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DEMOGRAPHIC EXPLANATIONS FOR THE RECENT RISE IN EUROPE'S FERTILITY: ANALYSIS BASED ON THE TEMPO AND PARITY ADJUSTED TOTAL FERTILITY RATE

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Abstract

In 1998-2008 European countries experienced the first continent-wide increase in the period total fertility rate (TFR) since the 1960s. After a discussion of period and cohort influences on fertility fluctuations the paper examines the role of tempo distortions of period fertility and different methods for removing them. We highlight the usefulness of a new indicator, called the 'tempo- and parity-adjusted total fertility' (*TFRP**), which is a variant of the Bongaarts-Feeney (1998) adjustment method based on parity-specific hazard rates. The *TFRP** is much less affected by short-term fluctuations typical of most other adjustment indicators. Finally, we estimate levels and trends in tempo distortions in selected countries in Europe. Our analysis of period and cohort fertility indicators from the Czech Republic, the Netherlands, Spain and Sweden, shows that 1) *TFRP** gives a remarkable fit with the completed fertility of women in prime childbearing years in a given period; 2) the tempo adjusted fertility as measured by *TFRP** has remained nearly stable over the analyzed period; 3) the recent upturns in the period *TFR* are therefore largely explained by a decline in the pace of fertility postponement and the resulting reduction in tempo distortions; and 4) the other currently used tempo-adjusted fertility indicators have not indicated such a large role for tempo effect in the recent TFR upturns.

1 INTRODUCTION

Fertility as measured by the period total fertility rate (*TFR*) rose in the large majority of European countries between 2000 and 2008. This trend represents an unexpected reversal from the historically unprecedented low levels reached by most countries in the 1990s or early 2000s. Increases from these minima have reached as high as 0.51 children per woman in Denmark and eighteen countries experienced increases greater than 0.2 (Goldstein et al 2009). The turnaround has been especially rapid in populations with the lowest fertility: The number of countries with a TFR below 1.3 declined from 16 in 2002 to just one in 2008 (Goldstein et al 2009). These new trends are a very welcome development because the potential adverse consequences of population ageing and population decline will likely be substantially lower than feared in the 1990s.

Explanations for this new phenomenon can be provided at two levels, demographic or socioeconomic. Demographic explanations include the disappearance of period tempo effects that have distorted the TFR downward in the past as the age at childbearing rose (Bongaarts and Feeney 1998; Bongaarts 2002; Sobotka 2004, Goldstein et al 2009), and a cohort driven process of recuperation at older ages of births that were postponed at younger ages (Lesthaeghe and Willems 1999; Frejka and Sardon 2009; Goldstein et al 2009, Sobotka et al. 2011). Further back in the chain of causation are social and economic determinants (e.g., economic growth, unemployment, gender equality) and pronatalist or family policies that affect the quantum and tempo of childbearing.

This study focuses on the demographic determinants of recent fertility increases in Europe until 2008, i.e., until the onset of the severe economic recession that has affected fertility trends in many countries (Sobotka, Skirbekk, and Philipov 2011). The availability of the new Human Fertility Database (HFD) in combination with other sources makes it possible to analyze fertility trends in much greater detail than before. The HFD provides estimates of numbers of births, exposure to the risk of childbearing and fertility rates by age, period, cohort, birth order of the child, parity of the mother, and country. The detailed empirical analysis below will focus on three countries included at present in the HFD—the Czech Republic, the Netherlands and Sweden—as well as on Spain. Especially in the Czech Republic and Spain, the period *TFR* bottomed out at extreme low levels below 1.2. The four analyzed countries have experienced significant recent upturns in fertility and they represent different regions of Europe as well as different socio-economic and institutional contexts.

After a brief overview of fertility trends, the paper focuses on three main topics. First, we provide conceptual and methodological discussion on the potential role of period and cohort influences as drivers of fertility fluctuations and relate it to the recent trends. Second, we examine the role of tempo distortions of period fertility and different methods for removing these distortions. Based on a comparison of different adjusted indicators with completed fertility of women born in 1961-67, we highlight the usefulness of a new tempo-adjusted indicator that is a variant of the Bongaarts-Feeney method based on parity-specific hazard rates (the so-called *tempo- and parity-adjusted total fertility, TFRP**). Third, using this new indicator we estimate the role of decline in tempo distortions in the recent rise in the total fertility rate in Europe.

The discussion highlights the analytic difficulties in interpreting quantum and tempo trends that have led to differing interpretations. The aim is to contribute to a resolution of these debates, to demonstrate the merits of the *TFRP** , to stimulate more rigorous research and to move closer towards a consensus on the demographic causes of recent fertility trends in most developed countries.

2 RECENT TRENDS IN THE QUANTUM AND TEMPO OF PERIOD FERTILITY

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

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

Central and Eastern Europe: Bulgaria, Czech Republic, Estonia, Latvia, Russia, Slovenia, and Ukraine;
Northern Europe: Denmark, Finland, and Sweden;
Southern Europe: Spain;
Western Europe: Belgium, France, the Netherlands, and United Kingdom.

In absolute terms these fertility increases may still seem modest, but they usually represent a relative rise by more than 20% and have important demographic consequences because they close a substantial part of the gap between the minimum fertility and the replacement level.

In part related to the fall in period fertility was a second major trend since the early 1970s, a continuous long-term rise in the mean age at childbearing, especially at first birth. This was labeled by some demographers as a “postponement transition” from an early to a late childbearing pattern (Kohler et al. 2002, Goldstein et al. 2009). Figure 2 illustrates this shift for six countries representing broader regional trends. Around 1970, when contraceptive pill just started spreading across Europe, the mean age at first birth (*MAFB*) stood between 22 and 25 years in most countries. By 2008, the *MAFB* in most European countries increased to 27-29 years, although in Eastern Europe, including Russia, it still remained considerably younger. At the same time, the pace of increase in *MAFB* diminished markedly after 2000 in most countries reaching high values, which is also observed in Figure 2 for the Netherlands, Spain and Sweden. As will be demonstrated below this reduction in the pace of postponement is a crucial factor in explaining the recent rise in fertility.

An examination of trends in the total fertility rate and the mean age is a first step in any analysis of fertility trends, but the aggregate nature of these indicators can obscure important birth order-specific changes. For example, Figure 3 plots the TFR by birth order for the Czech Republic, the Netherlands, Spain and Sweden for the period after 1990 which covers the recent trough and subsequent rise in period fertility. In all four countries increases in the overall TFR were mostly due to increases at birth orders one and two while TFRs at higher orders were flat or down. In Spain, practically all the increase in the TFR between 1998 (1.16) and 2008 (1.46) was concentrated into first-order TFR. Fluctuations in fertility were largest in the Czech Republic and smallest in the Netherlands.

Since trends in quantum and tempo of fertility differ by birth order any in-depth analysis of fertility trends should be conducted birth order by birth order, and the remainder of this paper will follow this approach.

3 PERIOD VERSUS COHORT CHANGES.

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

Definitions

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

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

2) A *period tempo* change is defined as an increase in the mean age at childbearing from one period to the next with the shift in the fertility schedule independent of age or cohort. As shown in Figure 5 this tempo change involves a move up or down the age axis of the fertility schedule while its shape remains invariant.

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

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

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

Are observed fertility fluctuations due to period or cohort effects?

The question of whether period or cohort effects dominate in determining fluctuations in fertility has been examined in a number of key studies in recent decades. Brass (1974) concluded that cohort completed fertility reveals no significant feature that distinguishes it from time averages of period indexes. Pullum (1980) concludes that "temporal variations that cut across cohorts, such as economic cycles, appear to be more important than changes in those variables that distinguish cohorts, such as shared socialising experiences". Foster's (1990) analysis of data for eight countries in Europe and North America arrives at a similar conclusion. In an authoritative review, Ní Bhrolcháin (1992) concludes that "of the two dimensions of calendar time—period and cohort—period is unambiguously the prime source of variation in fertility rates." These studies are essentially in agreement that period influences on fertility are more important than cohort influences.

These findings contrast with the arguments about cohort-driven process of fertility change. Norman Ryder has asserted that "in the model of reproductive behavior, the driving force is change in cohort fertility. The actors are members of cohorts; their behavior is manifested in cross-section period summations in a distinctive manner because of ongoing change in the way these actors are distributing their reproductivity over time" (Ryder 1990: 444). However, most recent proponents of the 'cohort view' on fertility behavior, including Ron Lesthaeghe (Lesthaeghe 1988, Lesthaeghe and Willems 1999, Lesthaeghe 2001), Tomas Frejka (Frejka 2010), and Joshua R. Goldstein (Goldstein and Kenney 2001, Goldstein 2010, Goldstein and Cassidy 2010) pursue a more nuanced picture, which, with some simplification, can be summarized as follows. They recognize strong period influences, especially at younger ages when period trends like increased participation in higher education, are dominant. However, their description of fertility change emphasizes the arguably cohort-driven process of 'recuperation' at higher ages, which assumes that the cohorts of women that reduced fertility at younger ages will try to 'make up' for at least a part of this decline in order to realize their childbearing intentions. This does not mean, however, that these cohorts would be insensitive to period influences (see also Sobotka et al. 2011).

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

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

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

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

4 TEMPO DISTORTIONS AS CAUSE OF FLUCTUATIONS IN THE TFR

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

$$TFR(t)=(1-r(t))\ TFR^*(t)$$

where $r(t)$ denotes the annual rate of change in the period mean age at childbearing in year t. $TFR^*(t)$ is referred to as the *tempo-adjusted* total fertility rate, which equals the total fertility rate that would have been observed if the mean age at childbearing had been constant during year t. The absolute tempo distortion in the observed *TFR* equals $TFR(t)- TFR^*(t)$ which is negative when the mean age is rising i.e. when $r(t)>0$. For example, when the mean age is rising at a rate of 0.1 year per year then the *TFR* contains a downward distortion of 10%. The above equation is usually and preferably applied separately for each birth order. A later section will comment on this and other methods for removing tempo effects and their strengths and weaknesses.

Simulation of period tempo distortions

The impact of tempo distortions on contemporary fertility trends is not always obvious in part because tempo and quantum changes often occur simultaneously. It is therefore useful to begin an examination of tempo distortions with a simulation of a hypothetical population in which conditions are simplified. Specifically, the simulation calculates the pattern of age-specific fertility over the period 1965-2015 in a hypothetical population in which 1) cohort quantum at birth order 1 is constant at 0.9 (i.e., 90% of women have a birth), and 2) the period mean age moves through a transition from an equilibrium at 25 years before 1965 to another equilibrium at 30 years after 2015 (i.e. a rise of five years). This pattern of change in the mean age at first birth is plotted in Figure 6. The annual rate of increase in the mean age rises and falls during this transition and is most rapid around 1990 (see dashed line in Figure 6).

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

The impact of the pace of tempo change on the TFR

The essence of a tempo distortion is that its size depends on the rate of change (and not the absolute value) of the mean age at childbearing. As a result, the simulated trend in the *TFR* (a decline from 0.9 in 1965 to a minimum of 0.62 in 1990, before turning up to 0.9 again in 2015) follows the inverse pattern of the trend in the rate of change of the mean age which rises and falls over the same period (compare Figures 6 and 7). The direct relationship between the $TFR(t)$ and $r(t)$ is plotted in Figure 8 with each data point representing one year between 1965 and 2015. The *TFR* equals 0.9 in 1965 and 2015 when the mean age is not changing ($r(t)=0$) and it reaches its lowest point in 1990 when $r(t)$ is at its maximum. This relationship is described formally as

TFR(t)=0.9 · (1-r(t)). Since *r(t)* reaches a maximum of 0.31 in 1990, it follows that *TFR(t)* reaches a minimum value of 0.9 · (1-0.31) = 0.62 in the same year.

Broadly similar relationships between annual estimates of *TFR(t)* and *r(t)* are observed between 1970 to 2007 in the Czech Rep, the Netherlands, Spain, and Sweden. As shown in Figure 9 the association between these variables in the Czech Republic (separately for birth orders one and two) are roughly linear, inverse and statistically significant (data for the Netherlands, Spain, and Sweden not shown, but are available from the authors upon request). The observations for individual years deviate somewhat from the expected linear relationship for the following reasons: 1) The observed *TFR* is affected by quantum changes as well as tempo distortions (this explanation is particularly pertinent to Spain, which experienced a fall in fertility quantum during the period of observation); 2) measurement errors; and 3) deviations from the assumptions in the BF framework. Nevertheless, it is encouraging that the empirical evidence clearly supports the theoretically expected relationship between the observed *TFR* and the rate of change in the mean age at childbearing.

