.4). As these two countries show similar trends in the recuperation index for the first and the second births, the main factor behind their different projected completed fertility is the lower initial *CTFR* level of the *benchmark cohort* in Austria combined with a complete absence of recuperation at third and higher-order births.

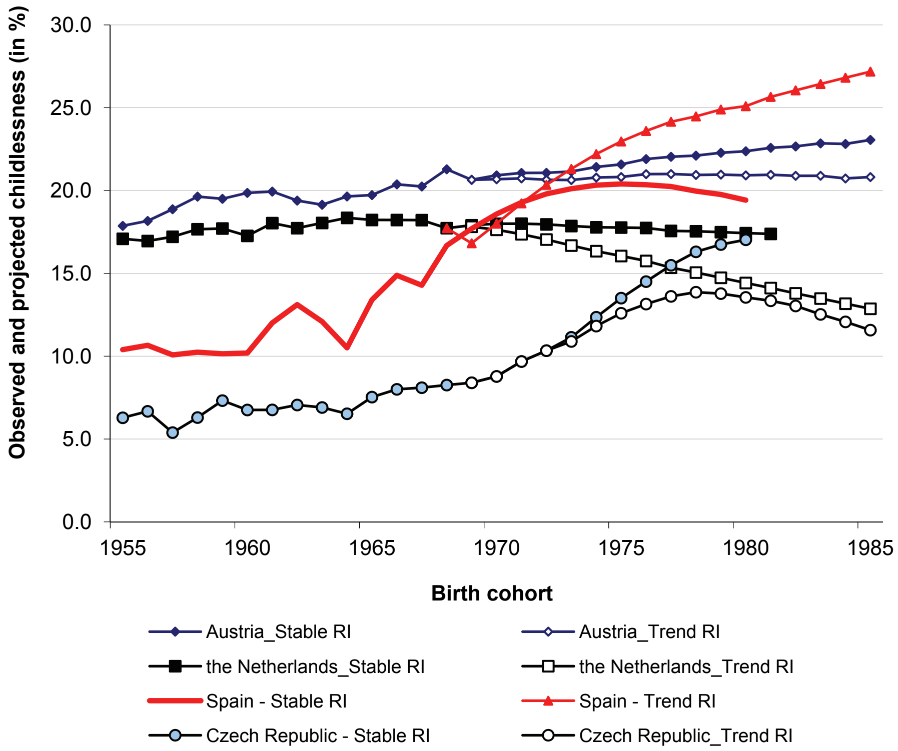
For the Czech Republic and Spain, the projection results are less stable and less reliable due to a later start of the postponement process and dynamic changes in fertility since the late 1990s. Therefore, we show four projection scenarios, which illustrate considerable uncertainty about the completed fertility among the early 1980s cohorts, with Spain falling into a low-fertility range of 1.35-1.57. For the Czech Republic, the RI-based scenarios depict a wide range of 1.6-1.9 among the early 1980s cohorts, which is far above the period TFR of 1.1-1.5 recorded in 1994-2009. In contrast, the "freezing rates" scenario that ignores both the recuperation process and parity-specific changes, falls below 1.5 for the 1984-85 cohorts. We also show projections of childlessness based on the *stable RI* and the *trend RI* scenarios (Figure 14). These two scenarios differ considerably for the Czech Republic, the Netherlands as well as Spain: In the Netherlands, the trend scenario leads to a steady fall in childlessness, whereas in Spain it suggests its rapid increase to the levels above 25% in the early 1980s cohorts. Such differences illustrate nicely the considerable uncertainty in childlessness projections among women that were in their early stage of reproduction at the start of the projection period.

Figure 13 Observed and projected completed fertility among women born in 1955-1985; selected scenarios based on the Recuperation Index and on stable age-specific fertility rates since 2008



Such projections can be further complemented with purely hypothetical 'no recuperation' and 'full recuperation' scenarios. These can be seen as exercises in sensitivity analysis, demonstrating the importance of recuperation for the projected completed fertility, but also showing how narrow or wide the spread of the projected scenarios is within the hypothetical limits given by the 'full recuperation' vs. 'no recuperation'. Figure A4 in the Appendix, prepared for Austria and the Czech Republic clearly demonstrates that a complete absence of any fertility recovery at ages after the *trough* would eventually push completed fertility close to or even below 1.

Figure 14 Observed and projected childlessness (in %) among women born in 1955-1985. Stable and trend scenarios



While these illustrations show the potential use of the *recuperation index* and parity-specific analyses in projecting completed fertility and parity distribution during the *postponement transition*, it is important to emphasise limitations of this approach, namely the sensitivity of the projections to the specification of the *trend scenario*, which strongly depends on the type of extrapolation selected and even more on the reference period on which the extrapolation is based. Moreover, parity-specific projections are sensitive to the quality of birth statistics by birth order. We recommend performing sensitivity analysis when using this approach, modelling different possible trends in the *recuperation index* at each birth order considered.

6.3 Approach 2: Using the relational model of fertility for projecting cohort fertility schedules

The projection approach analysed in the previous section only gives final values of completed fertility and does not allow computing the whole schedule of cohort age-specific fertility rates. This task can be accomplished by using the relational model of cohort postponement and recuperation, introduced in Section 5. The idea is to project either the postponement ratio at age 40, $pPR_c(40)$, or the postponement ratio at age x ($pPR_c(x)$), or the recuperation ratio at that age ($pRR_c(x)$) and then use these projected values to recalculate age-specific fertility rates and cumulated fertility at age x ($pF(x)$), using the following formulas (see Section 5 for notations):

$$pd_c(x) = d_n(x) \cdot pPR_c(x) \text{ or}$$

$$pd_c(x) = d_n(m) \cdot PR_c(m) + r_n(x) \cdot pRR_c(x) \quad [14]$$

$$pF_c(x) = F_b(x) + pd_c(x) \quad [15]$$

This approach may be used for estimating the complete fertility schedule by age. The indicators derived at age 40 can be used for rough estimates of the completed fertility rate, but we advise adjusting the data for fertility rates that occur after that age (Section 6.2).

Because there are two different projection frameworks for employing the relational model—one relying on the postponement ratios only and the other combining postponement ratios and recuperation ratios—and various possibilities of how to project these ratios, we discuss three different methods derived from the relational model and compare them with two simpler projection scenarios based on projected recuperation indexes, analysed in Section 6.2 above. We first describe the three new projection scenarios (methods) based on the relational model, while the next section shows their empirical application for the same set of countries as studied in the projections derived solely from the Recuperation Index.

Method 1 predicts the recuperation ratio $RR_c(40)$ on the basis of observed postponement ratio at the trough age $PR_c(m)$ using linear regression:

$$pRR_c(40) = \alpha \cdot PR_c(m) + \beta + \varepsilon \qquad [16]$$

where α, β are regression coefficients and ε is the error term (residual). This method thus makes use of a sharp delineation of the postponement-recuperation process into two distinct stages, each captured by a separate index. It has, however two drawbacks. First, the recuperation ratios can be predicted only for the cohorts with known $PR_c(m)$, which limits particularly the application for higher birth orders with later trough ages. Second, the computation of the recuperation ratio is linked to the postponement ratio in that this method does not allow an acceleration of the recuperation, i.e., a faster rise in fertility at higher ages than that predicted on the previous pace of postponement.

Method 2 aims to address this drawback and predicts the $RR_c(40)$ not only on the basis of the postponement ratio, $PR_c(m)$, but also introduces an independent cohort trend, c:

$$pRR_c(40) = \alpha \cdot PR_c(m) + \beta \cdot c + \chi + \varepsilon \qquad [17]$$

This makes the projection less conditioned by the observed trajectory of birth postponement and allows an independent acceleration of recuperation across cohorts. However, the second method shares with the previous method the disadvantage of requiring the values of the $PR_c(m)$ to be known and limiting thus the number of cohorts for which a recuperation trajectory can be projected.

Method 3 works only with the postponement ratios PR_c across the whole reproductive age range up until age 40. We use linear regression to predict the *PRs* for the unknown (future) part of the fertility schedule. Initially, we simply regressed *PR*s across age x as dependent on the cohort birth year ***c***, but this approach gave implausible results. Using the postponement ratio in the preceding age $PR(x\text{–}1)$ as an explanatory variable turned out to be considerably more promising with respect to stability and plausibility of results. For example, when we dispose with fertility data up to the year 2008, we may compute fertility rates for the cohort of 1985 up to age 23. The postponement ratio for the next age $PR_{1985}(24)$ is then predicted using the relation between the known data series at ages 23 and 24 for the cohorts observed since the onset of the birth postponement. If sufficiently long cohort data series have accumulated after the benchmark cohort, we can use this approach to predict step-by-step the postponement ratio for each cohort and for each age (up to age 40, depending on the national schedule of deviations) using the following equation:

$$pPR_c(x) = \alpha \cdot PR_c(x-1) + \beta + \varepsilon \qquad [18]$$

This approach thus ignores the theoretically useful distinction between the postponement and recuperation phases of the ongoing cohort change. At the same time, this theoretical disadvantage may be outweighed by higher stability of the projection. [9]

6.4 Empirical illustrations 2: Projecting completed fertility using the relational model

Figure 15 presents projections of the cumulated cohort fertility rate at age 40, based on the three methods derived from the relational model and introduced in the preceding section (Methods 1-3) and additional scenarios based on the Recuperation Index RI, elaborated in sections 6.1 and 6.2. The projections, displayed for single birth cohorts starting from the benchmark cohort, are computed and evaluated separately for the first, second and third and higher-order births.

