Comparison of different fertility indicators in the case of three adjacent Central-European Countries

Which fertility indicator best represents the Czech, Hungarian and Slovak fertility trends between 1970 and 2011?

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Abstract

In this paper the Czech, Hungarian and Slovak fertility trends between 1970 and 2011 are compared with four different fertility rates. Three of them are calculated period fertility ratios: the traditional Total Fertility Rate, the Tempo and Parity Adjusted Total Fertility Rate proposed by Bongaarts–Feeney, and the Tempo and Parity Adjusted Total Fertility Rate proposed by Kohler-Ortega. The fourth indicator is the observed Completed Cohort Fertility. The authors demonstrate that in the 1990s and the years between 2000 and 2011 the adjusted fertility ratios are higher than the values of the total fertility indicator, but all of them are still below the reproduction limit, with a worsening trend. The least favourable situation is in Hungary. The most accurate fertility indicator was chosen by comparing the period fertility rates with the Completed Cohort Fertility ratios. The authors have shown that at the very beginning of the period analysed, when Mean Age at Births of the first child decreased in the Czech Republic and Hungary (but not in Slovakia), in the case of the first parity the Kohler-Ortega adjusted fertility rates performed best, but from the mid-1970s in the case of all birth orders and in each of the countries, during the whole period the Bongaarts–Feeney adjusted fertility rates got closer to the values of the Completed Cohort Fertility.

The systematic analysis of fertility trends has become part of the scientific research since the second third of the 20th century. Contrary to the theory of overpopulation by Malthus [1798] the main problem nowadays in developed countries is the low number of live birth and the decreasing population (Neyer [2013]). In certain cases – for example for calculating primary school places – it is enough to account for the number of newborns. But during longer periods and for complicated economic analysis – for example the sustainability of the pension system, the human factor of the economic growth – we must pay attention to the indicators of fertility rates. Up to now the most used traditional indicator for measuring period fertility is the so called total fertility rate (TFR), which might provide misleading estimate of a woman's average number of children. (Rallu–Toulemon [1994], Bongaarts–Feeney [1998], [2004], [2006], [2010], Kohler–Ortega [2002], Yamaguchi–Beppu [2004], Goldstein–Sobotka–Jasilioniene [2009], Sobotka–Lutz [2011]; Bongaarts–Sobotka [2012]; Berde–Németh [2014]).

TFR can estimate the fertility rate properly if the parity composition of women of reproductive age, the timing of the childbirth and the distribution of women upon other demographic characteristics remain unchanged. In periods during which the women's mean age at childbearing increases, the TFR can be very biased. Many authors pointed out that sometimes the so-called tempo effect is the reason of TFR decrease or increase (Philipov–Kohler [2001], Kohler–Billari–Ortega [2002], Husz

[2006], Goldstein–Sobotka–Jasilioniene [2009], Frejka et al. [2011], Sobotka–Lutz [2011], Bongaarts–Sobotka [2012], Faragó [2012], Berde-Németh [2014]). In Hungary since the eighties the TFR dropped back partly because of the presence of the tempo effect. However younger women did not totally give up childbirth (Spéder [2006], Spéder–Kamarás [2008], Pongrácz T.-né [2011], Szalma [2011], Kapitány–Spéder [2012], Kamarás [2012]), at older ages they try to realize at least some of their childbearing intentions. When these children are born some increase of the TFR can be experienced (tempo effect).

First Norman Ryder (Ryder [1956] [1964], [1980]) drew attention to the tempo effect in the middle of the last century. Since then some new fertility indicators were constructed, which calculate the average number of live-born children per women with adjustment of the tempo effect (Bongaarts–Feeney [1998], [2004], [2006], Kohler–Ortega [2002], Yamaguchi–Beppu [2004]). The estimation of the fertility indicators – which uses cross-section data to calculate the fertility behaviour of females during their whole reproductive age have other distortions besides the tempo effect. These distortions depend on the changes of the data structure and its variation over time. The newest fertility indicators have not only corrected the tempo effect but also pay attention to the parity composition of the female population (Kohler–Ortega [2002], Bongaarts–Feeney [2004], [2006], Yamaguchi–Beppu [2004]).

The different fertility indicators give different pictures about a country's fertility trend. It can happen that the difference between the values of the indicators may be as large as 40 percent or more (see Berde–Németh [2014] Figure 6). It is hard to decide which type of fertility indicator may be the best in the above mentioned cases. By comparing Completed Cohort Fertility with the calculated period fertility rates we may obtain an estimate of how well each indicator performs.

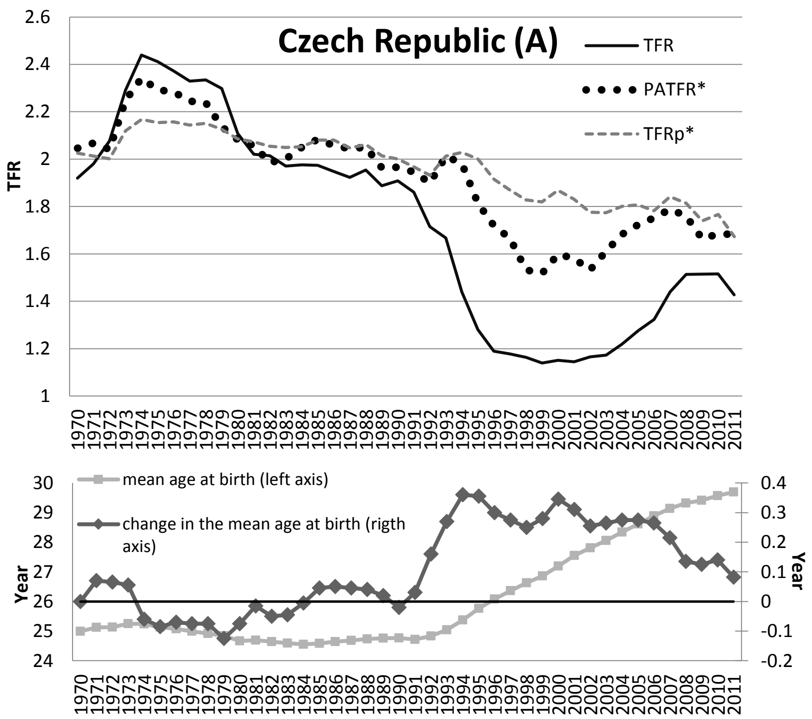
Apart from studying methodological questions about different fertility rates our paper's main focus is the Hungarian fertility trend. We accomplish the trend analysis by comparing fertility series of Hungary to those in the Czech Republic and Slovakia, because the history and economy of these three Central-European countries are very similar. We reveal that fertility indicators based on different methodologies and the Completed Cohort Fertility rate vary very analogously in the three countries. The time series of fertility rates indicate that fertility has dropped in each of the three countries in the last two decades. Additionally, the most critical fertility situation is in Hungary. However even the worst fertility values of Hungary are not as bad as would be suggested by the traditional TFR. Tempo and parity adjusting of the TFR help us to get closer to real tendencies.