The impact of tempo distortions on age-specific fertility rates

We first inspect the simulation of period fertility changes based on the assumption that these changes are entirely period-driven. As shown in Figure 10 ('period world') the surface of age-specific fertility rates in the simulated population changes substantially during the postponement transition. The schedules of age-specific fertility rates are constant before 1965 and after 2015. In the intervening years two forces operate: the shift of the schedule from a mean of 25 years before 1965 to 30 years after 2015 and the rise and fall of tempo distortions which affect each age proportionally the same. The surface is described as *f(a,t) = (1-r(t)) f(a-(MAB(t) - MAB(1965)),1965)* where *MAB(t)* is the mean age at birth and *r(t) = dMAB(t) /dt*. This rather complex pattern of change occurs solely because of a rise in the mean age at first birth since the cohort completed fertility as well as the tempo adjusted *TFR** are held constant at 0.9.

The rise in the simulated *TFR* between 1990 and 2010 is of particular interest because it can potentially shed light on the recent upturns in Europe. During this period the simulated schedule of age-specific fertility changes due to the continuing shift in the mean age from 27.5 to 30 years combined with the disappearance of the tempo distortions (see Figure 11, period world). The latter causes the elevation of fertility curves, resulting in large proportional increases at older ages (e.g., at age 40 the age-specific fertility rates triple from 40 to 120). Note that it is correct to describe the changes in fertility as a 'recuperation' for older cohorts and little or no change for younger cohorts. This is correct as a description, even though all change for the entire simulation is assumed to be driven only by period effects.

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

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

We have also undertaken a simulation of a 'cohort world' in which only cohort effects occur and the shape of the schedule of cohort age-specific fertility rates remains invariant over time. In this simulation the quantum is also fixed at 0.9 births per woman for all cohorts. The only change being simulated is a postponement transition which moves the mean age at childbearing of cohorts (not periods) from 25 to 30 years over a period of several decades. When these cohort shifts are 'translated' into period fertility trends, the annual rate of increase in the mean age rises and falls during this transition and is most rapid around 1990. The surface of age-specific fertility rates for this cohort simulation is presented in Figure 10 (cohort world). It shows the expected shifting of fertility to higher ages for successive cohorts but it does not show any variations in the mode of the fertility schedule. The resulting trend in the *TFR* is similar to the one plotted in Figure 7 with values of 0.9 before the transition, a minimum in 1990 and then a rebound to 0.9 after the transition is completed. The change in the period age-specific fertility during the TFR rebound after 1990 are plotted in figure 11 (cohort world). In addition, the variance in the period fertility schedule (which was constant in the period world) changes during the cohort-driven transition. Variance first falls (alongside the TFR decline) in the first stage of the transition and then it increases (alongside the TFR recovery) in the later stage of the transition, reaching back the initial values. The rise in the TFR is due to this increase in the variance of the period fertility schedule; no change in the mode is evident.

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

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

Cohort world: Mode of period age-specific fertility schedule is constant but shape changes with the standard deviation, first falling and then rising over the course of the transition.

These simulation results can now be compared with observed trends. Figure 12 plots the observed patterns of age-specific fertility for birth order 1 in the Czech Republic, the Netherlands Spain and Sweden, beginning in the year of the most recent minimum *TFR* (after 1990) and ending in 2007 or 2008, when considerably higher TFR was reached. The changes are most extensive in the Czech Republic and Sweden and smallest in the Netherlands which is in line with the expectations based on the earlier discussion of aggregate trends in these countries.

As in the period world simulation, the observed schedules shift over time to higher ages and they rebound beginning around the year of the minimum in the TFR. The mode clearly rises in all four countries. Spain shows an unusual early childbearing 'bulge' in fertility schedules after 2000; this is largely due to a rapidly rising population of immigrant women (Goldstein et al. 2009).

These empirical patterns do not confirm exactly to the simulated period-driven fertility changes because there are changes in childlessness (which was assumed constant in the simulation) as well as deviations from the BF assumption, including the assumptions of a 'pure' period-based shift[1]. Nevertheless the complex changes in the observed age pattern are broadly consistent with the changes expected from the simulated postponement transition in a period world.

This conclusion is generally supported by an examination of trends in the standard deviation of the age schedule of period fertility. In the period world, the standard deviation should be constant. The observed standard deviations of the period age-specific fertility schedule for the Czech Republic, the Netherlands, Spain and Sweden are plotted in Figure 13 (first births) and 14 (second births). These standard deviations show very little change at all orders in the Netherlands and Sweden and significant change in the Czech Republic, mostly at order one and in Spain. As noted these results for Spain are confounded by the rise in immigrant fertility at young ages which complicates the interpretation of this trend.

These results are largely consistent with the view that period effects are dominant in the Netherlands and Sweden. Period effects are also important in the Czech Republic and possibly Spain but significant cohort effects appear to be present as well especially at order one.

Estimating tempo distortions: past indicators and the new tempo- and parity-adjusted total fertility (TFRP*)

The tempo distortion equals the difference between the observed and tempo adjusted *TFR** (denoted here by an asterisk). Bongaarts and Feeney (1998) proposed to estimate the tempo adjusted *TFR** as

$$TFR^*(t) = TFR(t) / (1-r(t))$$

This equation requires only data on *TFR(t)* and *r(t)* by birth order which are available for many developed countries.

One of the main criticisms of this simple BF procedure is that it does not take into account changes in the parity distributions of the female population (Kohler and Ortega 2002; van Imhoff and Keilman 2000). There are two general approaches to addressing this issue (see appendix for details on different indicators used and their computation):

[1] It is possible that any cohort-driven change in fertility does not violate much the assumptions contained in this and other tempo-adjusted period indicators of fertility.

First, Kohler and Ortega (2002) proposed a tempo adjusted period fertility indicator (we will call it *PATFR*)* which is estimated from age and parity-specific fertility rates or probabilities in which only women at parity *i-1* are at risk of having a birth of order *i* (i.e., births are assumed to be repeatable events: giving an i-th birth exposes one to have an i+1th birth, and so on). This index represents a tempo-adjusted version of the *PATFR* index of period fertility introduced by Rallu and Toulemon (1994) and earlier elaborated by Park (1976).

Second, more recently Bongaarts and Feeney (2004, 2006) have proposed a variant of the BF basic method. This tempo- and parity-adjusted total fertility , *TFRP**, is estimated from age-specific birth hazard rates with all women who have not reached parity *i* – and not only those with i-1 births as in the case of the *PATFR* computation – are exposed to the risk of having an *i*-th birth (i.e., births are assumed to be separate non-repeatable events). The unadjusted version is called *TFRP*. Yamaguchi and Beppu (2004) proposed a very similar approach. In order to discuss the advantages and drawbacks of using different adjusted indicators, we provide a comparison between three non-adjusted fertility indexes, the *TFR, PATFR* and *PTFR* and their three adjusted counterparts, employing Bongaarts-Feeney (1998, 2004, and 2006) adjustment for the *TFR** and *PTFR** and Kohler-Ortega (2004) adjustment for *PATFR** (see Appendix for further details about these indexes). For further discussion of the underlying assumptions for these indicators and their interpretation see Bongaarts and Feeney 2006, Yamaguchi and Beppu 2004, Kohler-Ortega (2002, 2004), van Imhoff (2001), and Sobotka (2003).

The tempo adjusted fertility indexes in the period since 1970 or later, obtained by these adjustment procedures are plotted in Figure 16 for the Czech Republic, the Netherlands, Spain and Sweden for all years for which data are available from the HFD or national statistical sources. Figure 17 plots the same variables for birth order one. Generally, all the adjusted indicators are higher than their non-adjusted counterparts indicating fertility depressing tempo effects due to postponement of childbearing especially after 1990. Measures can differ widely in specific time periods, especially during the times of rapid fertility changes and trend reversals. This is well illustrated for the wild fertility fluctuations in Sweden around 1991, when rapid changes in birth interval (stimulated by an extension of parental leave) caused a sudden upturn in the conventional *TFR,* and an even more sudden shift in the *TFR** and *PATFR**. Similarly, different adjusted and non-adjusted indicators shed a very different light on the upturn in Spanish *TFR* after 1995, with the *TFRP* actually suggesting a stagnation in fertility and *TFRP** indicating a slight decline in fertility quantum during that period (see also below). In most figures the two BF adjusted measures (*TFR* and TFRP*)* are on average relatively close but the *TFRP** is slightly higher on average and *TFR** is considerably more variable than *TFRP**. This instability is most visible in the case of birth-order specific data, where *TFR** may show large year-to-year changes and implausible values, like the first-order *TFR** above 1 (see graphs for Spain and Sweden in figure 17)[2]. Whatever the source of this year-to-year instability in *TFR**, the

[2] These fluctuations are in part due to fact that *TFR** is sensitive to errors or slight changes in the registration of birth order in the official vital statistics data. Problems in birth order reporting in some provinces in Spain and in the birth order allocation to multiple births, especially around 1996 and in 2007-2008 (Ortega and Otiz, unpublished document) may lie behind some first-order *TFR** fluctuations there.

application of a simple moving average removes much of it and yields useful results as published regularly for many countries in the European Demographic Data Sheet (VID 2010).

It is clearly impractical to use all these indicators to analyze fertility trends. We therefore focus on our preferred indicator, the *TFRP** and highlight its advantages when compared with other fertility indexes, both conventional and tempo-adjusted. As a first step it is noteworthy to note that visual inspection of trends in Figures 16 and 17 shows the most stable trend in the *TFRP** among the three adjusted indicators.

5 COMPARISON OF PERIOD AND COHORT FERTILITY

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

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

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

Our analysis of this issue follows these procedures and compares the completed fertility of the cohort born in year *C* with the smoothed tempo adjusted measures in year *t*, where *t –C* equals the mean age at child bearing in year *t*. All estimates are made separately for different birth orders (1 to 5+) and the period measures are smoothed using a simple 5-year moving average. Only cohorts whose fertility up to age 40 has been observed by the last available period are included and their fertility after age 40 is assumed to equal the observed schedule above age 40 in that year.

We have compared three unadjusted and three adjusted period measures with the cohort completed fertility (*CFR*, see Appendix for further details):

1) *TFR* derived from age-specific fertility rates of the second kind;
2) *TFRP* derived from birth hazards with births as separate nonrenewable events;
3) *PATFR* derived from age and parity-specific fertility rates;
4) *TFR** , the tempo-adjusted version of *TFR* based on the conventional BF method;
5) *TFRP**, the tempo-adjusted version of *TFRP* using the conventional BF adjustment factor; (for a given birth order *i* and calendar year *t*, the same adjustment factor, *ri(t)*, is used for birth hazards across all age groups);
6) *PATFR**, the tempo-adjusted version of *PATFR* using an adjustment derived from the schedule of age and parity-specific fertility rates, following Kohler and Ortega's (2002) adjustment

Figure 18 presents data for the most recent cohort analyzed (1967 for the Netherlands, Spain, and Sweden and 1968 for the Czech Republic) and compares them with the three adjusted period indicators as well as the conventional period TFR. This exercise is performed separately for total birth orders and for birth order 1. In addition, Table A1 in the Appendix provides a comparison of the cohort *CFR* with all the six period indicators analyzed for each birth order analyzed (up to 4+). The agreement between the *TFRP** and *CFR* is striking and makes this indicator our preferred one for the analysis of tempo distortions. Figure 18 also shows that one of the critiques against the use of tempo adjusted measures, namely that they may give an inflated impression of tempo-free fertility in a period, is not warranted. The adjusted *TFR** also closely approximates the *CFR*(except for Spain), whereas the non-adjusted indicators show considerably lower values. (Appendix table A1).

To summarize the analysis on the proximity of the cohort and the corresponding period fertility, Table 1 displays the average absolute difference between them in the cohorts of 1961-67. This difference is our main measure for assessing the accuracy of the tempo adjustment achieved by different indicators. A number of important results emerge, corroborating the results in Figure 18. First, a comparison of the unadjusted measures indicates that for total birth orders combined, the *TFRP* index shows on average considerably better correspondence with the lagged completed cohort fertility than both the *TFR* and *PATFR*. The poor performance of the age and parity-specific *PATFR* index is due to its massive mismatch with the cohort *TFR* at third and higher birth orders (Table 1, Table A1). Second, as expected the adjusted indicators bring the period and cohort fertility on average much closer together, especially in the case of the two indicators derived using the BF method: *TFR**, and *TFRP** In particular, the *TFRP** shows a remarkably good approximation of the *CFR* in all the four countries analyzed, often wiping our 80-90% of the initial difference between *TFR* and *CFR*. For instance, it reduces the gap between the *TFR* and the corresponding *CFR* in the Netherlands from 13.8% to just 0.8% and in Spain it narrows the gap of 25% to below 3%.

Looking at the birth order dimension in Table 1, all adjusted indexes, including adjusted *PATFR**, show a remarkable correspondence with the *CFR* in the case of first births. Fertility rates at third and later births, however, show a major weakness of the adjusted *PATFR** index. Apparently, the huge tempo distortion documented in the *PATFR* at higher birth orders cannot be easily corrected by using the currently available tempo adjustment methods. In contrast, *TFR** and *TFRP** depict fairly good correspondence with the completed fertility at higher birth orders. As in the case of all birth orders combined, *TFRP** performs best of all indicators for third births (Table 1) and its performance has widely exceeded our expectations. The similarly good performance of the *TFR** is largely attributable to the 5-year smoothing of period fertility series used here, which took away most of its annual variation.