Method 1 often provides results that are similar to the stable scenario based on 'freezing' the most recently observed *RI*s (*Fixed RI* scenario). This similarity conforms to the shared methodological underpinning of both methods: In both cases, the predicted degree of recuperation, represented by the Recuperation Index and the Recuperation Ratio in Method 1, is conditioned on the past postponement trajectory.

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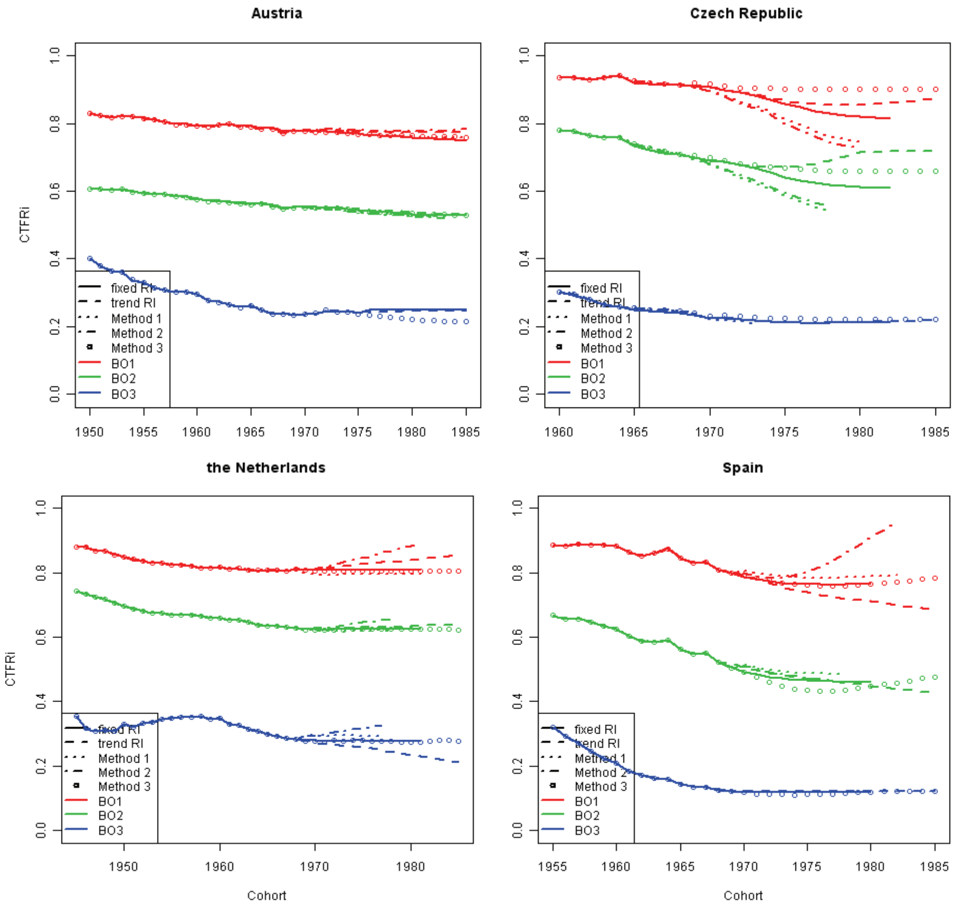
[9] One can also experiment with adding both the preceding age *PR(x–1)* and cohort *c* as explanatory variables:
$pPR_c(x) = \alpha \cdot PR_c(x-1) + \beta \cdot c + \gamma + \varepsilon$, allowing an acceleration of recuperation in future cohorts. However, this variant gives results that are very similar to Method 3 without an added cohort variable.

Figures 15a-d Cohort cumulated fertility rate at age 40, by birth order, projected by five different methods, up to cohort 1985; Austria, Czech Republic, the Netherlands, and Spain

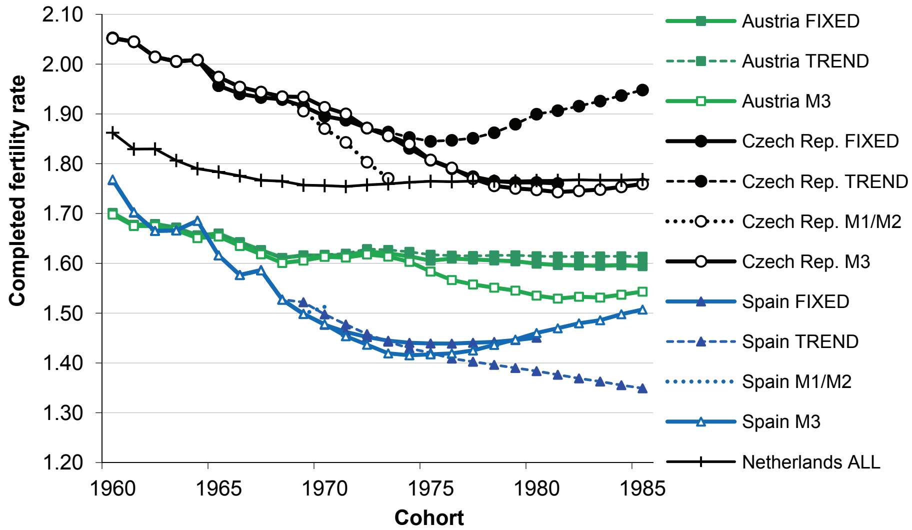


Note: Methods 1 and 2 do not allow computing the results for birth orders 3+ for Austria due to the absence of any measurable recuperation (*$RR^{3+}(40)$*). In distinction to other parts of our study, the benchmark cohort for the Czech Republic is set at 1960 rather than 1965 in order to obtain sufficient number of cohorts to specify projection parameters.

Method 2, which allows an independent trend influencing recuperation ratios across cohorts, gives results that deviate noticeably from the other methods discussed in the case of the Netherlands and Spain. In these two countries, the projected cumulated fertility at age 40 increases implausibly among the younger cohorts, especially for first births. In contrast, Method 3 displays remarkable stability which persists over the longer projection horizon, for which this method can be computed. This is most notable for the Czech Republic, where Method 3 suggests only a tiny fertility decline among the cohorts born in the 1970s and early 1980s despite the earlier radical reshaping of fertility schedules, translated into extreme low period fertility rates in the late 1990s. With some simplification, we interpret these results as indicative of a broad plausibility of Methods 1 and 3 as well as the two scenarios based on Recuperation Indexes. Method 2, in contrast, may give problematic and implausible results in some countries. At the same time, it may be useful for putting an extra weight to recent ups and downs in cohort fertility and thus it may also help picking up emerging trends.

In Figure 16 we combine these order-specific scenarios and present major results for the completed cohort fertility rate, extending thus Figure 13 that showed scenarios based on the Recuperation Index. For the Netherlands and Austria we show the results based on Method 3 only, as the other methods gave almost identical projected values. Overall, the projections based on the relational model give similar insights and broadly comparable trends of the future cohort fertility as the scenarios based on the Recuperation Index. This is further shown in Table A1 in the Appendix, which compares two parity-specific projections, based on the *Trend RI* scenario and on Method 3, of the cumulated fertility at age 40 for the 1980 and 1985 cohorts. Only for the latter cohort in Spain do the projected results differ by more than 0.1 children per woman.