Our paper consists of three parts. First we compare the Czech, Hungarian and Slovak fertility trends using Total Fertility Rates, the Tempo and Parity Adjusted Total Fertility Rates proposed by Bongaarts and Feeney [2004, 2006] and the Tempo, Parity and Age Adjusted Total Fertility Rates introduced by Kohler and Ortega [2002]. We also show that the three main fertility indicators represent more or less similar differences in each country, except for the very beginning of the analysed period. Second we analyse the relationship between the Completed Cohort Fertilities and the two corrected fertility rates. Finally we draw our conclusions and point out areas requiring further research.

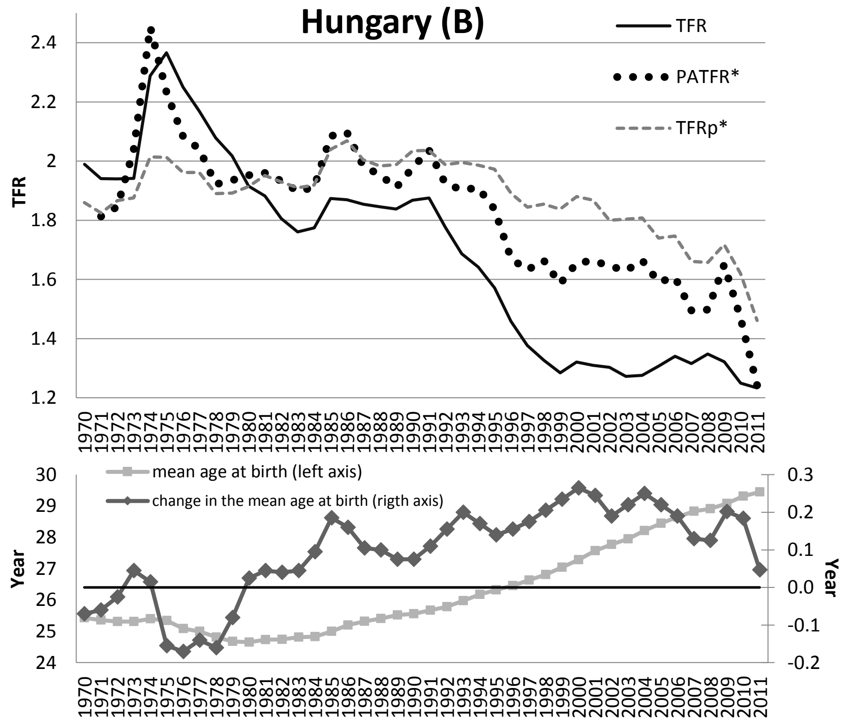
Hungarian fertility trends in comparison with Czech and Slovak data[1]

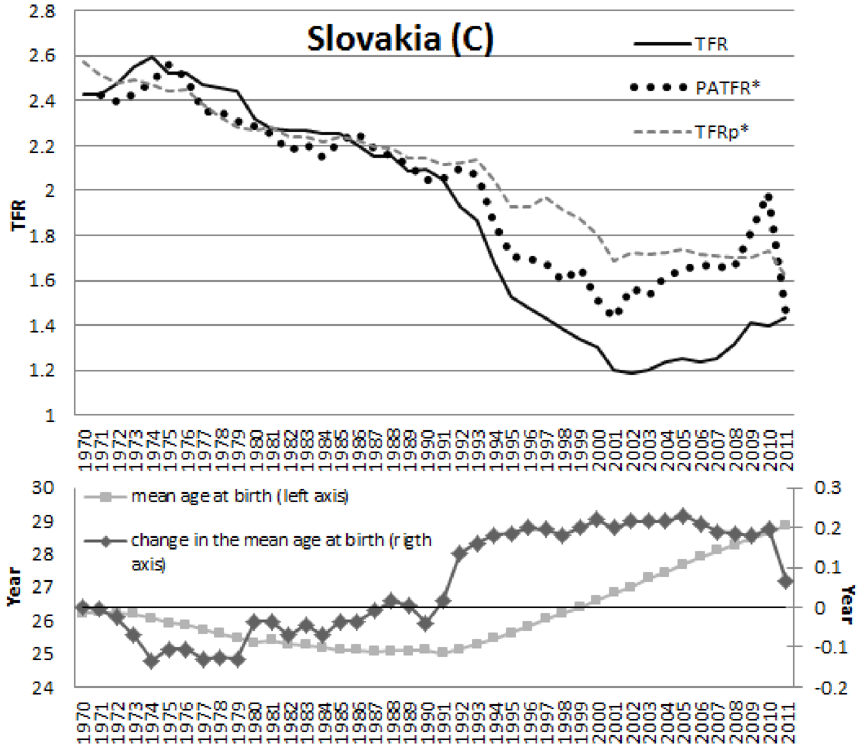
The Czech Republic, Hungary and Slovakia have many similarities with regard to their history and development (Matysiak [2011]). The same is true of their fertility trends (Sobotka [2003], Goldstein–Sobotka–Jasilioniene [2009], Berde-Németh [2014]) too, which here are represented for the periods between 1970 and 2011 by their different period fertility rates in Figure 1, and in addition Appendix 1 contains the figures for corrected fertility ratios. The period fertility indicators we use for the analysis are the traditional Total Fertility Rate (TFR) (Kuczynski [1932]), the Tempo and Parity Adjusted Fertility Rate proposed by Bongaarts – Feeney (TFRp*) (Bongaarts–Feeney [2004], [2006]) and the Tempo and Parity Adjusted Fertility Rate proposed by Kohler and Ortega (Kohler and Ortega [2002]).

Figure 1. The Total Fertility Rates (TFR), the Kohler – Ortega Tempo and Parity Adjusted Total Fertility Rates (PATFR*), and the Bongaarts – Feeney Tempo and Parity Adjusted Total Fertility Rates (TFRp*) in the Czech Republic (A), Hungary (B) and Slovakia (B) (upper graphs), and the mean average at birth and its change (lower graphs)



[1] The sources of all data used here and in the next chapter are: raw data came from the Human Fertitlity Database [2014], except for Czech data in 2011, Czech Statistical Office [2013], Hungarian data in 2010-2011, Hungarian Statistical Office[2010], [2011], [2012], and Slovak data in 2010, 2011, Statistical Office of the Slovak Republic [2010], [2011], [2012]. The calculation of the different adjusted fertility rates (based on the methodology described Jasilione et. al. [2012]) is our own work.