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Table 1: Percent absolute differences between completed cohort CFR and period fertility indicators, average of cohorts 1960-1967

Total births	Czech Republic[1]	Netherlands	Spain	Sweden	Sweden (cohorts 1966-67)
TFRP*	1.9	**0.8**	**2.7**	**1.8**	**1.0**
TFR*	**0.3**	1.4	3.3	5.3	3.0
PATFR*	4.6	5.0	7.3	3.4	7.5
TFRP	4.6	7.2	10.3	4.6	8.1
PATFR	11.2	9.8	17.2	10.1	14.4
TFR	9.9	13.8	25.0	8.5	16.0
First births					
TFRP*	1.1	**1.2**	3.4	**2.0**	**2.0**
TFR*	**0.5**	2.6	5.5	8.6	7.2
PATFR*	0.9	1.3	**1.7**	2.5	2.4
TFRP	1.0	5.5	6.2	2.4	3.7
PATFR	1.0	5.5	6.2	2.4	3.7
TFR	1.7	13.9	25.5	7.5	12.6
Third births					
TFRP*	**4.7**	**1.0**	**4.7**	**3.7**	**4.0**
TFR*	4.9	1.8	9.4	4.7	6.6
PATFR*	38.5	18.3	38.5	15.3	23.3
TFRP	25.9	10.0	17.4	10.8	17.2
PATFR	56.8	18.5	43.8	23.6	33.9
TFR	29.3	12.1	20.6	13.6	21.3

Notes: The indicator that is closest to the completed CFR is shown in bold. Indicators sorted from those which come closest to the completed fertility rates to those that are most distant from them in the case of total births.
1 Data for the Czech Republic pertain to the 1966-67 cohorts only, as the older cohorts experienced only a very minor shift in their childbearing ages.

6 CONTRIBUTION OF DECLINING TEMPO DISTORTIONS TO RECENT TFR RISE

One of the main purposes of the tempo-adjusted indicators is to analyse whether the observed changes in conventional *TFR* could be attributed to a 'genuine' change in fertility *quantum* or whether they are mostly due to changing *tempo effect*. A recent increase in the period *TFR* across most developed countries provides a particularly suitable opportunity for such analysis (see Goldstein et al. 2009). Unfortunately, the widely used tempo adjusted indicator *TFR** is subject to year-to-year instability which constitutes a weakness as it necessitates smoothing the annual data and thus also losing the most recent year(s) of observation. The new tempo adjusted indicators, in particular the tempo- and parity-adjusted total fertility, *TFRP**, display more stable values are therefore more suitable for examining the role of trends in tempo effects. Here we use the example of three of the four countries analysed in this paper that experienced ramarkable upturns in their period *TFR* in the order of 0.3-0.5 between the late 1990s and 2008—the Czech Republic, Spain and Sweden.[3] We assess whether using different adjusted indicators leads to different conclusions about the role of tempo effects in this increase.

To simplify the analysis, we compare three adjusted indicators: the *TFR**, which is by far the most widely used, the *PATFR*,* which has been, so far, its main alternative, and the realtively new *TFRP**, which has provided the best approximation of cohort fertility series. We decided using unsmoothed series of the adjusted indicators to check whether using more stable series of *TFRP** provides firmer conclusions about tempo component in the *TFR* changes without the need of further manipulating the data.

An inspection of trends in these three indicators, alongside the conventional the *TFR* and the tempo effect since the year of the *fertility* trough in the late 1990s yields several important insights (Figures 19 and 20). The main finding is the decline in the gap between the adjusted measures and the *TFR* which is due to the diminishing of the *tempo effect* over time in all three countries. This trend is broadly depicted by all three adjusted measures, but the *TFRP** stands out in several aspects: First, it gives smoother trends over time, relatively little interrupted by year-to-year ups and downs typical of the *TFR** and *PATFR**. This is potentially its great advantage as it gives more stable estimates of tempo effect and its changes over time—as shown, for instance, in Figure 19 for Sweden in 1999, when the lowest *TFR* value was reached and when *TFR** and *PATFR** suddenly fell. Second, the *TFRP** also shows considerably higher fertility values and therefore much higher tempo effect during the period of lowest fertility. More countries need to be analysed to say whether this is a systematic finding, but if it is, it would suggest that the *tempo effect* in many low-fertility countries around 2000 was previously higher than indicated by *TFR**. And, finally, because it reached comparatively high values during the times of the *TFR* minima, the *TFRP** subsequently shows stagnation when the other two adjusted indicators gradually increased (the Czech Republic and Sweden) or even some decline when the other adjusted indicators stagnated (Spain) in the period 1999-2008. In the case of Spain, all the indicators, including the *TFR*, converged to a value of 1.4 by 2008 and thus gave a contrasting reading of the period fertility trend in the preceding decade: while the ordinary *TFR* suggests a gradual 'recovery', the *TFR** and *PATFR** show a mere stagnation, whereas *TFRP** indicates a gradual decline.

Consequently, the assessment of the importance of *tempo effect* changes during the recent *TFR* increase depends widely on the indicator used. This issue is examined in Table 2 which presents the percentage of the TFR increase that is attributable to the diminishing tempo effect since the lowest TFR in the 1990s. Only in the case of Spain, all three indicators suggest that the *TFR* rise was entirely driven by diminishing *tempo distortion*. In contrast, for Sweden the *TFRP** suggests a dominant role of *tempo effect*, while the *PATFR** and *TFR** show very little importance of *tempo effect* and suggest that almost all the observed *TFR* increase was due to a rise in period fertility quantum. Most varied conclusions are obtained for the Czech Republic.

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[3] The results for the Netherlands are available upon request. They are less interesting due to the smaller period TFR upturn there as well as the more limited influence of tempo effect on the period TFR in the 1990s.

The picture is slightly different for first births, where *TFRP** and *KO PATFR** show in agreement prominence of *tempo component*, while the *TFR** trends offer a conclusion that a 'real increase' in fertility level was responsible for most of the *TFR1* upturn in the three countries analysed.

This somewhat contradictory story becomes simpler if we rely on our preferred indicator, the *TFRP**. It shows that the proportion of the recent *TFR* increase due to the decline in the tempo effect ranges from 100 % in the Czech Republic and Spain to 85% in the Netherlands and 69% in Sweden. These estimates are substantially higher than those obtained by Goldstein et al (2009) using the TFR*.

Table 2: Percent TFR increase attributable to diminishing tempo effects since the year the lowest TFR was reached

Total birth orders	TFR*	PATFR*	TFRP*
Czech Republic, 1999-2008	51	35	100
Netherlands 1996-2003	24	30	85
Spain, 1998-2007	93	97	100
Sweden, 1999-2006	14	12	69
First births			
Czech Republic, 1999-2008	43	85	100
Netherlands 1996-2003	-17	67	62
Spain, 1998-2007	14	100	100
Sweden, 1999-2006	9	70	70

CONCLUSIONS & DISCUSSION

Our study has made extensive use of the new indicator of period fertility, termed *tempo- and parity-adjusted total fertility* (*TFRP**) to highlight the importance of diminishing tempo effect for explaining the recent rise in period total fertility rates (*TFRs*) across Europe. The *TFRP**, which was first proposed by Bongaarts and Feeney and developed independently in a similar form by Yamaguchi and Beppu (2004), is based on a table computation using hazard rates with births treated as separate (disconnected) events. We demonstrate a remarkably close correspondence between the *TFRP** and the completed fertility rate of women having birhs in a given period. This analysis also suggests that tempo effects had a more prominent role in the recent increase in the period *TFR* than previously estimated with other tempo-adjusted fertility indicators. In other words, the *TFRP** provides a straightforward demographic explanation of recent fertility trends: there was only a minor increase in the level (*quantum*) of fertility between the late 1990s and 2008, while most of the observed *TFR* rise (Sweden, the Netherlands) or the entire *TFR* rise (Czech Republic and Spain) can be attributed to a diminishing pace of the postponement of childbearing. We reckon that period influences had an important role in these trends in the tempo and quntum of fertility, but a rising standard deviation in the age at childbearing, especially in the Czech Reopublic and Spain, also indicates an importance of cohort effects.

Overall, our analysis of four countries gives a very positive preliminary assessment of the new *TFRP** indicator. Why should anyone choose this indicator over the growing and at times bewildering set of adjusted and nonadjusted period fertility rates? First of all, for its empirical 'performance', especially its relative stability from one year to the next, but also because of its unexpected close approximation of the cohort *CFR*. This proximity is also aparent in order-specific analysis, especially at higher-order births, where other perod indicators often fail to get significantly closer to the completed fertility. Also from a theoretical perspecitive, a case can be made for using the *TFRP**, as well as its non-adjusted variant. In a 'classic' fertility table framework, births in one birth order *i* define the population of women exposed to having a next birth of order *i+1*. This interconnectedness of fertility tables based on age- and parity-specific birth probabilities or occurrence-exposure rates, may turn a disadvantage in the periods with rapidly changing timing of childbearing: a tempo effect at one birth order may then magnify a similar distortion at the subsequent birth orders, as the table population of women is assumed to give births and become exposed to the next birth at progressively later ages than is the real case. The *TFRP*,* as well as its non-adjusted variant, *TFRP*, treat each birth as a separate event, disconnected from the previous and subsequent births. This diminishes the risk that any tempo distortion in these indicators will be 'carried over' and magnified in the indicators for higher birth orders, as is especially the case in the PATFR* for higher birth orders.

Our study gave first results for selected countries and should therefore be interpreted with caution. The use of the *TFRP** has to be extensively tested with the data for more countries and different situations with regard to the changes in fertility timing. Also theoretical underpinning of this and other fertility indicators need to be studied more thoroughly. Our analysis pertained to a unique period of a European-wide increase in the period total fertility rates, which occurred on such a scale for the first time since the baby boom period of the mid-1960s. In a majority of European counteries, the recent economic recession has reversed this trend or put a break to the previous increase (Sobotka et al. 2011). We hope that the *TFRP** will soon prove a valuable indicator that will greatly contribute to our understanding of such fertility reversals.

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APPENDIX

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

- *f(a,t,i)* : age specific fertility rate of the second kind in year *t*, at age *a* and order *i* . Denominators of these rates equal all women aged *a* at time *t*, regardless of their parity
- *p(a,t,i)* : conditional fertility rates of the first kind (i.e., hazards) with births of each order treated as separate non-repeatable events. Denominators of the hazard for order *i* equal all women who have not yet reached order *i* .
-*h(a,t,i)* conditional fertility rates of the first kind with births of each order treated as repeatableable events. Denominators of the exposure-specific rates for order *i* and age *a* are equal to women of parity *i-1*.

Indicators are estimated as follows:

- *TFR(t)*, the conventional period total fertility rate is calculted from rates of the 2nd kind

$$TFR(t) = \sum_i TFR(t,i) = \sum_i \sum_a f(a,t,i) \qquad (1)$$

- *TFRP(t)*, the total fertility rate derived from rates of the first kind (births nonrenewable) (Bongaarts and Feeney 2004, 2006, Yamaguchi and Beppu 2004, 2007))

$$TFRP(t) = \sum_i TFRP(t,i) = \sum_i 1 - \exp[-\sum_a p(a,t,i)] \qquad (2)$$

PATFR(t), the total fertility rate derived from rates of the first kind *h(a,t,i)* with births renewable. See Rallu and Toulemon (2004) for details. *PATFR(t)* can be computed from increment-decrement fertility tables, where the computation of the indicator for any parity above 1 depends partly on the output (=table births) from the lower-parity tables. This interconnectedness across parities may be the main source of hugely magnified tempo distortion at higher parities. For birth order one the *PATFR(t)*equals the *TFRP(t)* but at higher orders they differ because the computation of the *TFRP(t*) resembles 'traditional' survival curves: All women are supposed to be exposed to having a birth of any parity at the beginning of their reproductive age and the computation of 'births' and 'survivorship' is provided for each parity independent on the other parities.

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

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

with

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

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

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

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

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

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

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

- *PATFR*(t)*, the tempo adjusted version of *PATFR(t)* calculated from occurrence-exposure rates *h(a,t,i)*. For details see Kohler and Ortega (2002). In this approach the tempo adjustment is based on the rate of change in the mean age of the schedule of hazards (instead of the BF appraoch based on the mean age of the schedule of rates of the second kind).

It should be noted that we examined a fourth tempo adjusted indictor in which the Bongaarts-Feeney tempo adjsustment is applied to remove the tempo effect from *h(a,t,i).* This indictor's ability to match cohort fertility is approximately the same as for the *TFR**.