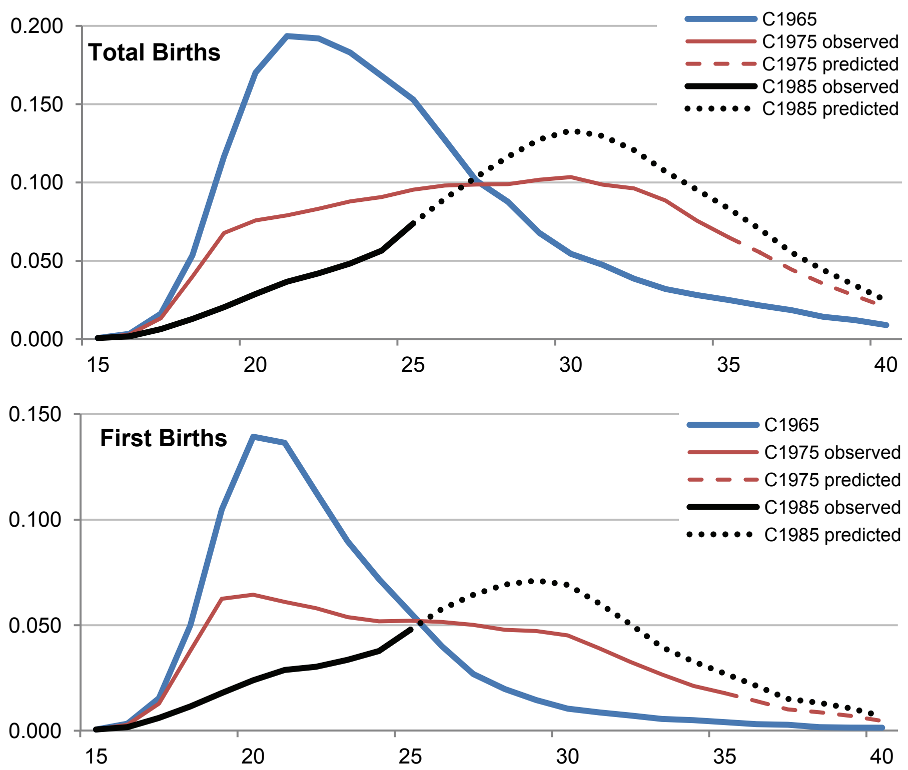
Figure 16 Completed fertility rate, projected by different methods for the cohorts born through 1985. Austria, Czech Republic, the Netherlands, and Spain



Note: Methods M1 and M2 are not shown for Austria as they cannot be computed due to the absence of any measurable recuperation at third and higher birth order. Methods M1 and M2 show very similar results for the Czech Republic and for Spain. For the Netherlands only one result is shown as all the five scenarios give very similar values. In distinction to other parts of our study, benchmark cohort for the Czech Republic is set at 1960 rather than 1965 in order to obtain sufficient number of cohorts to specify projection parameters.

The advantage of the relational model lies in its ability to project the whole schedule of age-specific fertility rates by age. In fact, this can be most easily done in the scenarios relying on the postponement ratios (PR), in our case used by Method 3. The use of both postponement and recuperation ratios in Methods 1 and 2 make projecting an entire schedule of age-specific fertility rates more complicated, especially when the trough age moves across cohorts. Figure 17 shows such a projection for the Czech Republic for the cohorts of women born in 1965, 1975, and 1985, depicting a massive shift to a late childbearing pattern. The magnitude of this shift is most apparent in the schedule of first births, where the peak childbearing age is projected to shift to 29 in the 1985 cohort, up from 20 in the 1965 cohort. Further elaborations and comparisons with other projection methods will show whether the relational model can become a useful tool for projecting fertility schedules in the countries undergoing the *postponement transition*.

Figure 17a and b Observed and projected cohort fertility rates by age for the women born in 1965, 1975, and 1985. Czech Republic. Relational model, projection method 3



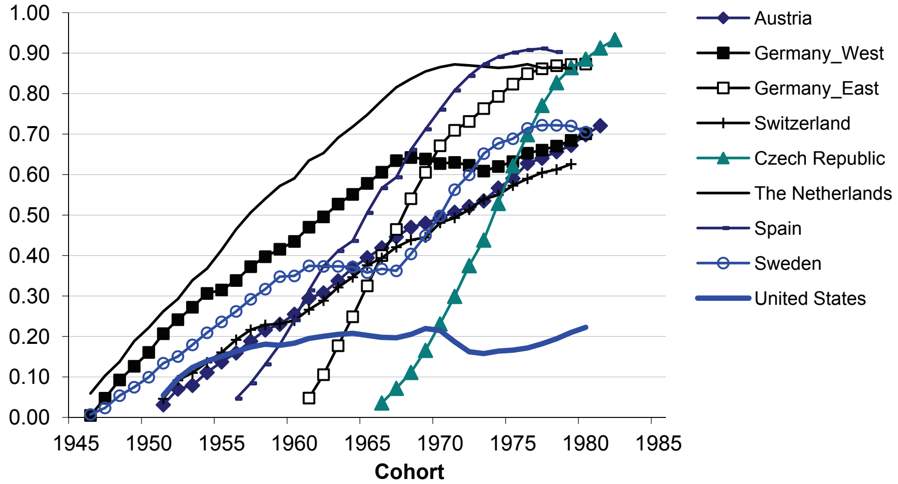
Note: In distinction to other parts of our study, the benchmark cohort for the Czech Republic is set at 1960 rather than 1965 in order to obtain sufficient number of cohorts to specify projection parameters.

7 CROSS-COUNTRY DIVERSITY IN THE TRAJECTORIES OF POSTPONEMENT AND RECUPERATION

Building upon the previous sections, we apply our methodological tools to analyse cohort *postponement* and *recuperation* in selected European countries and in the United States. Specifically, we look at the three predominantly German-speaking countries of Europe, Austria, Germany, and Switzerland, which experienced low fertility rates for several decades and compare them with four countries representing broader European regions (the Czech Republic for post-communist Central Europe, the Netherlands for Western Europe, Spain for Southern Europe and Sweden for Northern Europe). Owing to a lack of detailed order-specific cohort fertility data for Germany and Switzerland and also to save space we focus particularly on the results for all birth orders combined.

First we compare cohort trajectories of fertility decline at younger ages from the onset of the postponement transition, as measured by the size of cumulated fertility decline at trough age, *Pc*. Figure 18 shows particularly rapid transitions in the Czech Republic and Spain as well as in East Germany (former GDR). In contrast, birth postponement progressed in a more gradual and also regular fashion in Austria and Switzerland, whereas in West Germany and Sweden it stalled for about five cohorts before picking up again, rapidly in Sweden and gradually in West Germany. The pattern is very different in the United States, where this indicator suggests that the concept of the 'postponement transition' does not conform to the observed fertility trend: the fall in fertility at younger ages was relatively minor and mostly confined to the 1950s cohorts with a reversal among the late 1960s cohorts.

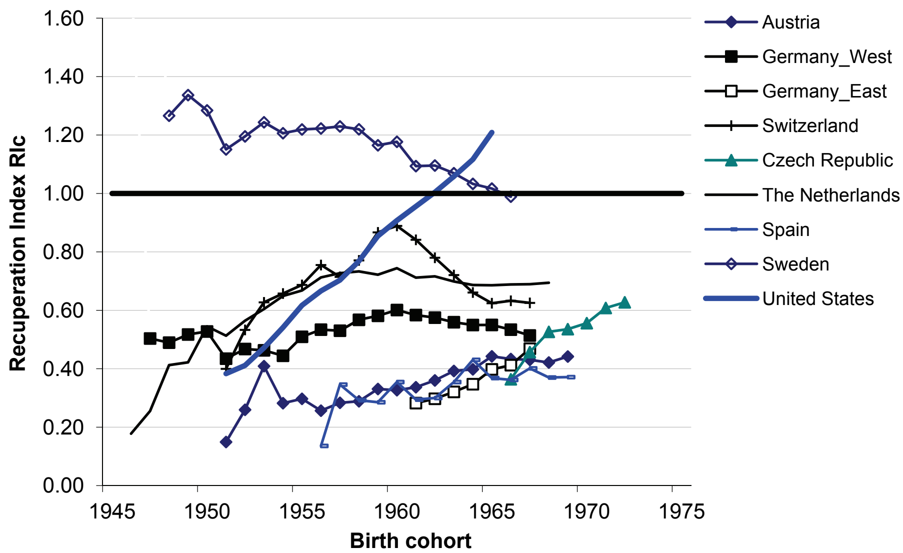
Figure 18 Absolute fertility decline at younger ages from the onset of fertility postponement (Pc), cohorts 1945-1982



To find out what portion of the presumably postponed births has eventually been ‘made up’ at later ages, Figure 19 plots the recuperation index *RIc* for all birth orders for the cohorts born until the late 1960s. It shows vast differences between countries, with Sweden constituting an example of a complete recuperation, the Netherlands registering a ‘healthy’ recuperation at around 70%, while Spain, East Germany and Austria lag behind with fewer than one half of the early fertility decline being compensated at higher ages (only around 37% in Spain). Whatever minor postponement there had been in the United States, it was subsequently ‘overcompensated’ at higher ages, with the recuperation index surpassing 1 for the cohorts born after 1962. Most other countries experienced stagnation or a minor rise in the recuperation index among the late 1960s cohorts.