Hungary (B)
TFR
PATFR*
TFRp*
TFR
2.4
2.2
2
1.8
1.6
1.4
1.2
mean age at birth (left axis)
change in the mean age at birth (rigth axis)
Year
30
29
28
27
26
25
24
0.3
0.2
0.1
0.0
-0.1
-0.2
1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011


Slovakia (C)
TFR
PATFR*
TFRp*
TFR
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
mean age at birth (left axis)
change in the mean age at birth (rigth axis)
Year
30
29
28
27
26
25
24
0.3
0.2
0.1
0
-0.1
-0.2
1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011

As we see in the upper parts of Figure 1 in the first half of the period between 1970 and 2011, with only a few exceptions, TFR reaches the highest values in each of the three countries. In tendency the TFR is definitely the highest graph between 1970 and 1980, later in 1981 the Hungarian, in 1983 the Czech and in 1986 the Slovak TFR line goes below the graphs of adjusted period fertility rates. Except for one year of one country of the three (the Slovak data in 1990 and even in this case only with a very slight difference) the TFR remains the lowest line. The graphs of PATFR* and TFRp* approach each other over the whole period and in each country.

If we look at the lower part of each graph, we can see that the mothers' mean age at birth (MAB) begins to increase in each country in that our nearby years, when the TFR line falls below the graphs of TFRp* and PATFR* in each country. This coincidence makes a conjecture that the decline of TFR in neither country was exclusively caused by the quantum decrease in the number of new-borns, but postponing having children also belongs to the factors behind the low numbers of TFR. Since Ryder [1956] first dealt with the postponement of having children this topic has become one of the most often analysed facts in the literature (Bongaarts–Feeney [1998], Kohler–Philipov [2001], Kohler–Billari–Ortega [2002], Ortega–Kohler [2002], Sobotka [2004a], Husz [2006], Goldstein–Sobotka–Jasilioniene [2009], Frejka et al. [2011], Sobotka–Lutz [2011], Bongaarts–Sobotka [2012], Myrskylä – Goldstein. – Yenhsin [2013], Berde–Németh [2014]). The crucial role of the mean average age at birth regarding Hungary is shown in Berde-Németh [2014], where the estimated linear regression between the increase of MAB and the ratio of TFR for the first parity in Hungary obtained a very high multiple correlation coefficient, the square of the multiple correlation coefficients was 0,745. A similar strong linear regression is shown for the Czech Republic between 1970 and 2008 in Bongaarts - Sobotka [2012].

If we analyse the connection between the figures for TFRp* and PATFR*, we can see that PATFR* mostly remains higher than TFRp* until the year when TFR is – with a few exceptions, as we mentioned previously - the greatest among the three period fertility indicators. The explanation of this fact can probably be found in the way the PATFR* is constructed. If the PATFR* has a low (high) value for a certain parity, it stays low (high) for the next parity too, because in the fertility table only those women could bear a second child, who have already born the first, and those who have born the second, can have the third and so on. The values of different parities for TFRp* however are much more independent from each other, because TFRp* relates the number of the second children to all women without two children – i.e. with no child, or with one child - in the age group, and so on. Due to this method biases in the same direction are not cumulated.

All the explanations about the different fertility indicators are only important if they help us to get closer to the answer to the next question: how many babies are expected on average from one woman during her whole life? In Graph 1, regarding Czech, Hungarian and Slovak women living in recent years, the answer to this question is: fewer and fewer babies. The relative decrease in the Czech Republic may be slightly smaller than in the two other countries, and it also looks like at the end of the period analysed the least favourable situation is in Hungary. Altogether from 1995, in each of the three countries all the values of the two tempo and parity adjusted indicators are below 2.1, which is regarded as the reproduction (or replacement) limit (Chesnais [2000], Sobotka [2004b]) in modern market economies.

The decrease in the figure for the fertility ratio could be caused by the consequences of the delayed economic crisis (Bongaarts–Sobotka [2012], VID [2012], Goldstein et al. [2013], Berde–Németh [2014]), but if we analyse the mean average years at birth (MAB) data on the lower parts of Graph 1, it is evident that the tendency in the change of the MAB must be among the causes. At the end of the period the increase in the MAB slowed down, probably because women got very close to the end of their fertility period. Basically there was almost nowhere to delay any more their decision to have a baby, if they wished to give life to more than one child. Further research is needed to provide a clear explanation of the situation, but one fact is evident even now: the hopes regarding the change in fertility trends in the three countries are completely mistaken. The slight increase in TFR values in the previous decade due only to the retardation of the postponement effect, which has very little further opportunities, and politicians should continue to be preoccupied by the decrease in the size of their populations.

The adjusted period fertility indicators definitely show much more perfectly the real fertility quantum than the traditional TFR. But how much more perfectly? And which one of the two tempo and parity adjusted total fertility rates performs better? A posteriori we can find out - at least in the case of countries like those we analyse here and where statistical recording of the population has been well-developed for a long time – the value of the completed cohort fertility rate (CFR) (See Human Fertility Database [2014]). However, the question is still not so easy to answer because we must decide what we should compare with what, and the method of evaluating the results also raises some problems. In the next section we suggest a way to answer these questions, and at the same time we compare the CFR ratios of the countries analysed with the values of tempo and parity adjusted period fertility indicators.

Differences between the various fertility rates

After women of a cohort have finished their fertility period, and if the country has accurate fertility records[2], we can calculate the 'real' fertility ratio of the cohort. However this so-called Completed Cohort Fertility (CFR), which shows how many children an average woman gave birth to, does not help policy-makers to introduce the best measures for increasing (or decreasing) the number of children born, because it is too late to intervene. CFR is good for describing what happened in the past, but cannot tell us what must be done now, and also has very little use when we try to model future developments using different scenarios. It can, however, help in describing and evaluating the actual situation indirectly. If we compare CFR with the period fertility indicators, which are calculated upon the cross-sectional data of a given year, we can deduce which period fertility must be used to get closest to the real fertility rate.

In times when the inner structure of the female population – regarding different features of childbearing, such as parity and the age of the mother, also mortality, migration and so on – is not changing significantly, both the TFR and the two parity and tempo adjusted period fertility ratios predict accurately the average total number of children of a mother. But when something in the structural composition changes the correct fertility ratio must be controlled for this change as

[2] The Human Fertility Database [2014] contains suitable Czech and Slovak data from 1935, and the Hungarian figures are from 1937.