Table A1: Latest available cohort CFR and period fertility indicators in year of mean age (by birth order, period indicators based on a 5-year moving average)

	Birth order				
Czech Republic	**Total**	**1**	**2**	**3**	**4+**
CFR (Cohort 1968)	1.897	0.919	0.716	0.189	0.072
TFRP*	1.934	0.929	0.759	0.180	0.065
TFR*	1.898	0.909	0.746	0.177	0.066
PATFR*	1.795	0.932	0.731	0.100	0.031
TFRP	1.768	0.925	0.656	0.132	0.055
PATFR	1.612	0.925	0.590	0.074	0.022
TFR	1.634	0.889	0.564	0.126	0.055
The Netherlands	**Total**	**1**	**2**	**3**	**4+**
CFR (Cohort 1967)	1.766	0.817	0.645	0.217	0.086
TFRP*	1.758	0.813	0.640	0.217	0.088
TFR*	1.739	0.807	0.629	0.215	0.089
PATFR*	1.673	0.803	0.618	0.190	0.063
TFRP	1.667	0.777	0.602	0.205	0.083
PATFR	1.663	0.777	0.607	0.202	0.076
TFR	1.575	0.724	0.567	0.201	0.083
Sweden	**Total**	**1**	**2**	**3**	**4+**
CFR (Cohort 1967)	1.980	0.878	0.724	0.269	0.109
TFRP*	1.971	0.888	0.724	0.256	0.104
TFR*	1.969	0.906	0.710	0.249	0.104
PATFR*	1.811	0.891	0.665	0.207	0.048
TFRP	1.803	0.839	0.648	0.221	0.094
PATFR	1.683	0.839	0.603	0.179	0.062
TFR	1.627	0.747	0.575	0.211	0.095
Spain	**Total**	**1**	**2**	**3**	**4+**
CFR (Cohort 1967)	1.597	0.864	0.579	0.119	0.035
TFRP*	1.557	0.872	0.542	0.115	0.029
TFR*	1.458	0.788	0.537	0.103	0.030
PATFR*	1.439	0.860	0.476	0.075	0.028
TFRP	1.426	0.793	0.499	0.103	0.031
PATFR	1.338	0.793	0.436	0.082	0.027
TFR	1.176	0.605	0.440	0.100	0.031

Note: Indicators sorted from those approximating most closely the completed fertility rates to thos that are most distant from them.

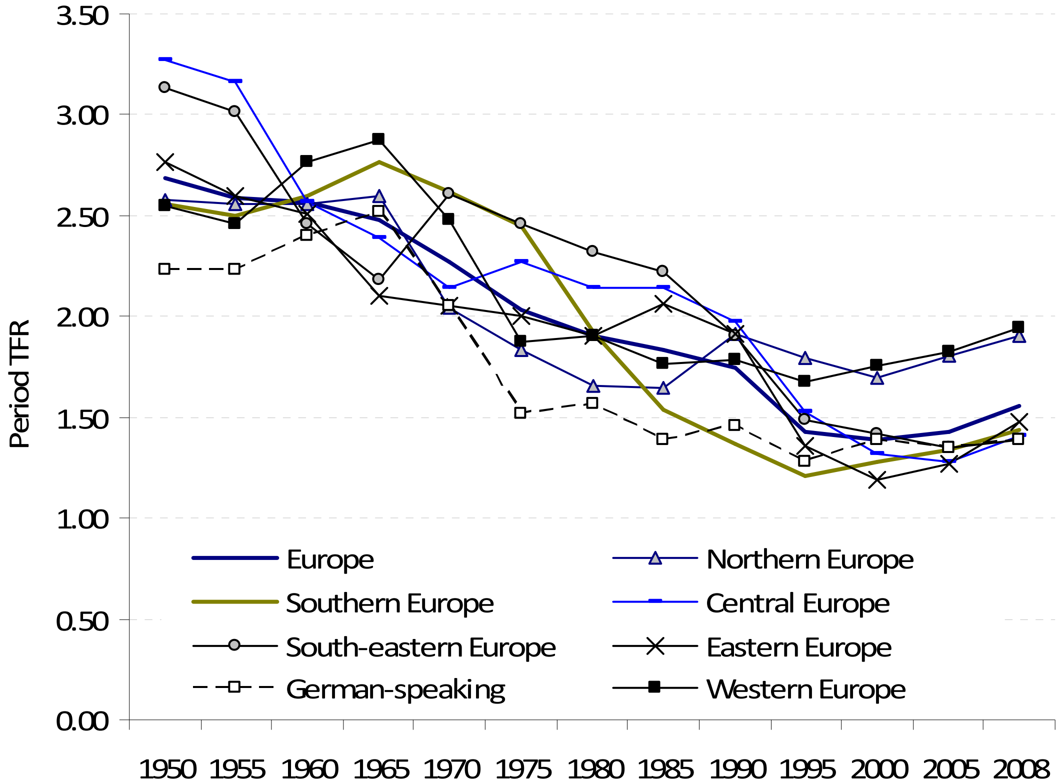


Figure 1: Period TFR in European regions, 1950-2008

Notes: Regional data are weighted by population size of countries in a given region. Data for the whole Europe include all territory of Russia and exclude Turkay and Caucasus countries.
Countries are grouped into regions as follows:
Western Europe: Belgium, France, Ireland, Luxembourg, the Netherlands, United Kingdom;
German-speaking countries: Austria, Germany, Switzerland;
Northern Europe: Denmark, Finland, Iceland, Norway, Sweden;
Southern Europe: Cyprus, Greece, Italy, Malta, Portugal, Spain;
Central Europe: Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, Slovenia;
South-eastern Europe: Bosnia-Herzegovina, Bulgaria, Macedonia, Montenegro, Romania, Serbia (recent data exclude Kosovo);.
Eastern Europe: Belarus, Moldova, Russia, and Ukraine
Sources: Own computations based on Eurostat (2010), VID (2010), Council of Europe (2006) and national statistical offices.