As shown earlier, huge parity differences exist with respect to the share of ‘recuperated’ fertility: For first births, recuperation surpasses 67% among the 1960s cohorts in all the countries studied. For the second births, it reaches low values in Spain and moderate levels around 65% in Austria, the Czech Republic, the Netherlands and Switzerland (Figure A5 in the Appendix). The largest differences exist in the extent of recuperation in higher order births, where no measurable recovery of cohort fertility took place in Austria and Spain, a very modest one of about 30% in Switzerland and a large 'overcompensation,' with an RI index surpassing 2, occurred in the US cohort of 1965. Huge fluctuations across cohorts, as found especially for Switzerland, may be attributable to the small absolute size of the postponement component *Pc* that can make trends in recuperation index unstable, or to unreliable estimations of birth order distribution of cohort fertility.

Figure 19 Recuperation Index, *RIc* at age 40 (total birth orders), cohorts born through the late 1960s



Note: Observed and projected recuperation index for the Czech Republic is computed at age 38.

Table 4 summarises key indicators of the *postponement transition* in the analysed countries. There is little variation in fertility levels among the benchmark cohorts, ranging from the values around 1.8 children per woman

Table 4 Selected indicators of the postponement and recuperation process

Country	Benchmark cohort	Cumul. fert., F_b(age 40)	Observed Pc		Observed RIc at age 40, cohort 1968 or most recent				Final Decline FD (C 1968)
			C1968	C1978	BO1	BO2	BO3+	Total	
Austria	1950	1.84	-0.47	-0.65	0.76	0.64	0.02	0.41	-0.28
Germany	1945	1.78	-0.64	-0.72	-	-	-	0.48	-0.33
Germany East	1960	1.78	-0.54	-0.87	-	-	-	0.49	-0.33
Germany West	1945	1.76	-0.64	-0.67	-	-	-	0.48	-0.28
Switzerland	1950	1.77	-0.44	-0.61	0.68	0.64	0.25	0.57	-0.19
Czech Republic	1965	1.90	-0.11	-0.83	0.77	0.64	0.41	0.63	-0.15
The Netherlands	1945	1.98	-0.84	-0.86	0.83	0.68	0.46	0.69	-0.23
Spain	1955	1.87	-0.66	-0.90	0.75	0.48	0.00	0.39	-0.40
Sweden	1945[1]	1.95	-0.41	-0.72	0.94[1]	0.88[1]	0.08[1]	0.92	-0.03
United States	1950	1.99	-0.18	-0.18	1.10	1.08	3.29	1.30	0.05

Notes: [1] for Sweden, order-specific results are computed using the cohort 1955 as a benchmark, since the complete set of age and order- specific fertility rates is not available for the older cohorts.

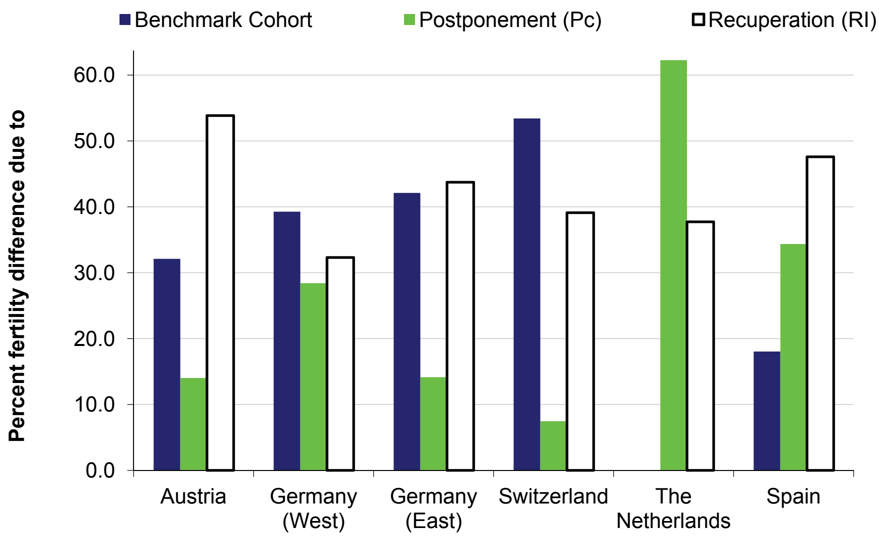
Swiss data were estimated and kindly provided by M. Burkimsher; these estimates are partly based on the Population Census of 2000. The recuperation indexes RIc in Sweden are shown for the 1967 cohort and in the United States for the 1968 cohort as more recent data are not available. For the Czech Republic, we show RIc for the cohort of 1972, at age 38.

in German-speaking countries up to the values close to 2 in the Netherlands and the United States. The postponement indicator, P_c, shows massive declines in early fertility in all the analysed countries except the United States, with the cohort of 1978 having by 0.6-0.9 fewer children per woman when reaching the trough age than the benchmark cohort. In combination with diverse degrees of recuperation, some of the early fertility declines remained permanent in all the countries except the United States, with the ultimate decline (measured at age 40) being largest in Spain (-0.4), Austria and Germany (both East and West, around -0.3).

Combining these three indicators, a simple decomposition may explain the difference between the cumulated fertility rate at age 40 in Sweden and in the other analysed countries. Looking at the 1967 cohort, which has recently reached age 40, Swedish cumulated fertility of 1.95 remained very close to two children per woman. A difference between the relatively high and stable fertility rate in Sweden and the corresponding cumulated fertility rate of the 1967 cohort in other countries may be due to different fertility levels among the benchmark cohort ($CTFR_b$), due to different levels of fertility decline at younger ages (P_c), or due to different levels of recuperation, as captured by the RI_c. To find out which of these three components mattered most, we provide a simple decomposition of the difference between the completed fertility of the women born in 1967 in Sweden and in the other countries analysed here except the Czech Republic, where the postponement shift started only among the mid-1960s cohorts. Our method is briefly described in Appendix 2; the main results are summarised in Figure 20 (relative contributions of different components) and in Appendix table A2 (absolute values of these components).

Figure 20 leads to one clear-cut conclusion: In the six regions analysed, each of the three components—a lower fertility in the benchmark cohort fertility, a steeper decline in trough and a less vigorous recuperation—played a role in explaining lower fertility in the 1967 cohort when compared with Sweden. The only exception was the higher level of benchmark cohort fertility in the Netherlands. Within individual components, a slow recuperation was a key factor in Austria, Spain and by a small margin in East Germany; low initial fertility level among the benchmark cohort was the main factor in West Germany and Switzerland, while a sizeable fall in fertility at the trough age was the major factor in the Netherlands. This relative picture should be compared jointly with the size of absolute differences from Sweden, which ranged for this birth cohort from 0.19 in the Netherlands up to 0.48 for West Germany (Appendix Table A2).

Figure 20 Relative contribution of three components of the postponement transition to the differences in cumulated cohort fertility at age 40 between Sweden and selected countries of Europe. Women born in 1967



8 Summary and Conclusions

Our study has revisited the analysis of cohort fertility postponement and recuperation. This trend has gained importance as women in Europe and many developed countries outside Europe progressively reduced their fertility in their teens and early to mid-twenties and subsequently offset some or most of these reductions at later childbearing ages. Whereas period fertility rates became increasingly distorted by this timing shift and thus also less reliable for a range of analytical and projection purposes, the cohort approach allows for a much neater and tidier look at the recent fertility transformations.

We have discussed a range of extensions, elaborations and improvements in the methods used to date, focusing both on the analysis of the actual progression of the postponement and recuperation process and on projecting completed fertility among the cohorts of women of reproductive age. This effort has been facilitated by the increasing availability of detailed single-year and order-specific fertility data for a growing number of populations, especially those contained in the *Human Fertility Database*. We placed emphasis on analysing and projecting cohort trends by birth order. Whenever data allow, dissecting the overall trends in fertility into order-specific components clearly provides an added value to the analysis and more reliability to the projections. Furthermore, the choice of the reference cohort is important, as the *postponement transition* has been initiated by different cohorts of women across countries, broadly varying between 1945 (e.g., the Netherlands and Sweden) and 1970 (Bulgaria). We therefore specify a reference cohort for each country, choosing one of the cohorts initiating first birth postponement, and recommend employing this approach for future analyses. We have also shown that postponement can be analysed as an ongoing and dynamic process, with each cohort becoming a benchmark for the analysis of changes in fertility by age and birth order in the subsequent cohorts. In addition, we suggest that it is important to allow for a flexible definition of the age when the cumulated fertility decline is maximal—the 'trough' age—across cohorts, as the age patterns of postponement and recuperation may change. The use of an inflexible 'trough' age may distort results. Based on a more detailed and improved comprehension of cohort fertility dynamics, methods of completed cohort fertility and childlessness projections have been elaborated and illustrated for four countries.

The *postponement transition* can be illustrated by several key order-specific indicators that capture the progression of this transition, specifically, the fertility level of the benchmark cohort, the size of younger-age fertility decline, and the degree of 'recuperation' at older ages, measured by the recuperation index (RIc). These three indicators can also serve as the main inputs of completed cohort fertility projections. Alternatively, a full set of age- and order-specific cohort fertility rates can be projected using the 'relational model' of cohort fertility, first proposed by Lesthaeghe (2001) and further elaborated here.