TFRp* and PATFR* do. Both of these indicators take into consideration the parity composition of mothers (the order of birth of the child) in the year observed and also make correction for the change in the mean age at birth, i.e. for the tempo effect. The construction of the two adjusted indicators differs (Bongaarts–Feeney [1998] Equation (3) page 278; Kohler és Philipov [2001] Equation (11) page 8), so their values are not equal as we saw in figure 1. Until about the second third of the 1980s, TFRp* and PATFR* are quite close to each other, and in this relatively quiet time large changes are not observed in the mean age at births (MAB), as we see in the lower graphs of Figure 1. However, in the last third of the 1980s in each of the three countries a steep fall began in TFR[3], and also a rise in MAB, and the differences between the values of TFRp* and PATFR* became larger and larger. The difference began to contract from the second half of the 2000s.

To find out which of the two adjusted fertility indicators performs better, we compared CFR with TFRp* and PATFR* first in two time periods, leaving out the beginning years of our researched time, then we did a separate calculation for the left first few years. For the comparison we applied a method similar to that used by Bongaarts–Sobotka [2012], and we also used some methodology written in Caselli–Vallin–Wunsch [2006], and Myrskyla–Goldstein–Yenhsin [2013]. It is not immediately obvious which year of period fertility must be compared with which CFR value. For example, women born in 1955 according to the presently used statistics could already have given birth when they were aged 15 (earlier births are included for this age), and their fertility period ended in 2005, when they became 50 years old (later births are included in the 50-year-old age group). Regarding the total fertility rate we should have used the mean age at birth of this cohort, and compared CFR with the period fertility rates of this year. Considering each order of births, parity fertility ratios must be added up, which could level off, and in such a way conceal some mistakes and the conclusion could be false. It seems to be more appropriate to compare the CFR by parities with the adjusted period fertility indicators. For example, if the cohort born in 1955 in a country give birth on average to their first child at the age of 25 (or at the age of 24.7 or 25.3), i. e. in 1980, then the first parity value of the period indicators calculated for the year 1980 must be compared with the first parity component of CFR.

We did this comparison only for the first, second and third birth orders, the other birth orders represented only a very negligible part of the fertility rates in each of the three countries we analysed (Goldstein–Sobotka–Jasilioniene [2009], Kapitány–Spéder [2012]). It is possible to carry out the comparison until the year for which, the latest CFR exists for the first birth order. For example if we want to calculate the fertility rate in 2003, and if we assume the cohort which obtained their MAB for the first birth in 2003 was born in 1973, then we still must wait until 2023, when this cohort finishes their fertility period, to really learn the MAB and the number for the CFR.

If we wish to take into consideration only the second and third parity CFR, and we estimate that the cohort which obtained their MAB for the second birth in 2003 was born in 1970, we must wait until 2020 to find out the real data. This means 3 years less, than in the original plan. Because in the period when MAB increases due the way the TFRp* and PATFR* are constructed, these two period fertility rates differ very slightly with regard to the first parity, the differences of first parity values of

[3] This late (in comparison with western European countries) and accelerated decrease in TFR happened in many other former communist countries, such as Estonia, Latvia, Lithuania, Poland, Russia, Slovenia and, Ukraine. (Eurostat [2014], Goldstein–Sobotka–Jasilioniene [2009]).

the two period fertility indicators must be smaller than the differences in the case of the second and third parities.

We can shorten the waiting time even more, if we are interested in the births that have taken place by the time the women are aged 40 year. In the previous example in the case of the second birth we must wait only until 2010, to find out the real data. Unfortunately collecting and elaborating data takes time, so for example in the Human Fertility Database [2014] the latest year when observed fertility numbers are given is 2011 for the Czech, 2009 for the Hungarian and for the Slovak data. However, our aim, to compare CRF with TFRp* and PATFR*, is not really prevented by the delay in data collection.

The first period for which we did the comparison was between 1978 and 1987. We regard these years as quite calm ones, when big changes between different period fertility indicators did not occur, and MAB also remained comparatively stable (see Figure 1), neither a significant increase or decrease occurred. There were still slight differences per country in MAB of the same parities, and so we used only slightly different cohorts in each country.[4] The value of the period fertility indicators in a single year greatly depends on occasional events, and to exclude uncertainty we calculated a 5-year moving average for the TFRp* and PATFR*, which is represented by the (MA) symbol after the indicator. A similar method of excluding random noise was used in Bongaarts and Sobotka [2012]. The result of our comparison is shown in Table 1 by differences between CFR and PATFR*, and by differences between CFR and TFRp*, we also show the graphs of the three indicators compared in Figure2

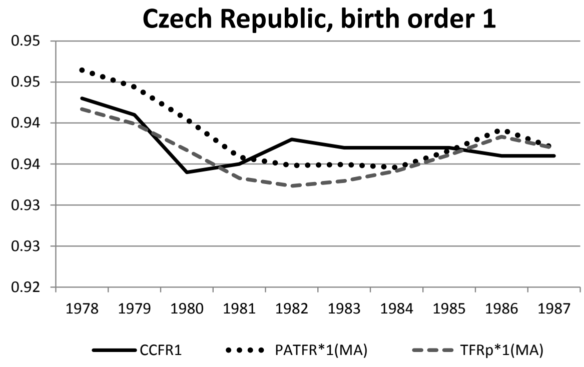
Table 1. Averages of the absolute values of differences between CFR and PATFR* and between CFR and TFRp* for the period 1978-1987 in the Czech Republic, Hungary and Slovakia, for the first three parities

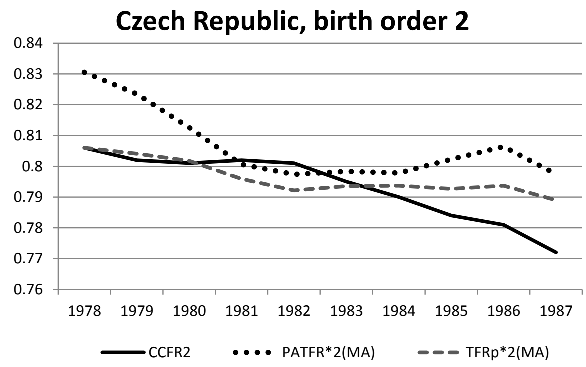
		First Parity	Second Parity	Third Parity
Czech Republic	CFR – PATFR*(MA)	0.002634	0.014209	0.011643
	CFR – TFRp*(MA)	0.002354	0.006138	0.005925
Hungary	CFR – PATFR*(MA)	0.005154	0.013206	0.010781
	CFR – TFRp*(MA)	0.004379	0.007687	0.010775
Slovak Republic	CFR – PATFR*(MA)	0.004837	0.017752	0.005480
	CFR – TFRp*(MA)	0.003879	0.010610	0.006977
Averages of per country differences	CFR – PATFR*(MA)	0.004208	0.015056	0.009301
	CFR – TFRp*(MA)	0.003537	0.008145	0.007892