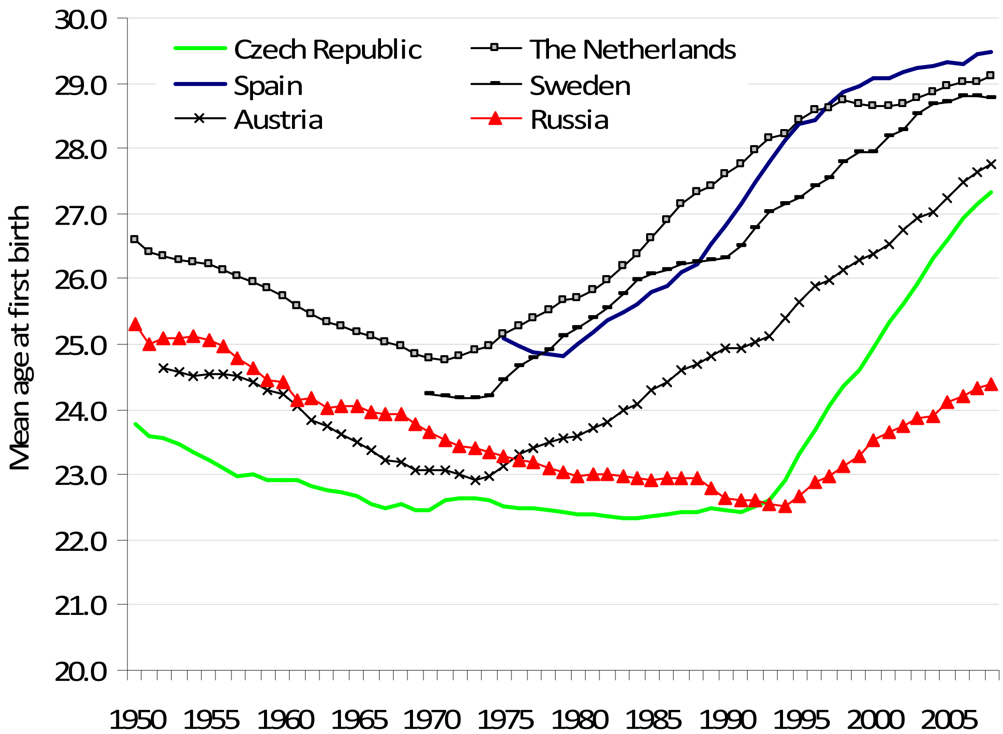


Figure 2: Period mean age at first birth in six European countries, 1950-2008

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

Figure 3: TFR by birth order

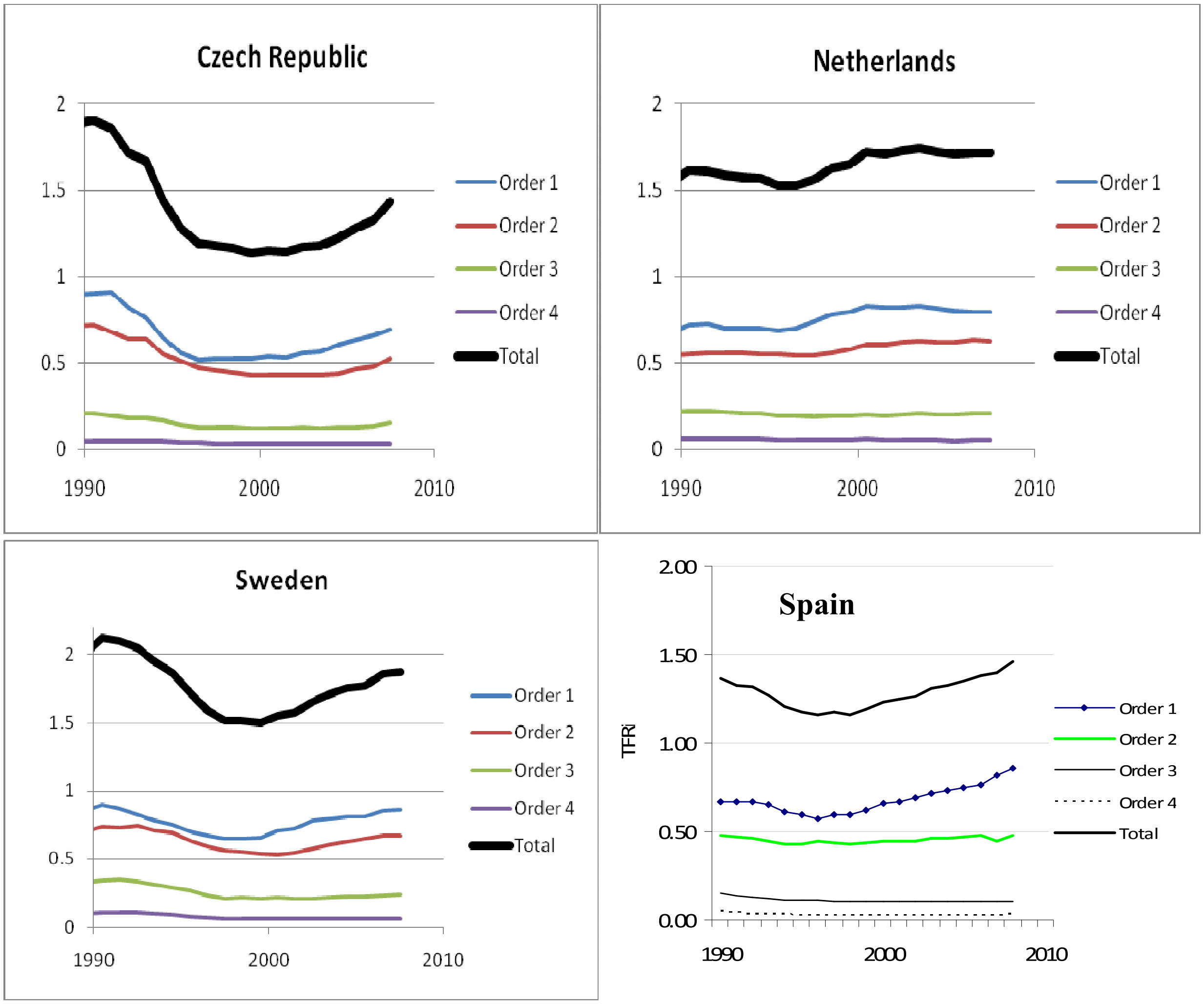


Figure 4: Simulated Quntum change

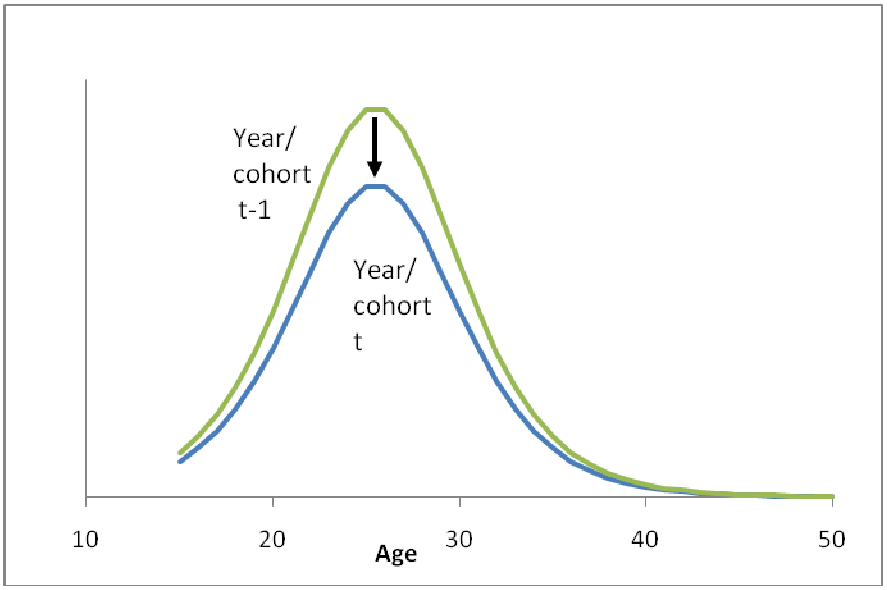


Figure 5: Simulated tempo change

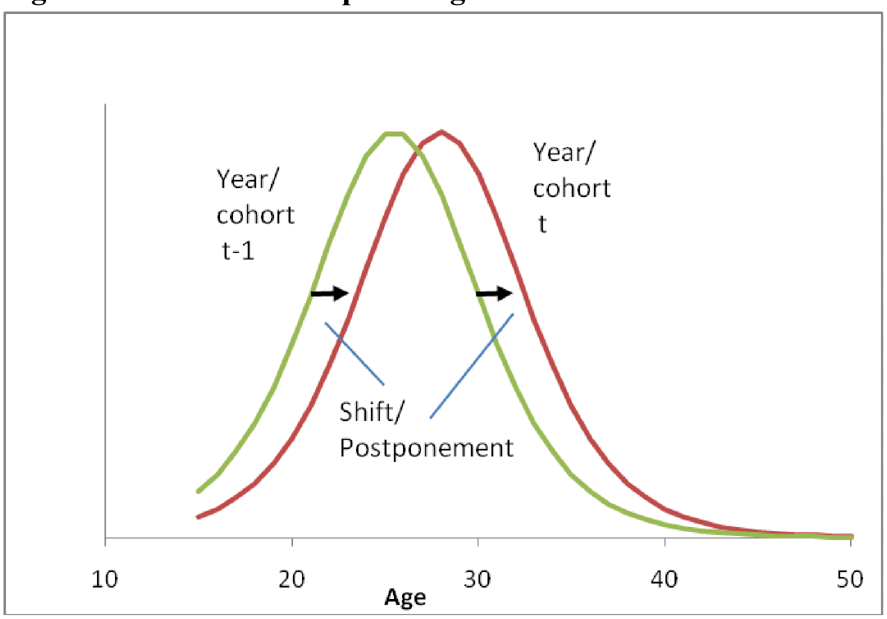


Figure 6: Simulated mean age at childbearing and rate of change in mean

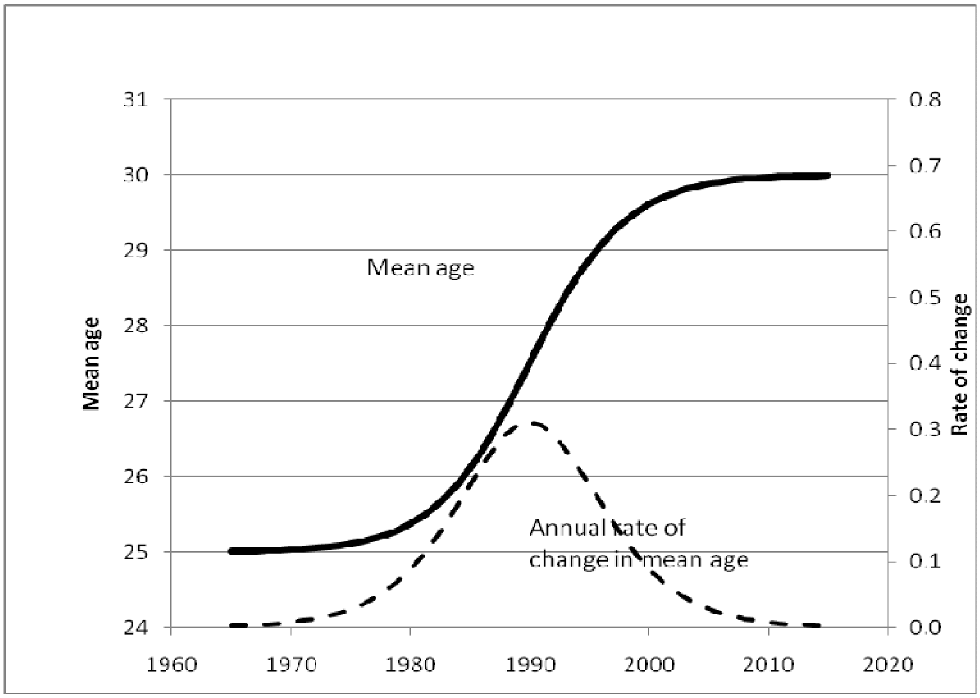


Figure 7: Simulated total fertility rate and tempo distortion

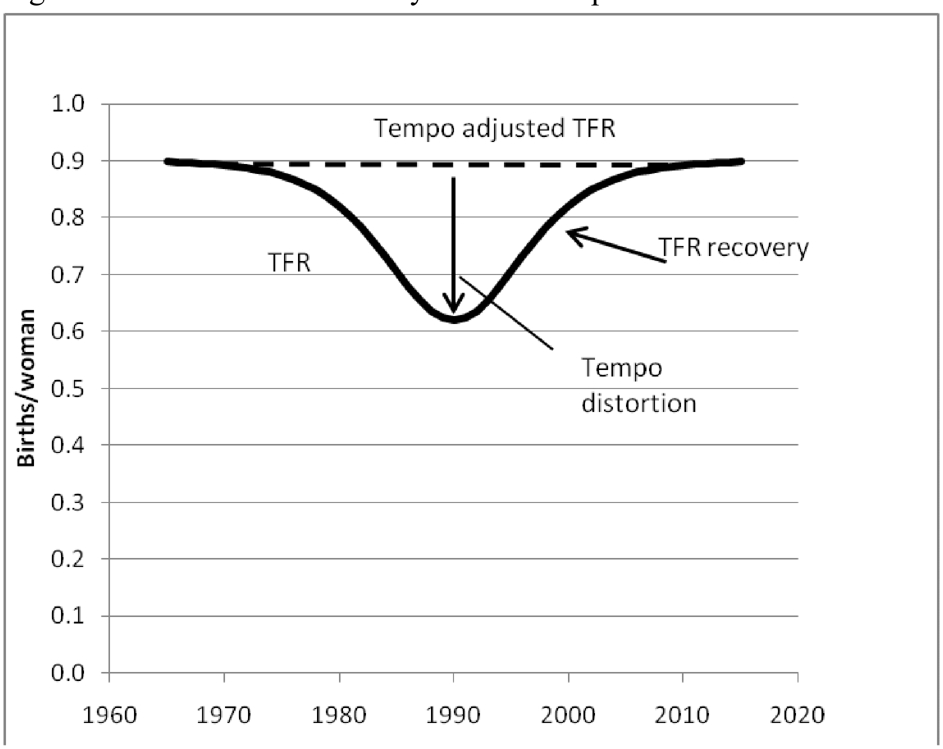


Figure 8: Simulated TFR by rate of change in mean age

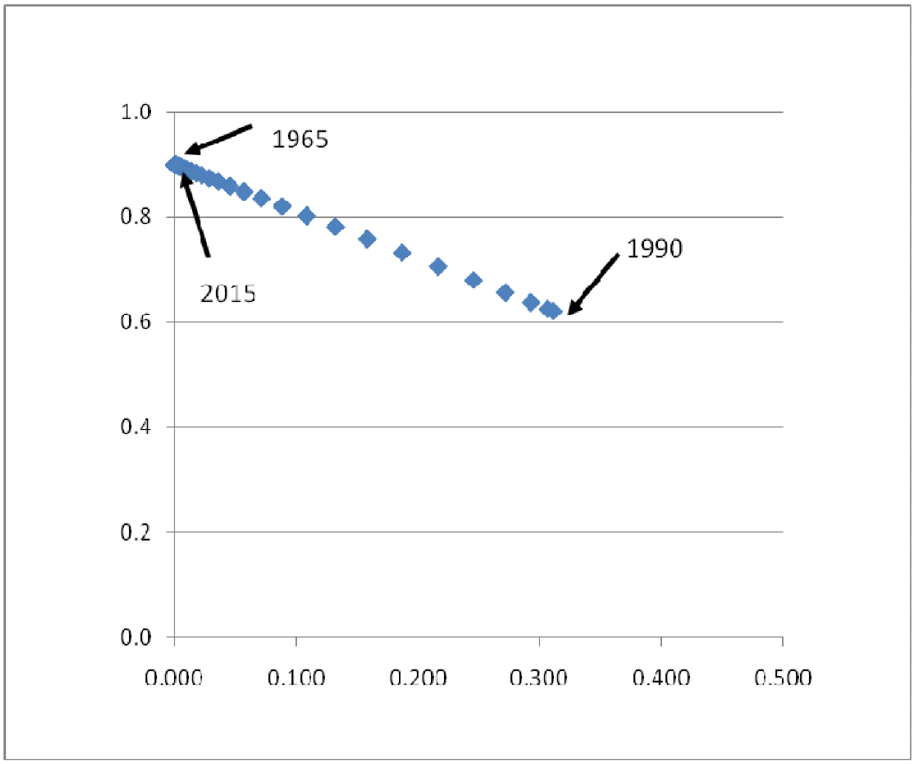


Figure 9: TFR by rate of change in the mean age at childbearing (ri(t)); Czech Republic

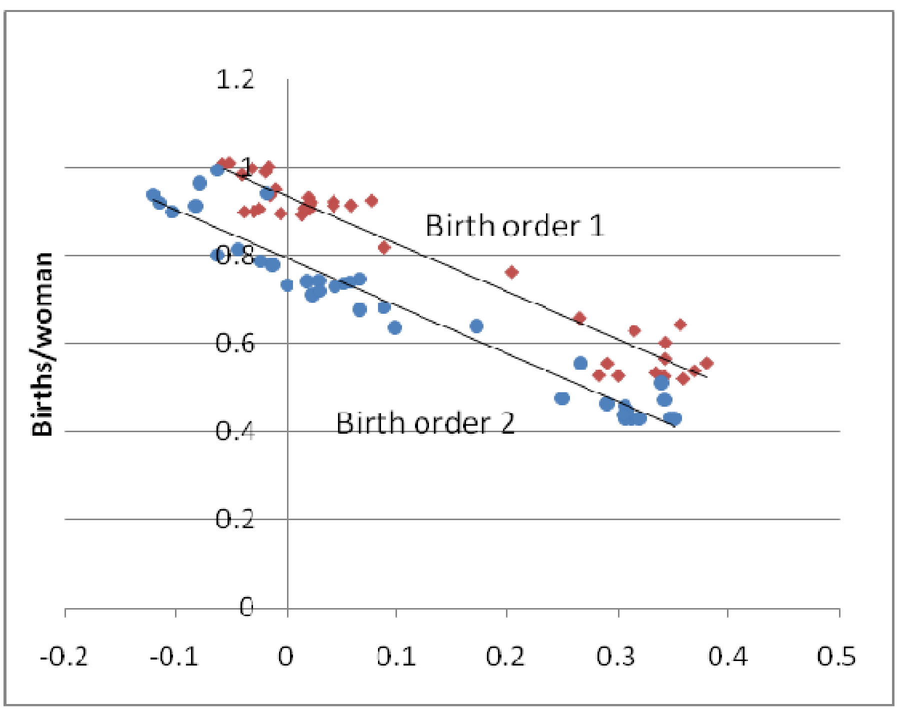


Figure 10: Simulated age specific fertility rates by year doring postponement transitioon