An ongoing discussion among demographers about the prominence of cohort or period factors in driving the observed fertility has also brought more attention to the cohort fertility analysis. We reckon, however, that our analytical tools would remain useful for descriptive, analytical and projection purposes even if the observed fertility transformations were mostly driven by period factors, like economic ups and downs, fashion trends, sudden changes in the labour market, or government policies.

Our illustrations and cross-country analyses, focusing on predominantly German-speaking countries of Europe (Austria, Germany, and Switzerland, with Germany split into two regions with distinct fertility developments), four European countries representing broader regions (Czech Republic, the Netherlands, Spain and Sweden) and the United States, bring a number of important observations, which can be summarised as follows:

- Initial fertility levels matter. Some of the recent cohort fertility differences between countries can be traced back to the initial differences before the onset of the *postponement transition*. Countries with currently low fertility levels usually had low fertility levels already at the onset of first birth postponement.

- The recuperation process is paramount for understanding the observed differences in fertility. Typically, countries with low cohort fertility in the order of 1.4-1.6 births per woman in the late 1960s cohorts, including Germany and Spain, show much weaker recuperation than the countries with comparatively higher completed fertility rates around 1.8-2.0, such as the Netherlands and Sweden.

- However, fertility recuperation differs widely by birth order. All the analysed countries show a strong recuperation in first birth rates, whereas the recuperation index in the third and higher-order births varies between null in Spain and Austria through 0.4-0.5 in the Czech Republic and the Netherlands to an 'over-compensation' in the United States, bringing the index far above 1 (Note that when the absolute amount of postponement is minor, the recuperation index is highly sensitive to small absolute changes in recuperation, which may produce a high or an unstable recuperation index).

- Fertility postponement, as measured by the cumulated absolute fertility decline at younger ages, *Pc*, has come to an end, at least temporarily, in many developed countries starting in the early- to mid-1970s cohorts. This also holds for four countries in our analyses—the Netherlands, East Germany, Spain, and Sweden. The cessation of fertility postponement, however, does not necessarily imply a future cessation of the recuperation process.

- Completed cohort fertility projection scenarios suggest relatively stable fertility levels in the countries that have progressed furthest in the postponement process, while for the countries where childbearing postponement started relatively late, the scenarios often diverge, capturing considerable uncertainty in the unfolding recuperation. Among the analysed countries, the scenarios studied indicate a stabilisation in the completed fertility among the women born after 1975 in the Netherlands (close to 1.8 children per woman) and Austria (at 1.6), while a rather broad range of fertility levels was projected for the Czech Republic and Spain, with the former potentially retaining a higher fertility of up to 1.9 and the latter experiencing a fall in completed fertility to the value of 1.3 in the lowest scenario presented.

- In the countries still undergoing the *postponement transition* projections elaborated here often show considerably higher completed fertility than the simplistic method that keeps the most recent set of age-specific fertility rates constant. Accounting for the recuperation process thus helps the projection-makers avoiding scenarios with unrealistically rapid fertility declines and unlikely low completed fertility rates.
- The projected fertility and childlessness levels differ considerably across countries, indicating a likely continuation of the observed differences in low fertility. The completed fertility of the early 1980s cohorts in individual countries may range between the threshold of lowest-low fertility of 1.3 births per woman and the replacement fertility level of 2.1 births per woman.
- Among the analysed countries, the United States clearly stand out for its persistently high fertility among teenage women and young adults and therefore a limited extent of birth postponement combined with an 'overcompensation' of the postponed fertility during the recuperation stage. This unique pattern brings a slight increase in completed fertility among the cohorts experiencing fertility postponement, resulting in the completed fertility around 2.1 in the late 1960s cohorts. High fertility rates among the Hispanic

population and some religious groups (Mormons, Evangelical Protestants) have repeatedly been noted as the main reason for the relatively high and early fertility pattern in the U.S. (Cherlin 2010, Westoff and Marshall 2010, Frejka and Westoff 2008, Frank and Heuveline 2005).

The approaches and analyses elaborated in this study are not without caveats. First, these methods are suited solely for analysing and projecting cohort fertility when a long-lasting process of changing timing pattern of childbearing, be it either postponement or advancement of births, sets in. Other methods should be used for analysing short-term changes or for analysing cohort fertility among the cohorts with broadly stable pattern of birth timing. Second, as more births have occurred at advanced reproductive ages, including ages 40-45, projections of the completed cohort fertility of women who are currently in the middle of their reproductive span have become more uncertain. The shrinking fertility at younger ages often tells very little about the subsequent childbearing trajectory, whereas the full course of fertility recuperation cannot be analysed even at ages 38 or 40. Third, projection methods based on the relational approach need further testing, comparisons with the existing projection methods, and potentially also further elaboration.

With these limitations in mind, the research presented here has broad relevance and use. Graphical representations and the indicators of postponement and recuperation can be employed in a variety of contemporary settings, leading to more rigorous analyses of cohort fertility changes. These approaches are potentially suitable for studying emerging cohort postponement transitions in less affluent societies outside Europe, especially in Latin America (Rosero-Bixby et al. 2009) and East Asia (Frejka et al. 2010). Additional dimensions can be included—especially the education level which strongly affects the degree and the progression of both fertility postponement and recuperation (Neels and De Wachter 2010). Modelling the postponement transition, using selected social, economic and cultural variables alongside the key indicators of the postponement and recuperation process constitutes another promising extension. The factors driving fertility recuperation have not been adequately studied to date, although several, including gender equality, family policy regimes, and an acceptance of fertility outside marriage have been repeatedly suggested as important (Sánchez-Barricarte and Carro 2007, Sobotka 2008, Lesthaeghe 2010). Six decades after Ryder's (1951) pioneering work cohort fertility analysis has become ripe with new research potential. It is set to benefit from fresh and critical looks, new methodological developments, and new research directions.

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APPENDICES

Appendix 1: Cohort fertility projections: projection parameters and results for Austria, the Czech Republic, the Netherlands, and Spain

Figure A1 Maximum decline of cumulated cohort fertility (*P*) relative to the benchmark cohort (absolute values of *P* are displayed)

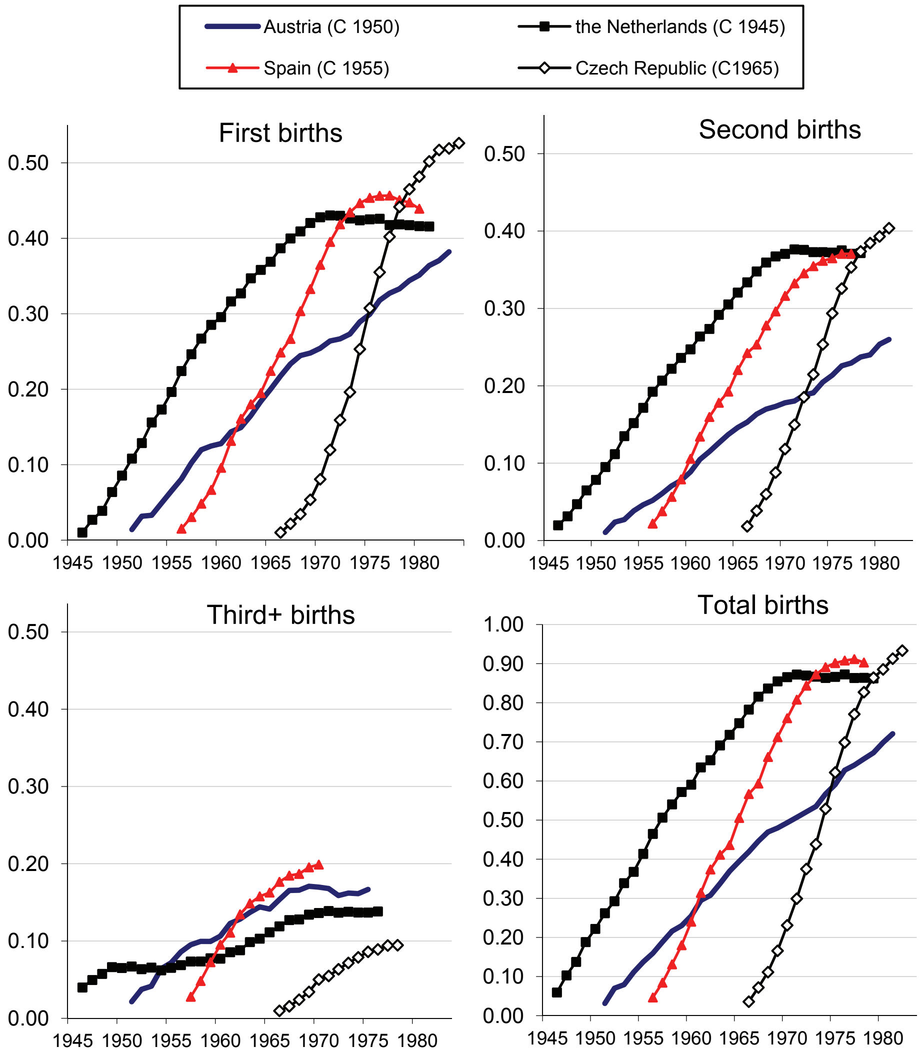
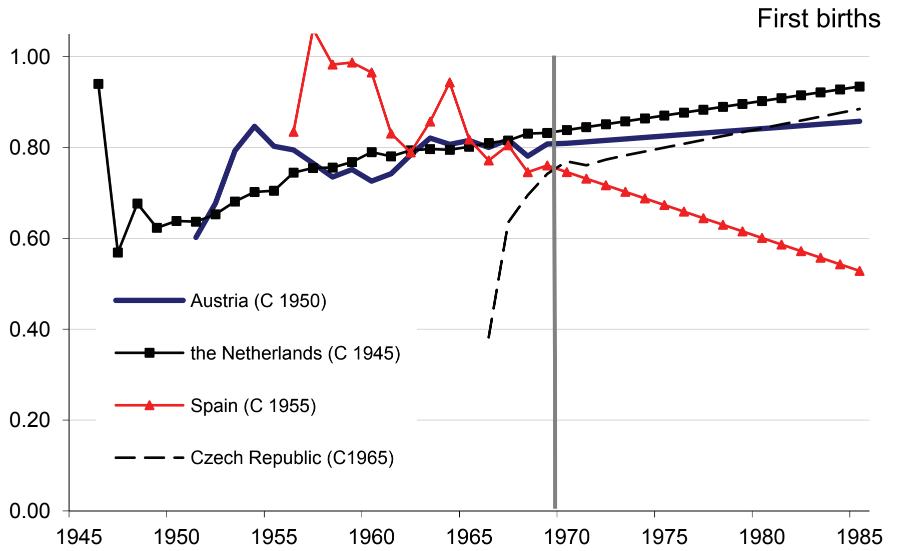