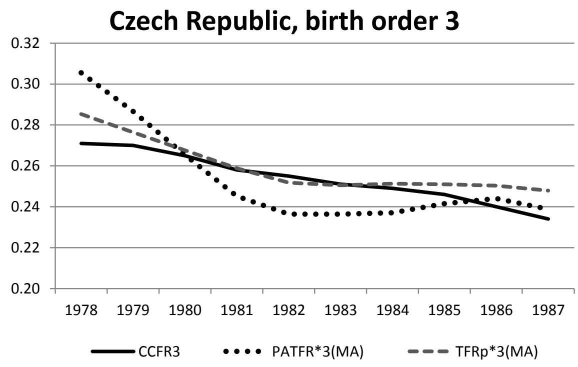
The basic data are as written in footnote 1, the period fertility indicators are our own calculations.

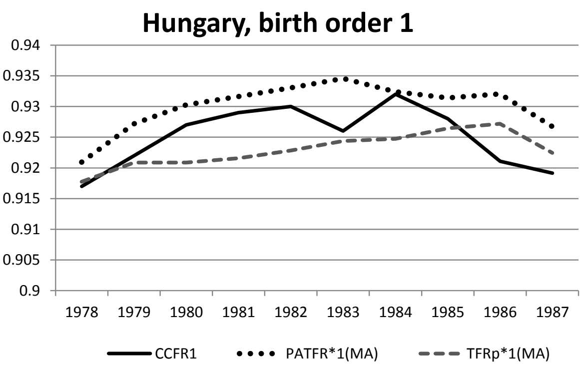
Figure2. The values of PATFR*, TFRP* and CFR by parity between 1978-87 in the three countries

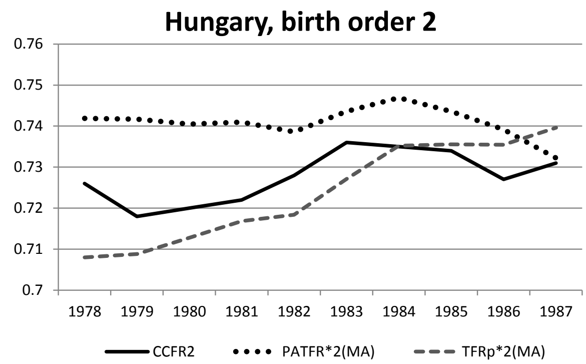
[4] For the first parity in the Czech Republic we used the cohorts for the years between 1956 and 1965, and in Hungary and the Slovak Republic between the years 1955 and 1964. Regarding the second parity in Hungary we used years 1952-1961, and in the Czech Republic and in the Slovak Republic the period between 1953-1962. The years for the third parity regarding Czech and Slovak data were 1950-1959, and regarding Hungary 1949-1958.

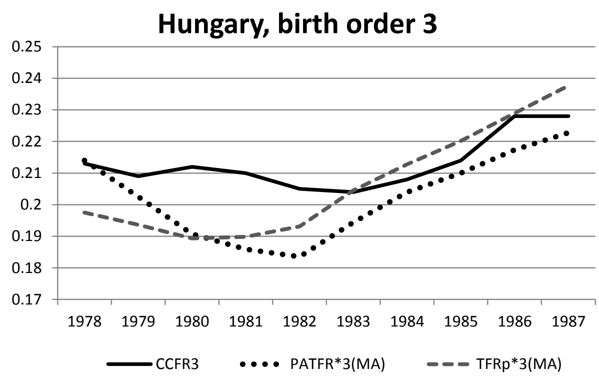

Czech Republic, birth order 1
0.95
0.95
0.94
0.94
0.93
0.93
0.92
1978 1979 1980 1981 1982 1983 1984 1985 1986 1987
CCFR1
PATFR*1(MA)
TFRp*1(MA)

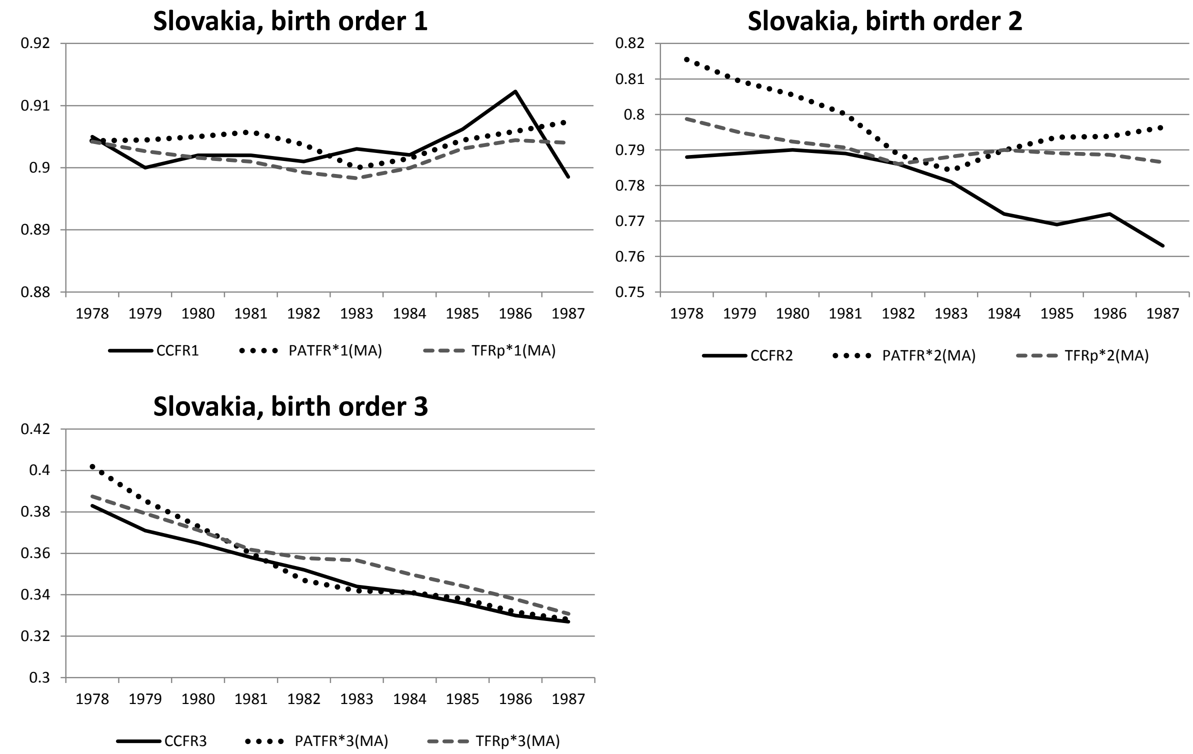

Czech Republic, birth order 2
0.84
0.83
0.82
0.81
0.8
0.79
0.78
0.77
0.76
1978 1979 1980 1981 1982 1983 1984 1985 1986 1987
CCFR2
PATFR*2(MA)
TFRp*2(MA)