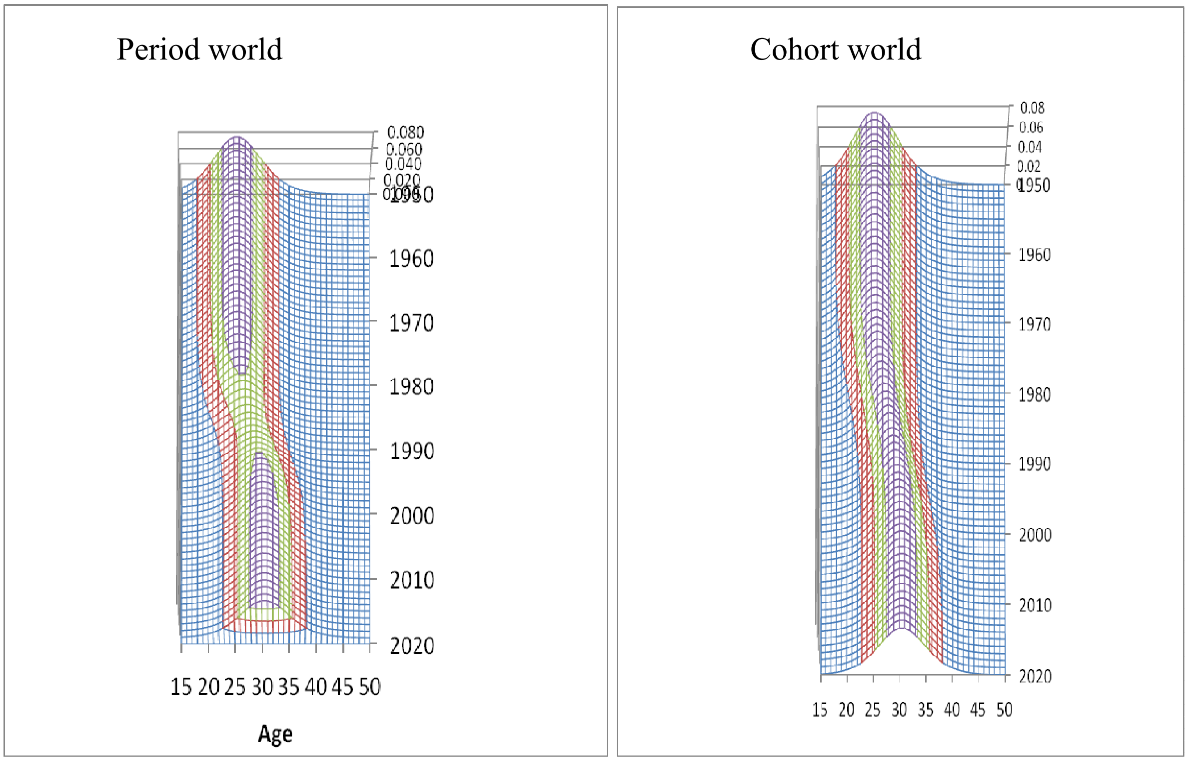


Fig. 11: Simulated age specific fertility rates 1990-2010

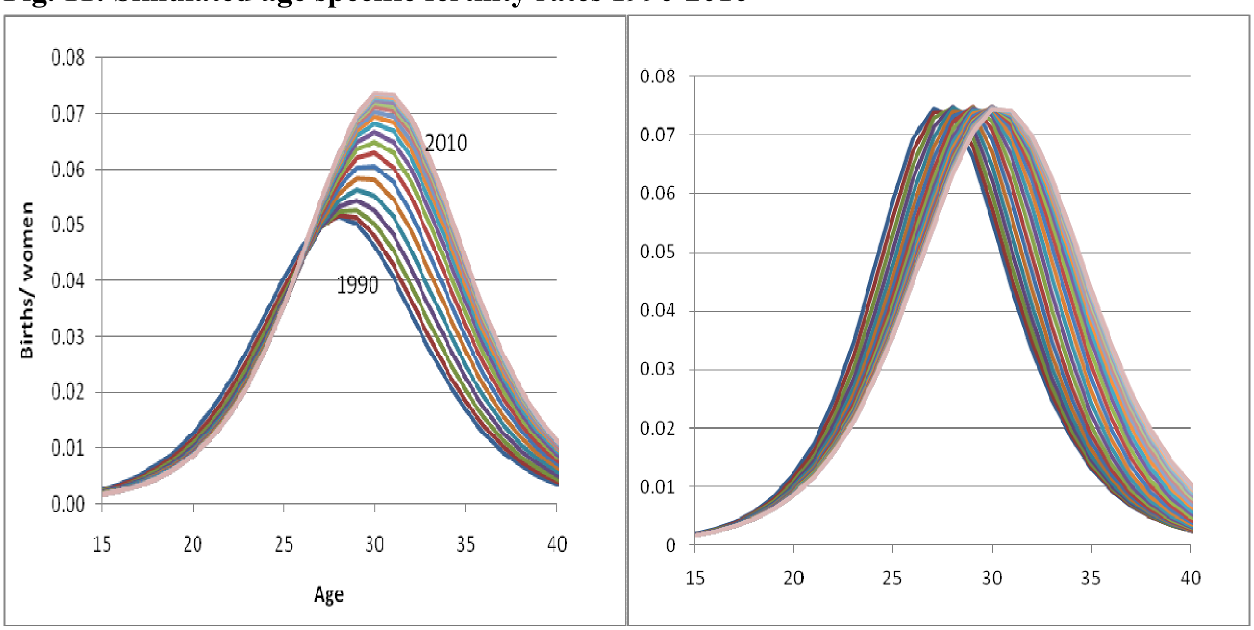
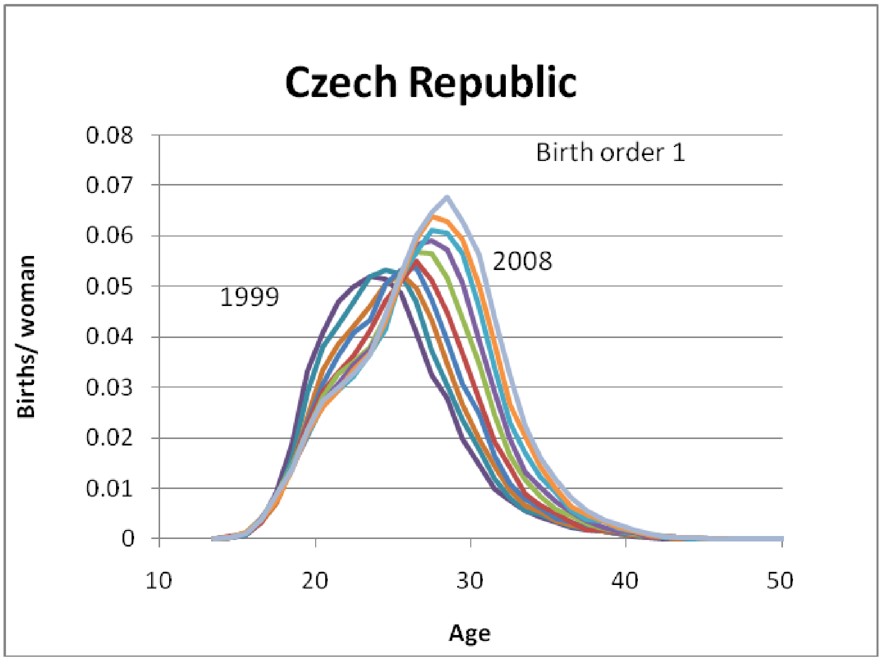
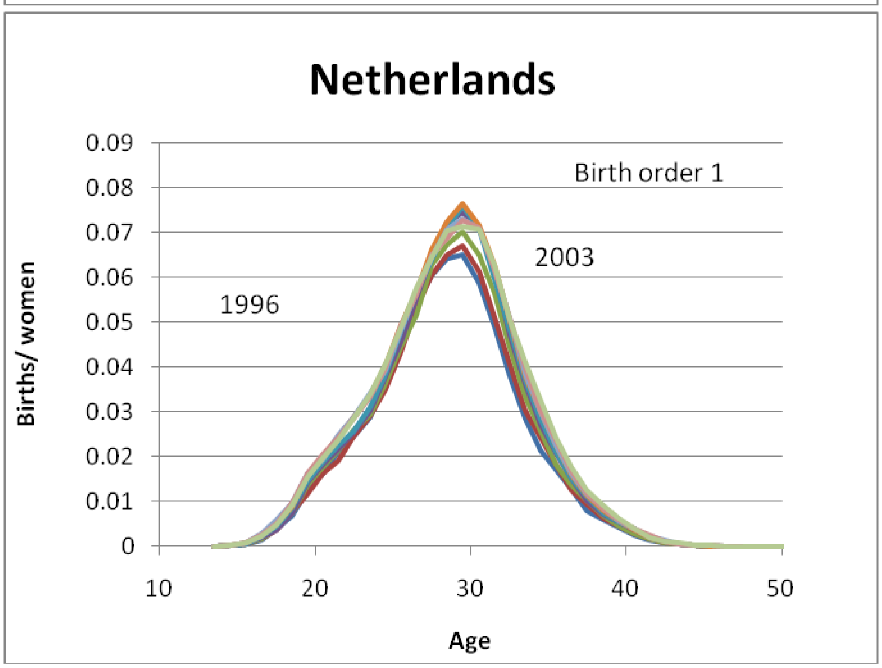
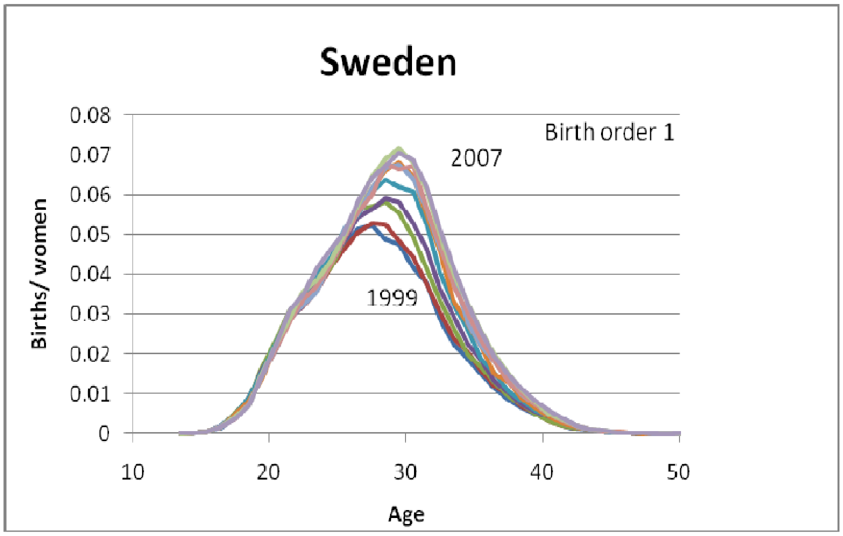


Figure 12
Age-specific fertility rates for birth order 1 (rates of the second kind, incidence rates)






Sweden
Birth order 1
2007
1999
Births/ women
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
10
20
30
40
50
Age

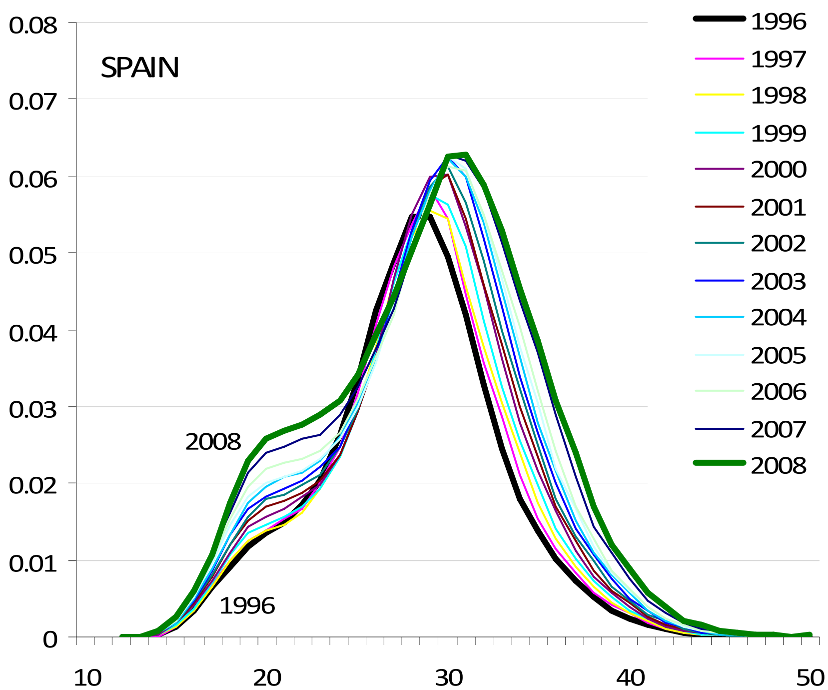

SPAIN
2008
1996
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
10
20
30
40
50
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008