Figure A2 *Recuperation Index* (*RI*) at age 40 by birth order, observed (for the cohorts through 1969) and projected in the *trend scenario* (cohorts 1970–1985, right of the grey line)



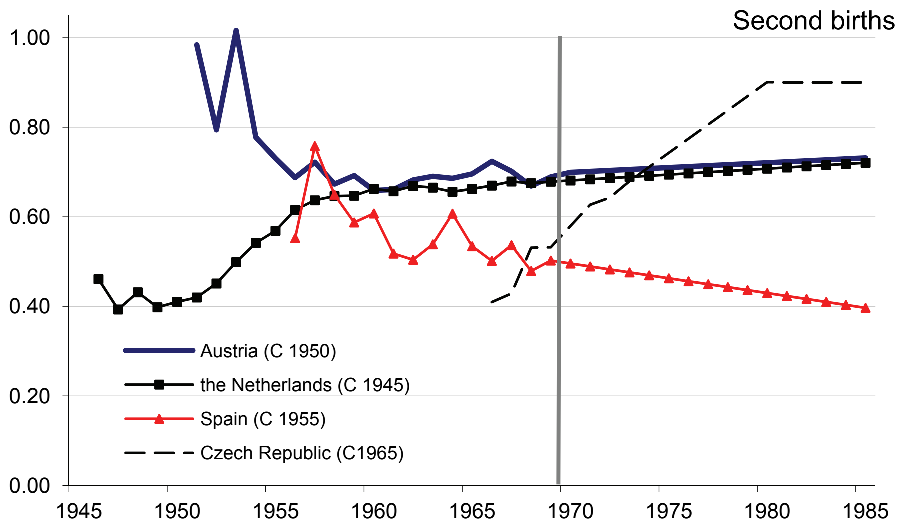


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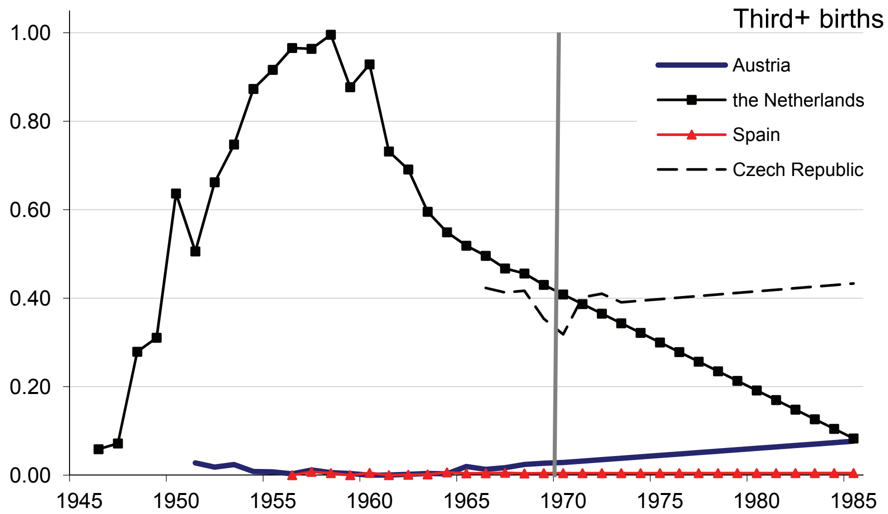
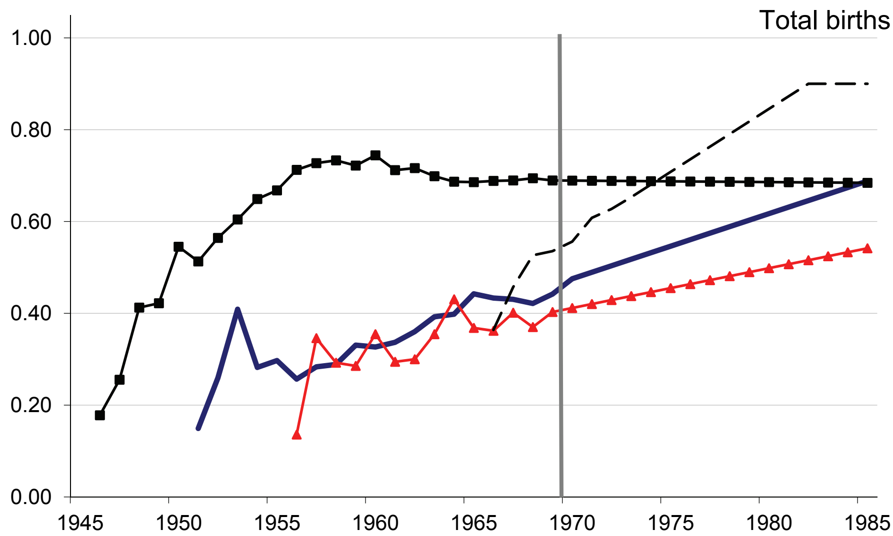
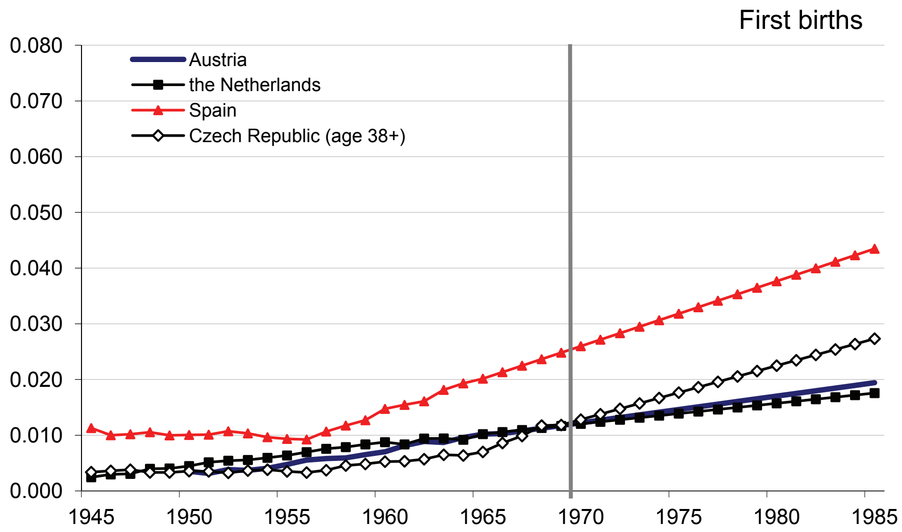
Figure A2 continued





Note: The observed and projected recuperation index for the Czech Republic is computed at age 38; see note below Table 1.