Czech Republic, birth order 3
0.32
0.30
0.28
0.26
0.24
0.22
0.20
1978 1979 1980 1981 1982 1983 1984 1985 1986 1987
CCFR3
PATFR*3(MA)
TFRp*3(MA)


Hungary, birth order 1
0.94
0.935
0.93
0.925
0.92
0.915
0.91
0.905
0.9
1978 1979 1980 1981 1982 1983 1984 1985 1986 1987
CCFR1
PATFR*1(MA)
TFRp*1(MA)


Hungary, birth order 2
0.76
0.75
0.74
0.73
0.72
0.71
0.7
1978 1979 1980 1981 1982 1983 1984 1985 1986 1987
CCFR2
PATFR*2(MA)
TFRp*2(MA)


Hungary, birth order 3
0.25
0.24
0.23
0.22
0.21
0.2
0.19
0.18
0.17
1978 1979 1980 1981 1982 1983 1984 1985 1986 1987
CCFR3
PATFR*3(MA)
TFRp*3(MA)



Source: as written in footnote 1. The period fertility indicators are our own calculations.

Table 1 shows less differences between CFR and TFRp* than between CFR and PATFR* in each country and regarding each parity. This means that in 'peaceful' times, where there are not big changes in the fertility trends, as in the period 1978-87 in our three countries, the Boongarts – Feeney tempo and parity adjusted period fertility rate performed better than the Kohler – Ortega indicator. It is worthy of note that differences in the case of the 2nd and 3rd parities are greater than the differences of the first parities. Because in TFRp* and PATFR* the values of the parity indicators are added together, the total period fertility indicators are very sensitive to the components of the second and third parities. From Table 1 we can see that the Coler-Ortega PATFR is much more unreliable than the Boongarts – Feeney TFRp*. We think that this great sensitivity is due to the way the PATFR* is constructed, because fertility tables inherit biases of the lower parity to the higher parities. Calculating the next parity the TFRp* begins the process again, so previous errors could not be passed on.

The accuracy of period fertility indicators is much crucial in periods when the fertility trend and the structure of the female population – for example when postponement becomes longer - are changing, than in stable periods. Such a period occurred in the history of the three countries from 1993-97. The forces for change increased between 1988 and 1992, but they did not reach the level of the years 1993-97. The transition continued after 1997 too, however CFR values do not exist for this late period yet. For the years from 1993-97 there are no CFR ratios for the first parity yet, nor for the whole fertility period of the women in the case of the second and third parity. We could have used CFR for the second and third parity taking into consideration the latest available year - as Boongarts – Sobotka [2012] did - , and substitute the missing years' data with the proper part of TFR. Instead we used CFR until the 40th year of women, and calculated PATFR* and TFRp* also until the 40th year of women. We use the notation after the symbol of the indicator '40', to signal that only data are taken into consideration that include 40-year-old and younger women. In some cases, it was impossible to find a cohort the MAB of which belonged to the year needed between 1993-1997. This also happened in the case of the second and the third parity and was caused by the rapid structural changes of the period. In these times we took the average CFR40 of the two adjacent cohorts, the MAB of which was just before and after the relevant year.

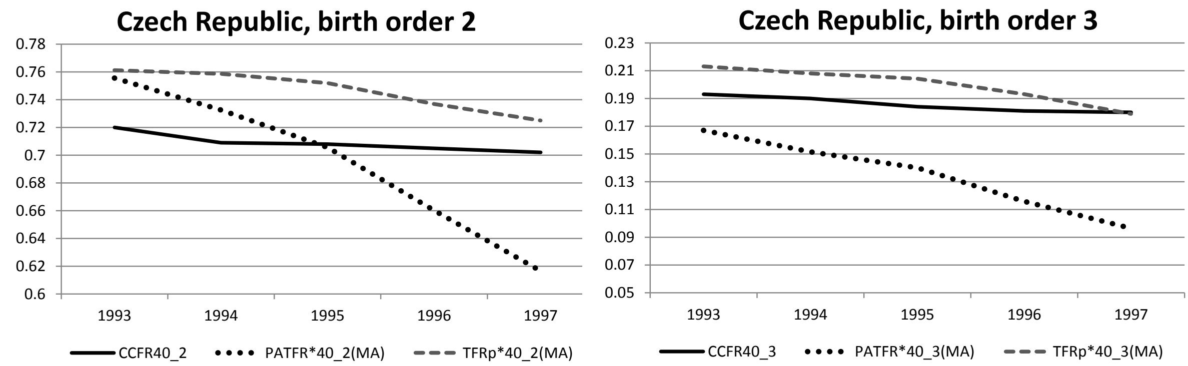
The result of our comparison is shown in Table 2 by the differences between CFR40 and PATFR*40, and by differences between CFR40 and TFRp*40. The trends of the three indicators are represented in Figure3.