Figure 13: Standard deviations of fertility schedules

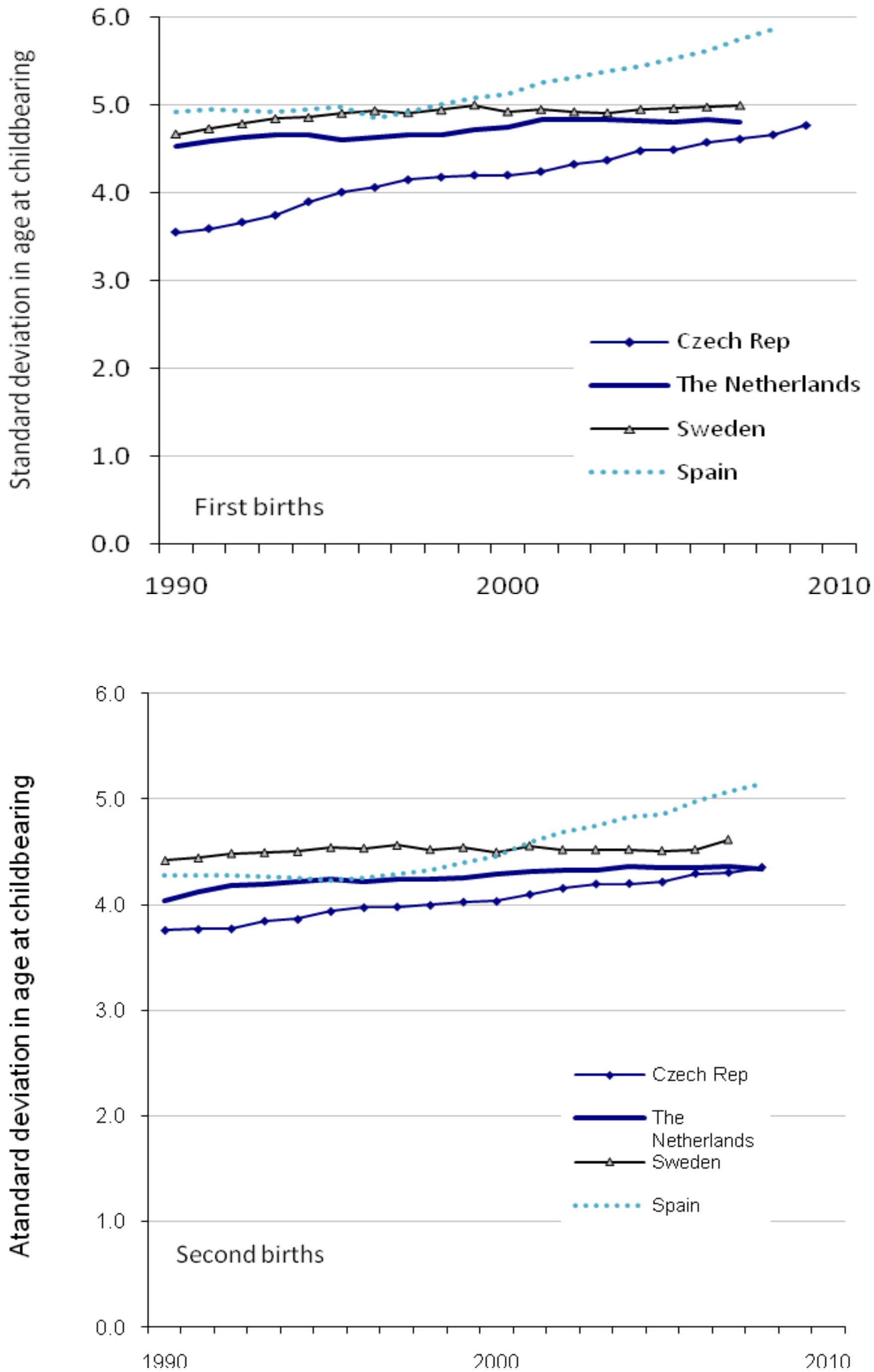
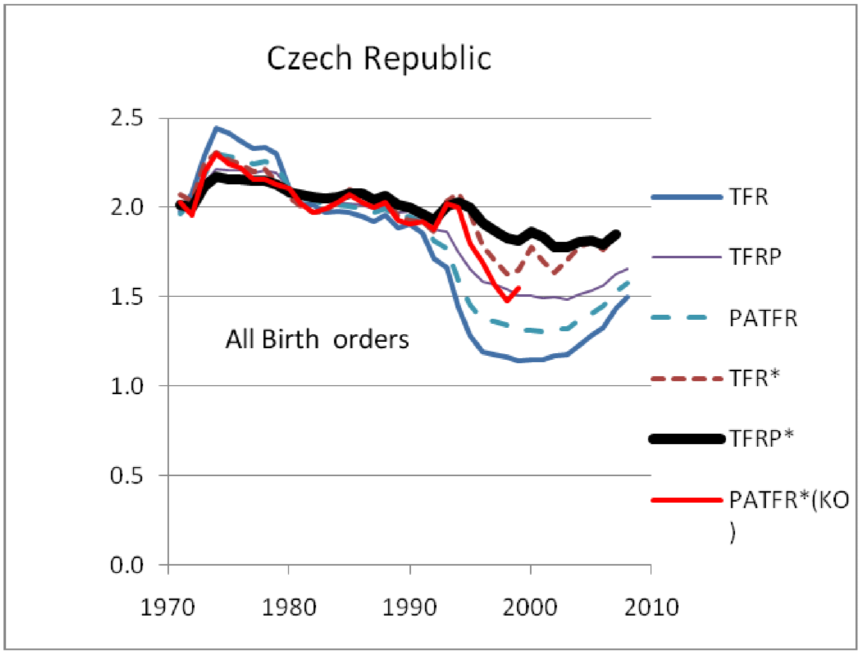
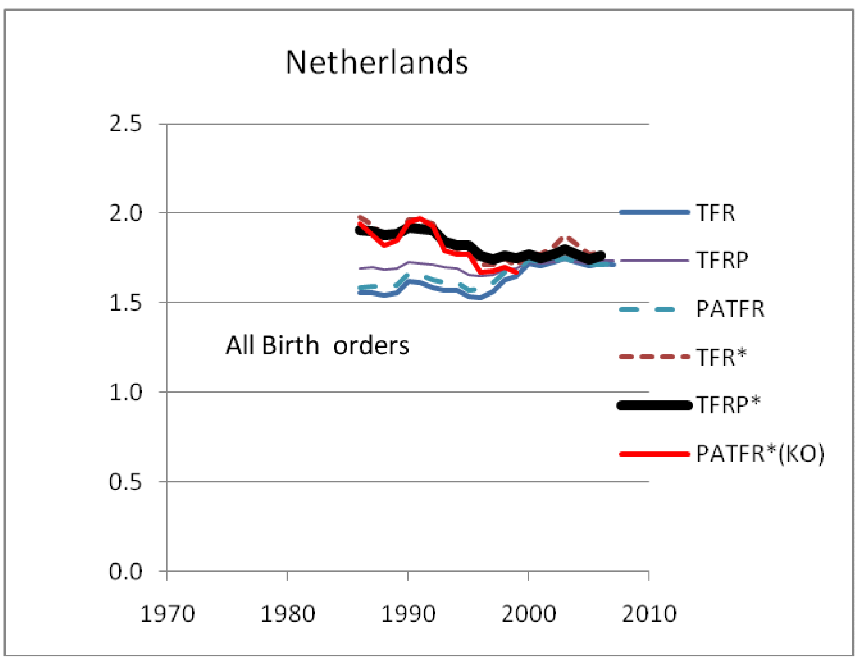
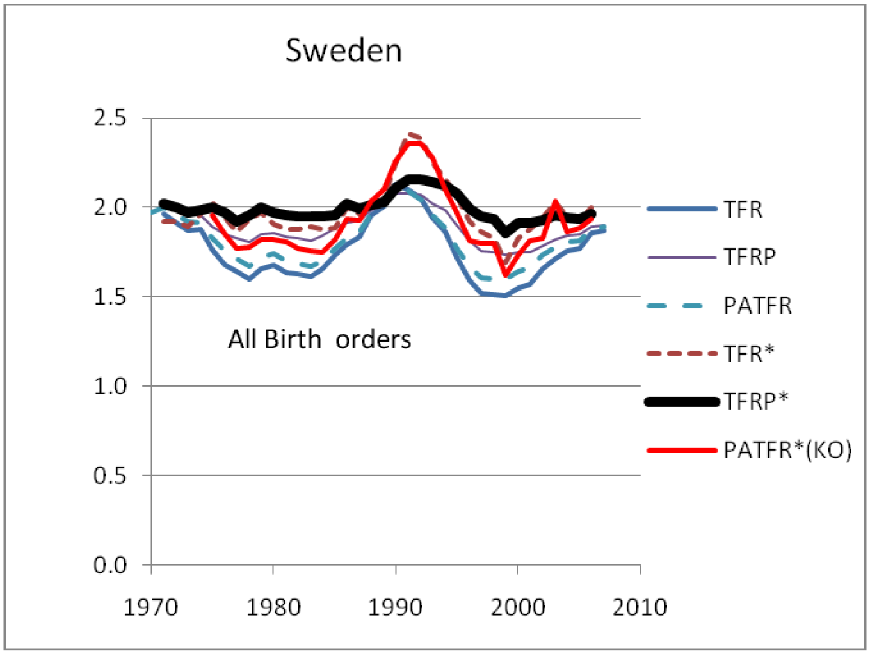


Fig.16: Observed and tempo-adjusted total fertility indexes for all birth orders






Sweden
2.5
2.0
1.5
1.0
0.5
0.0
1970
1980
1990
2000
2010
All Birth orders
TFR
TFRP
PATFR
TFR*
TFRP*
PATFR*(KO)

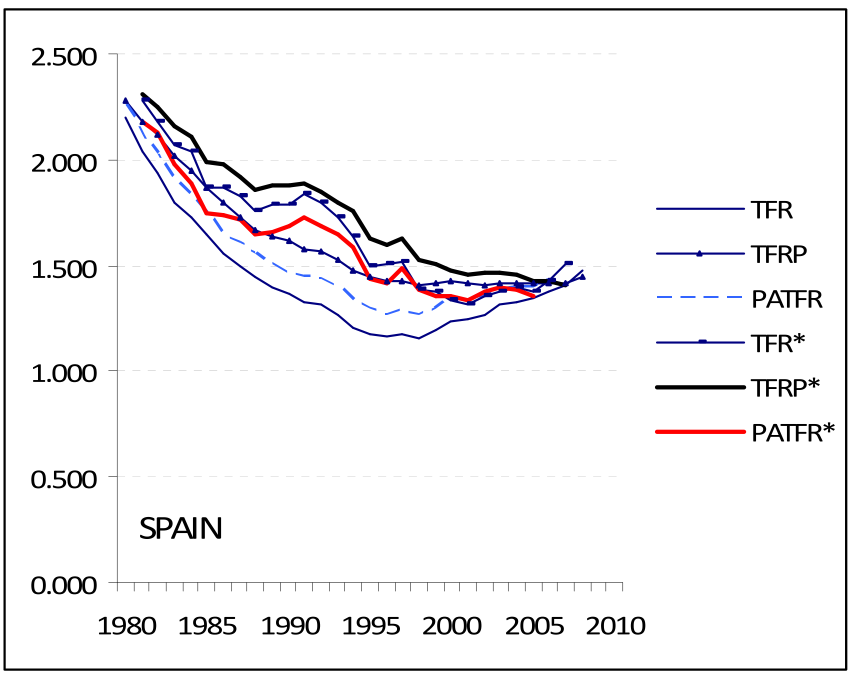
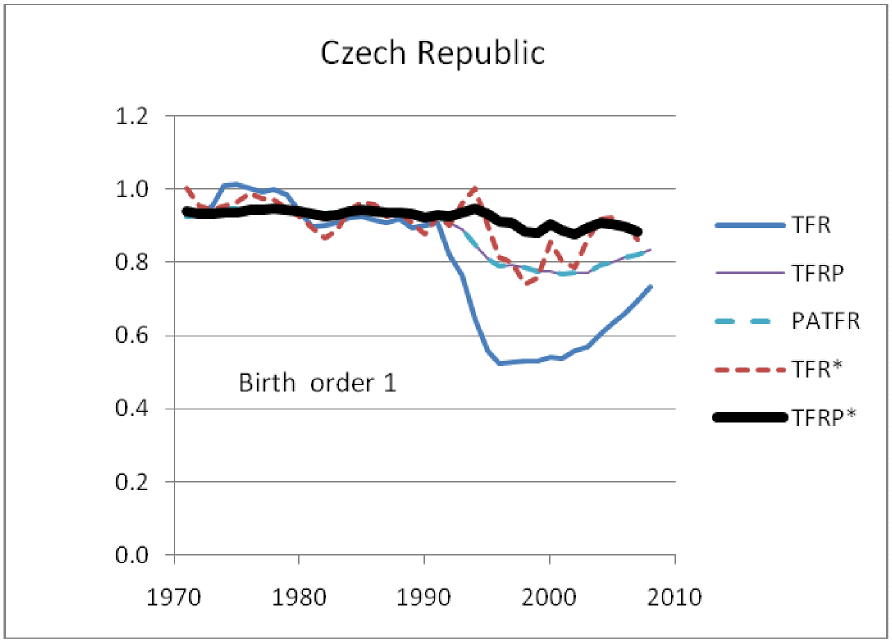
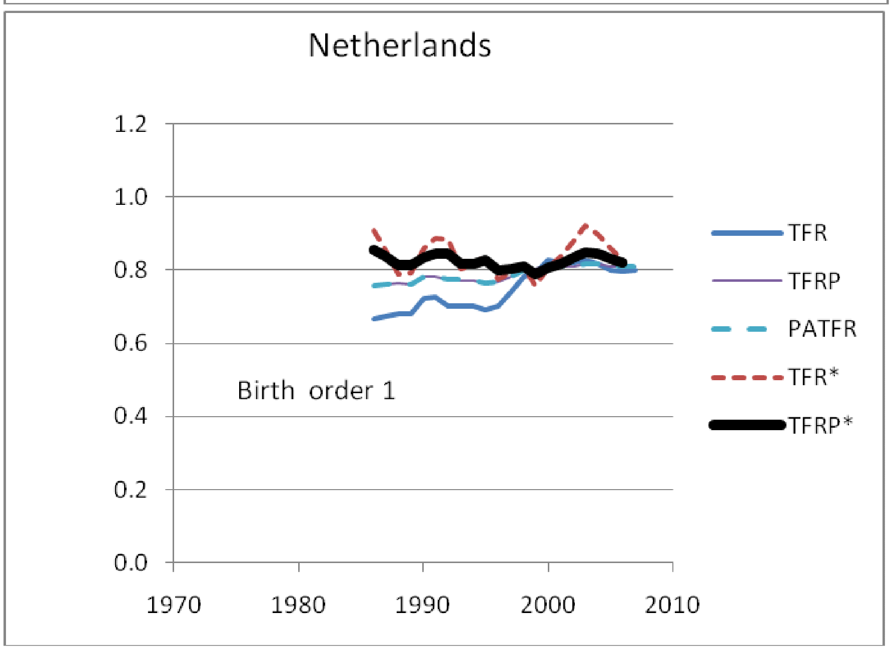
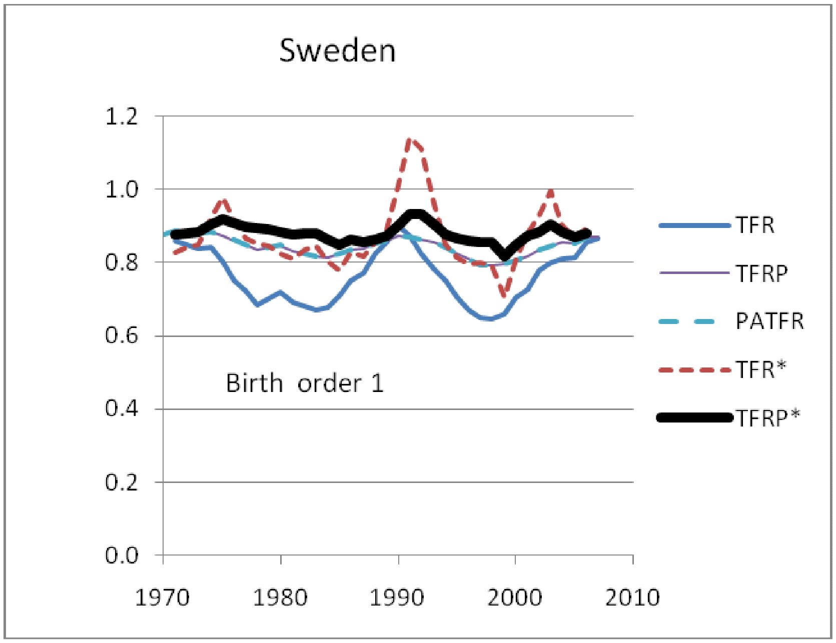