Figure A3 Cumulated fertility rates at ages 40+ by birth order, observed (for the cohorts through 1969) and projected (cohorts 1970–1985)



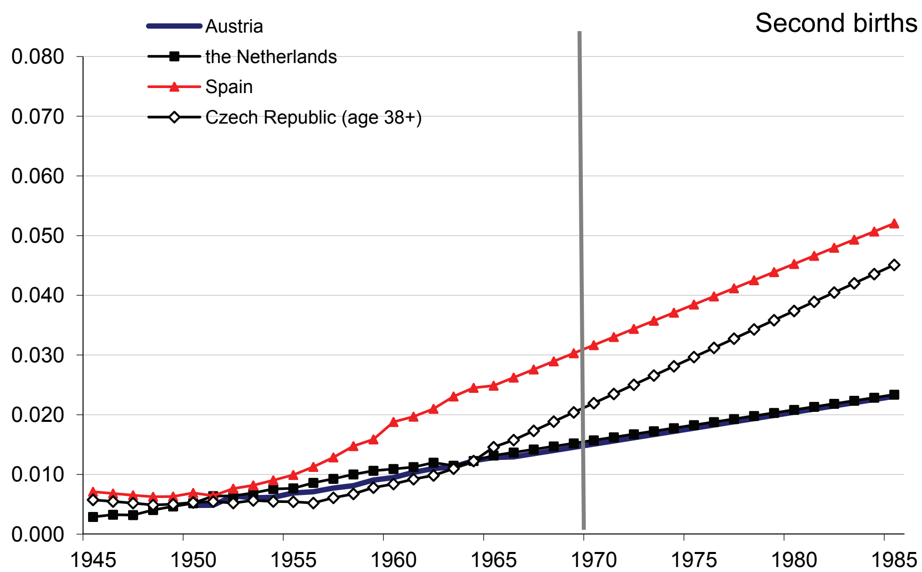


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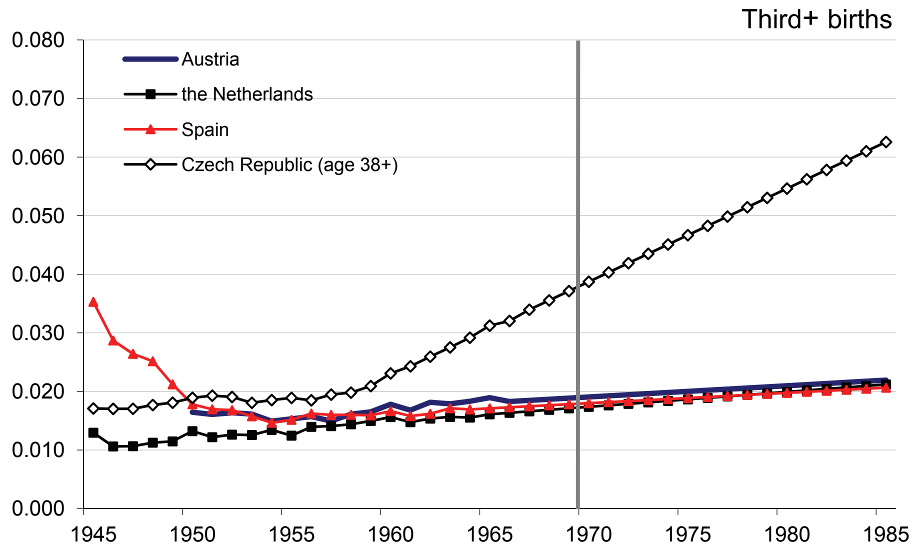
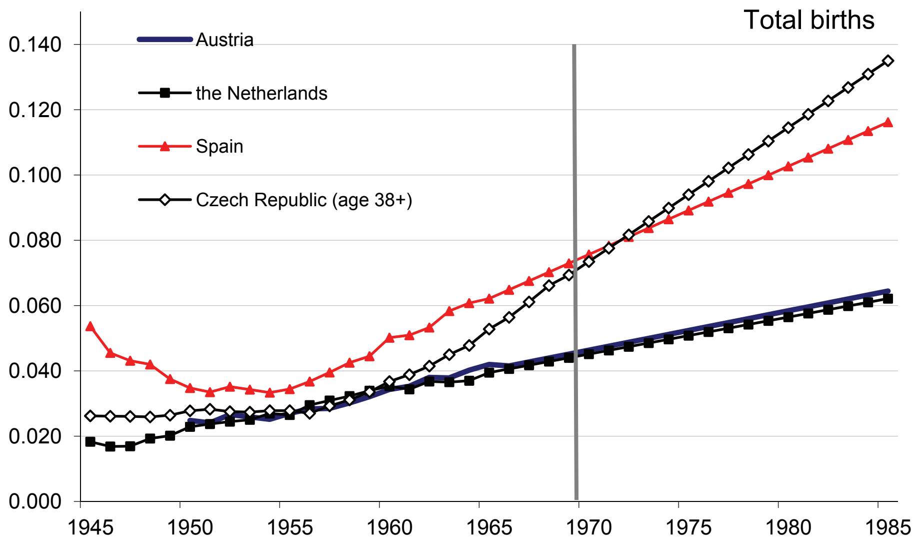
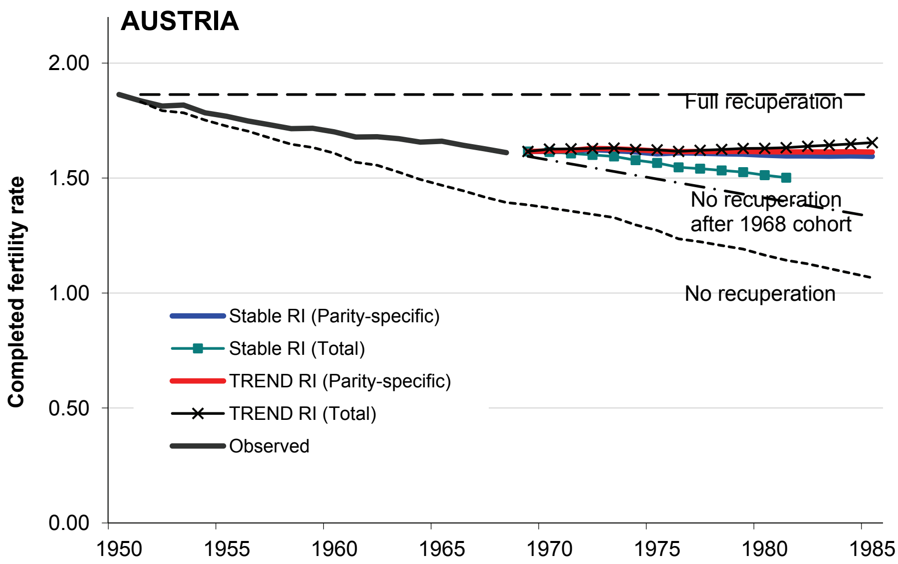
Figure A3 continued





Note: The observed and projected cumulated fertility in the Czech Republic is computed for ages 38 and higher.

Figure A4 Projected completed fertility in four scenarios as compared with the hypothetical 'no recuperation' and 'full recuperation' scenarios