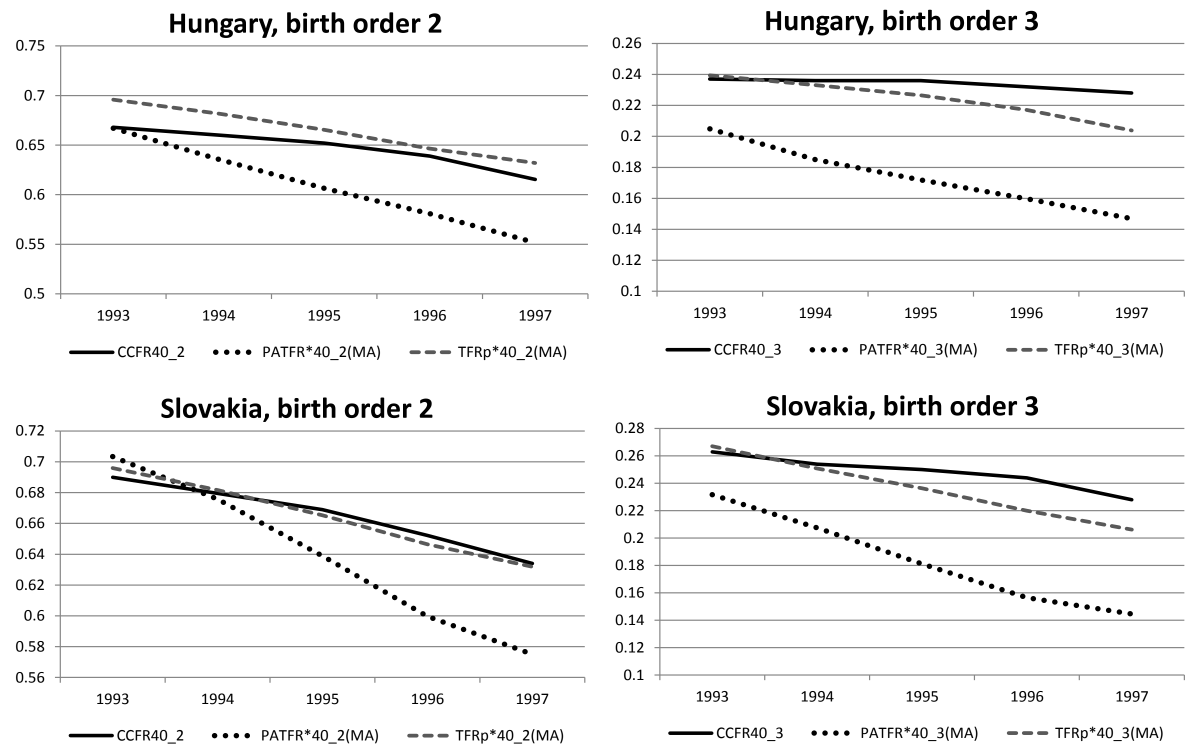
Table 2. Averages of absolute values of differences between CFR40 and PATFR*40 and between CFR40 and TFRp*40 in the period 1993-1997 in the Czech Republic, Hungary and Slovakia, by the second and third parities

		Second Parity	Third Parity
Czech Republic	CFR40 – PATFR*40(MA)	0.038392	0.051421
	CFR40 – TFRp*40(MA)	0.037999	0.014328
Hungary	CFR40 – PATFR*40(MA)	0.038559	0.060083
	CFR40 – TFRp*40(MA)	0.017378	0.006381
Slovak Republic	CFR40 – PATFR*40(MA)	0.031766	0.063525
	CFR40 – TFRp*40(MA)	0.003918	0.016633
Averages of per country differences	CFR40 – PATFR*40(MA)	0.036239	0.058343
	CFR40 – TFRp*40(MA)	0.019765	0.012447

The basic data are as written in footnote 1, the period fertility indicators are our own calculations.

Figure 3. Graphs of CFR40, PATFR*40, and TFRp*40 by parity in the years 1993-97 in the three countries.



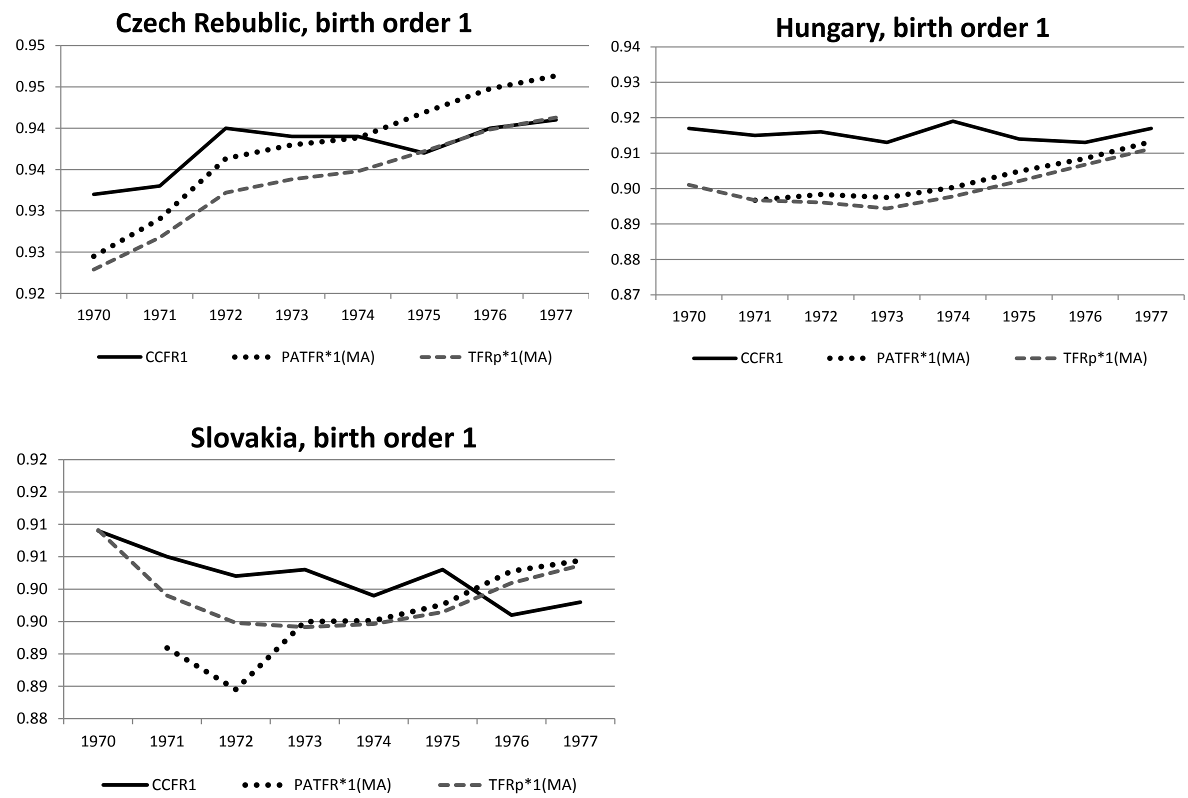


Source: as written in footnote 1.

It can be seen from Table 2 and Figure 3, that TFRP*40 in each country is closer to CFR40, than PATFR*(40) in the case of both the second and third parity. The average of the differences of CFR40-TFRp*40 is about 55 % of the differences of CFR40-PATFR*40 regarding the second parity, and it is about only 20 % in the case of the third parity. It is evident that altogether TFRp* performs better than PATFR* in the Table 2 too, not only in Table 1. However, differences in Table 2 are greater than in Table 1, which is due to the fact that during the time when the structure of the female population changes even TFRp* cannot calculate the exact fertility rate. Further research is needed to discover what corrections should be made to improve the accuracy of the fertility indicators.