2.500
2.000
1.500
1.000
0.500
0.000
1980
1985
1990
1995
2000
2005
2010
SPAIN
TFR
TFRP
PATFR
TFR*
TFRP*
PATFR*

Figure 17: Observed and tempo-adjusted total fertility indexes for birth order 1






Sweden
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1970
1980
1990
2000
2010
Birth order 1
TFR
TFRP
PATFR
TFR*
TFRP*

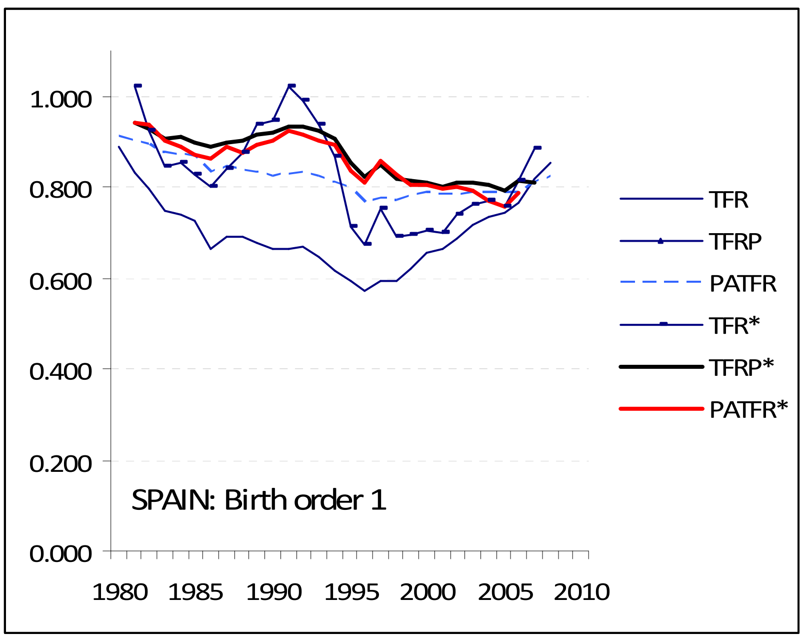

1.000
0.800
0.600
0.400
0.200
0.000
1980
1985
1990
1995
2000
2005
2010
SPAIN: Birth order 1
TFR
TFRP
PATFR
TFR*
TFRP*
PATFR*

Figure 18: A comparison of the completed fertility rate among women born in 1967 (1968 in the Czech Republic) with three adjusted fertility indicators (TFRP*, TFR*, and PATFR*) and with the conventional period TFR in the year the this cohort reached the mean age at childbearing

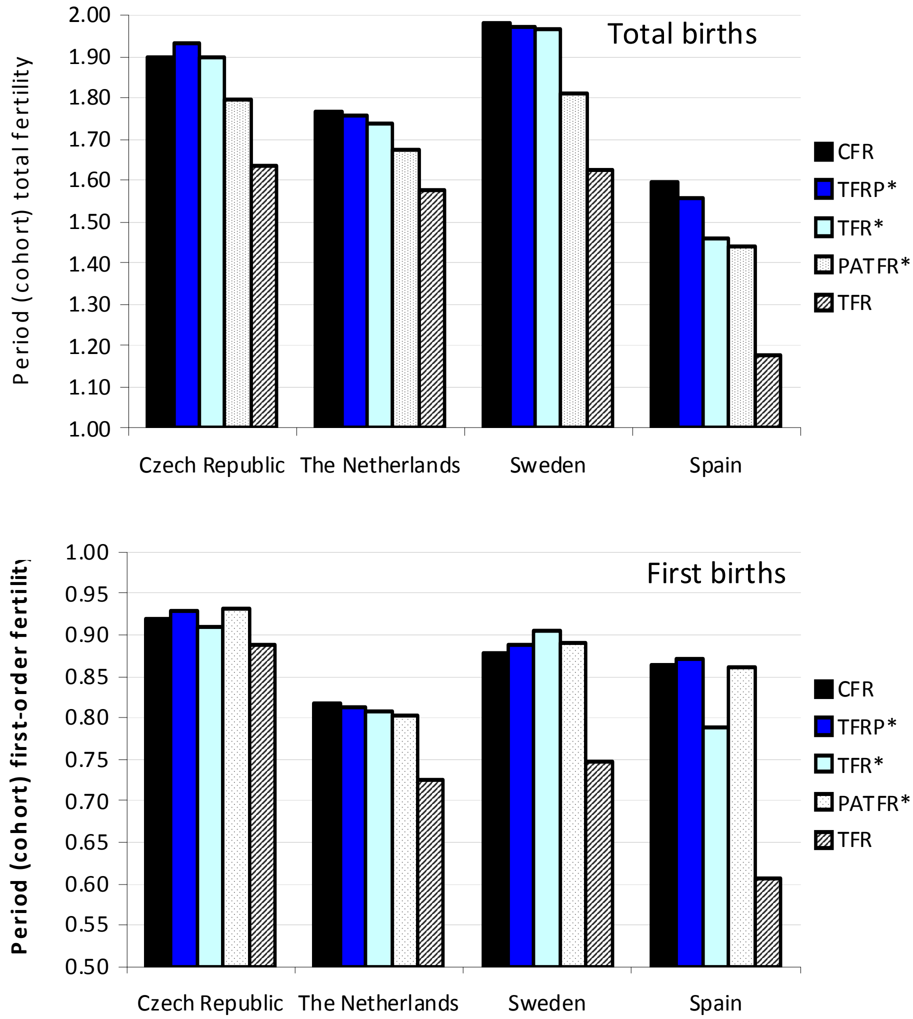


Figure 19: Period TFR during the period of its recent increase as compared with three adjusted indicators in the Czech Republic, Spain and Sweden

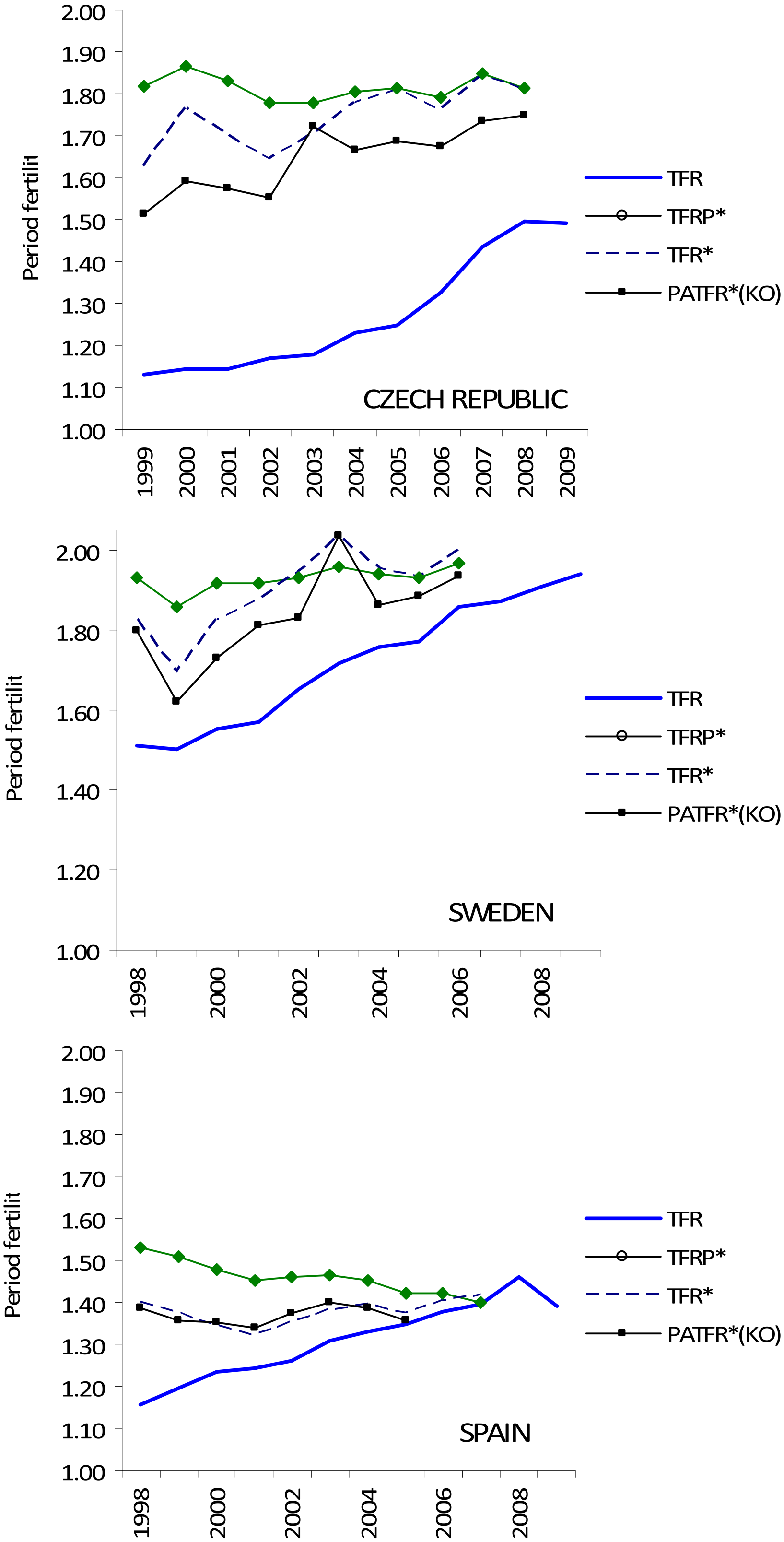


Figure 20: Estimated tempo effect in the period TFR during the its recent increase in the Czech Republic, Spain and Sweden