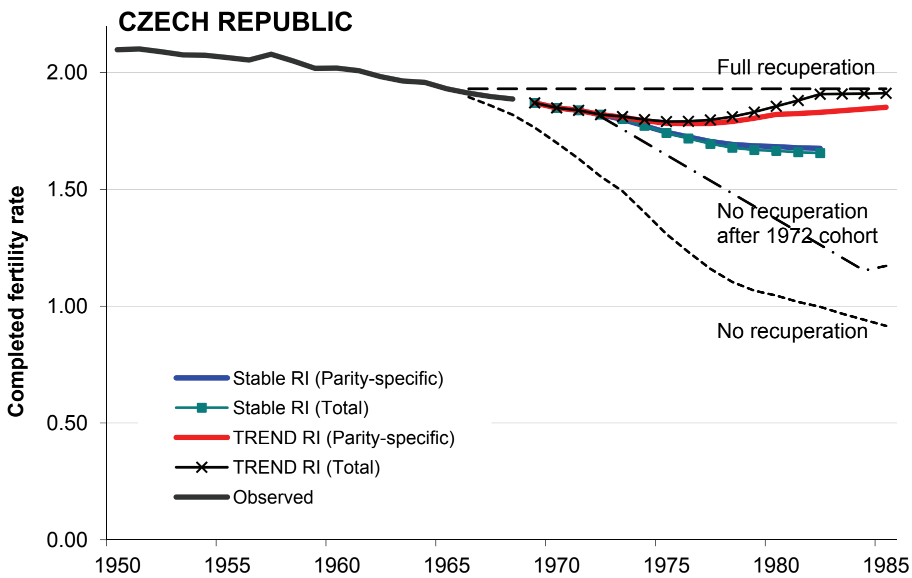
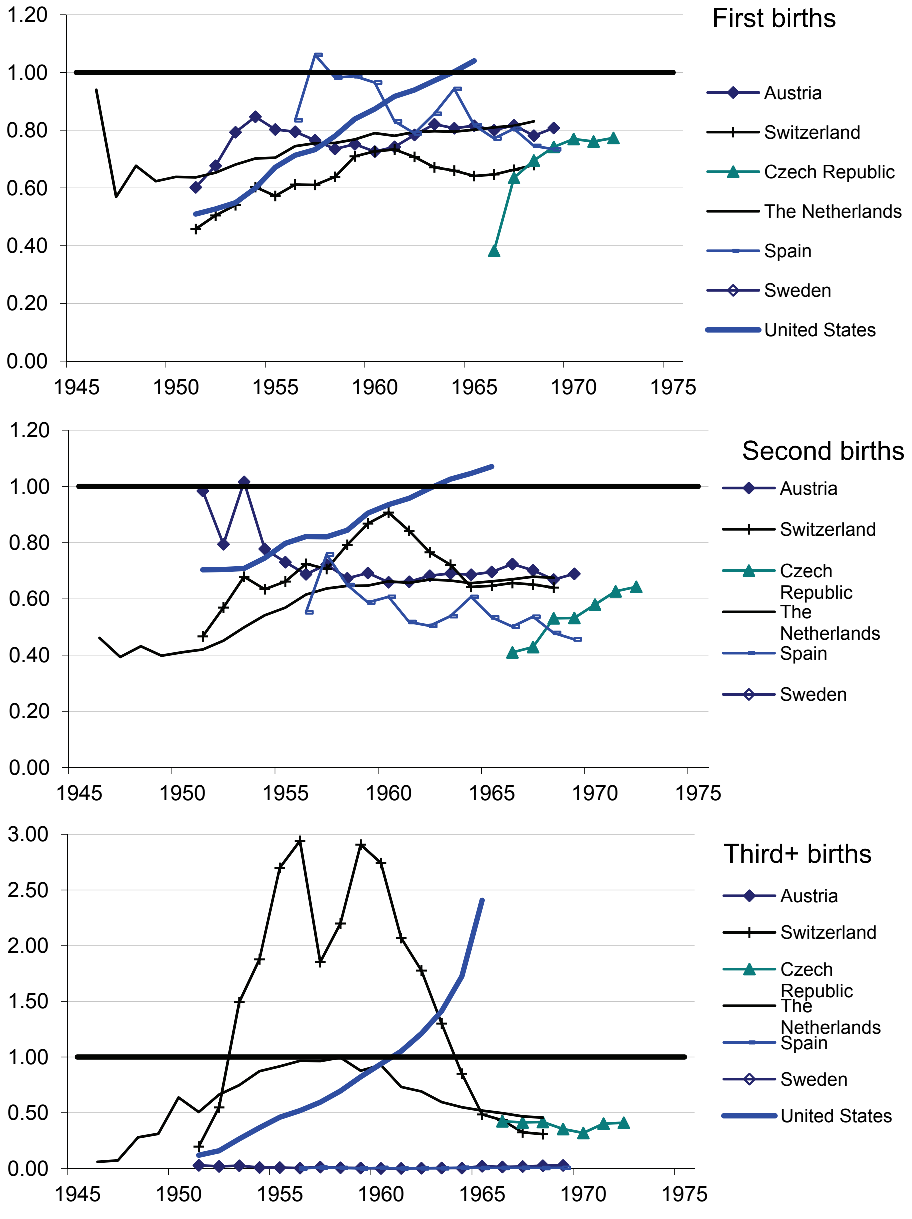


Figure A5 Recuperation Index RI_c by birth order, selected countries



Note: Scale of the vertical axis differs in the graph for third and higher-order.

Table A1 Cumulated cohort fertility at age 40 by birth order: *Trend scenario* based on the *Recuperation Index* RI and Method 3 based on the relational model

		1980				1985			
		BO1	BO2	BO3+	TOT	BO1	BO2	BO3+	TOT
Austria									
	RI	0.77	0.54	0.24	1.56	0.77	0.53	0.25	1.55
	M3	0.74	0.52	0.22	1.48	0.74	0.52	0.22	1.48
	Diff	-0.03	-0.02	-0.03	-0.08	-0.03	-0.01	-0.03	-0.07
Czech Republic									
	RI	0.84	0.69	0.18	1.71	0.86	0.68	0.18	1.72
	M3	0.84	0.60	0.20	1.63	0.83	0.59	0.20	1.62
	Diff	0.00	-0.09	0.02	-0.07	-0.02	-0.09	0.02	-0.09
the Netherlands									
	RI	0.84	0.64	0.23	1.71	0.85	0.64	0.21	1.71
	M3	0.80	0.62	0.28	1.70	0.80	0.62	0.28	1.70
	Diff	-0.04	-0.01	0.04	-0.01	-0.06	-0.02	0.07	0.00
Spain									
	RI	0.71	0.45	0.12	1.28	0.68	0.43	0.12	1.23
	M3	0.76	0.47	0.12	1.36	0.78	0.49	0.12	1.39
	Diff	0.05	0.02	0.00	0.08	0.10	0.06	0.00	0.16

Note: The benchmark cohort for the Czech Republic in the M3 scenario is set at 1960 rather than 1965 in order to obtain a sufficient number of cohorts to specify projection parameters.

Appendix 2: Decomposing cross-country differences in the cumulated fertility rate at age 40 into three components

To analyse the role of fertility postponement and recuperation for explaining differential fertility between countries, we provide a simple decomposition of differences in cumulated completed fertility at age 40 between selected countries and Sweden. We look at the 1967 cohort, the most recent one for which we can compute the cumulated fertility rate at age 40. Swedish fertility is characterised by a high degree of fertility recuperation (the recuperation index stood at 93% for the 1967 cohort) combined with the completed fertility rate close to the replacement level (see Table 4). We decompose the difference in the cumulated fertility in this cohort between any country A ($F_{1967,A}(40)$) and Sweden ($F_{1967,SWE}(40)$) into the following three components:

1. A difference in the **fertility of the benchmark cohort *b***: $\Delta F_b(40) = F_{b,A}(40) - F_{b,SWE}(40)$. Recall that the benchmark cohort varies by country, depending on the onset of first birth postponement.

2. A difference attributable to a stronger **fertility decline at younger ages** (Pc) since the start of postponement. This difference is computed only as a 'net' final difference, not accounting for any additional decline that was subsequently recuperated: $\Delta P_{1967} = (P_{1967,A} - P_{1967,SWE}) \cdot (1 - RI_{1967,A})$.

3. A difference attributable to weaker **fertility recuperation**, as captured by the recuperation index RIc. This difference is computed only for the part of fertility decline equal to that observed in the 1967 cohort in Sweden ($P_{1967,SWE}$), as the impact of any additional decline is already captured by the previous component ΔP_{1967}: $\Delta RECUP_{1967} = P_{1967,SWE} \cdot (RI_{1967,SWE} - RI_{1967,A})$.

Each component, which contributes to the lower fertility in a country of interest as compared with Sweden, reaches a negative value. A total difference can simply be computed as the sum of all three components: $\Delta F_{1967}(40) = F_{1967,A}(40) - F_{1967,SWE}(40) = \Delta F_b(40) + \Delta P_{1967} + \Delta RECUP_{1967}$

When all the three components turn negative, as was the case in five out of the six countries (regions) analysed in Table A2 below, the absolute difference in cumulated fertility can easily be dissected into the relative contribution of each of these three components, as shown in Figure 20.

To keep this illustration simple, our decomposition is not order-specific. However, it can easily be extended and performed for each birth order separately. The decomposition can also be computed differently than described here. For instance, the second component, ΔP_{1967}, can also include the additional younger-age fertility decline that has subsequently been recuperated, with this ‘extra’ recuperation subtracted from the final component, $\Delta RECUP_{1967}$. Our solution seems to us analytically cleaner, as we distinguish more clearly the differential effect of recuperation $\Delta RECUP_{1967}$ given the size of the postponement in Sweden ($P_{1967,SWE}$), making thus all the results readily comparable across countries. The alternative solution gives results that are more affected by the interaction between the differences in the postponement and recuperation differences, ΔP_{1967} and $\Delta RECUP_{1967}$.

Table A2 Absolute contribution of three components of the *postponement* and *recuperation* to the differences in cumulated cohort fertility at age 40 between Sweden and selected countries of Europe. Women born in 1967

	Abs. diff. in cumulated fertility from Sweden			
	Benchmark cohort ($\Delta F_b(40)$)	**Post-ponement (ΔP_{1967})**	**Recuperation $\Delta RECUP_{1967}$**	**Total**
Austria	-0.107	-0.047	-0.179	-0.333
Germany, West	-0.188	-0.136	-0.155	-0.479
Germany, East	-0.163	-0.055	-0.169	-0.387
Switzerland	-0.175	-0.024	-0.128	-0.328
the Netherlands	0.033	-0.141	-0.085	-0.193
Spain	-0.072	-0.137	-0.190	-0.399