To demonstrate that TFRp* doesn`t provide the best estimate in every situation we are going to look at the period between 1970 and 1977. We calculated the CFR for this period employing the same method we had used previously, and received a contradictory result. The results can be seen in Figure 4.

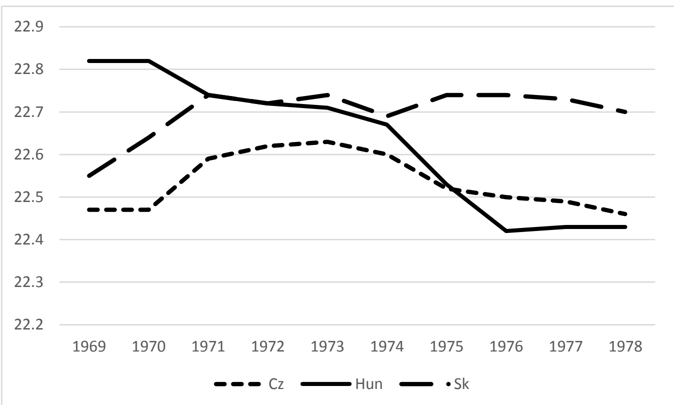
Figure 4. CFR, PATFR* and TFRp* for the first parity in the Czech Republic, Hungary and Slovakia in the period between 1970 and 1977.



Source: as written in footnote 1.

In the period between 1970 and 1977 both in the Czech Republic and Hungary PATFR* performed better for the first parity than TFRp*, but in Slovakia TFRp* is still the best. If we look at the MAB for the birth order 1 using figure 5, then we can find the explanation.

Figure 5. The MAB values for the first parity in the three countries between 1969 and 1978



Source: as written in footnote 1.

Between 1970 and 1977 in Hungary the mean age for the birth order 1 fell continuously, in the Czech Republic it both rose and fell, while in Slovakia it increased and then remained almost constant. The MAB changes have a crucial role in the correction factor for both of the corrected period fertility rates. As a general rule, if the MAB increases, then the correction raises the original fertility number, and a falling MAB also lowers the fertility ratio. However the correction in the case of PATFR* depends on the age of mothers, and also on the standard deviation of the childbearing age, but in the case of TFRp* the correction factor is the same for all ages. When MAB rises the correction factor helps to reveal the real fertility rate of the younger generations, and does not have a strong effect on the older generation, where fertility numbers are low. However when MAB falls the value of the TFRp* for the younger generation is distorted due to the correction, which is either negligible, or could even raise the value of the indicator in the case of PATFR*. We think that during the time when MAB increases, TFRp* always performs better, but in times of decreasing mean average ages the PATFR* is the best, at least regarding the first parity. Table 3 below shows however, that these conclusions could be disputed in the cases of higher birth orders. In spite of the fact that MAB values for the second and third births show very similar tendencies as the MAB in the same country for the first birth, TFRp* performs better in each of the three countries for the second and third parities.

Table 3. Averages of the absolute values of differences between CFR and PATFR* and between CFR and TFRp* for the period 1970-1977 in the Czech Republic, Hungary and Slovakia, for the first three parities

		First Parity	Second Parity	Third Parity
Czech Republic	CFR – PATFR*(MA)	0.003918	0.020410	0.054809
	CFR – TFRp*(MA)	0.004147	0.012946	0.022726
Hungary	CFR – PATFR*(MA)	0.012500	0.029060	0.049782
	CFR – TFRp*(MA)	0.014559	0.018155	0.017444
Slovak Republic	CFR – PATFR*(MA)	0.008869	0.018897	0.024957
	CFR – TFRp*(MA)	0.006231	0.007261	0.01509
Averages of per country differences	CFR – PATFR*(MA)	0.008429	0.022789	0.043183
	CFR – TFRp*(MA)	0.008312	0.012787	0.018420

The basic data are as written in footnote 1, the period fertility indicators are our own calculations.

As our results show, there is no straightforward rule to tell us which of the two period indicators performs better in all circumstances. In Table 4 below, we summarize the strengths, weaknesses, opportunities and the threats of the two tempo and parity adjusted period fertility indicators, borrowing this generally used tool from economics.

Table 4. The SWOT analysis of the two tempo and parity adjusted fertility indicators

TFRp*			
Strengths	Weaknesses	Opportunities	Threats
During birth postponement periods it produces the real quantum of births.	It could give false values when MAB decreases.	Introducing into the correction factor the age of the mother could improve the performance of this indicator.	A correct quantum number cannot be expected if postponement of birth behaviour is reversed.
PATFR*			
In addition to MAB correction it depends on the age of the mother and the standard deviation of childbearing age too.	The mistake in calculation of a rate regarding a certain parity is passed on to the next parities	Could be used instead of TFRp* when MAB continuously decreases.	The fertility table brings too much rigidity into calculations.

In spite of the fact that Table 3 shows that using these two indicators involves a number of drawbacks, we still recommend calculating them instead of TFR when large changes in the structure of the female population have occurred. During child postponement we suggest using TFRp*, and in the very rare cases when MAB continuously decreases, we recommend further investigation before choosing the method of calculating period fertility rates.

Conclusions

In our paper we have analysed the fertility trends in three adjacent Central-European countries, in the Czech Republic, Hungary and Slovakia between 1970 and 2011. These three countries have a very similar history, and it is not surprising that many similarities have been found regarding the number of children women have and their age at childbirth. The general tendency in each country was the continuous decrease of fertility ratios, with a few, short, exceptional periods, and an even steeper decrease at the very end of the time interval examined.

Looking at only the traditional Total Fertility Rate (TFR) some policy-makers mistakenly recognized a reverse or recovery in the fertility trend of the three countries in the 2000s. However, taking into consideration the adjusted fertility ratios, we found that the quantum factor of birth further decreased. Contrary to some Western European countries, there is no sign of climbing out of the fertility hole. Still the picture is not as tragic as might be thought using only TFR ratios. The postponement of birth from the beginning of the third third of the 1980s has accelerated and resulted in the 'lowest low' (Kohler – Billari – Ortega [2002], Sobotka [2004b]) TFR, but the Bongaarts – Feeney Tempo and Parity Adjusted Fertility Rates (TFRp*) and the Kohler - Ortega Tempo and Parity Adjusted Fertility Rates (PATFR*) show that if we consider the whole fertility period of women they still intend to give birth to more children than the TFR forecasts. However, the steep fall at the end of the period analysed really gives cause for concern, even if changes in 2-3 years cannot be regarded as significant statistically.

In addition to comparing and evaluating the Czech, Hungarian and Slovak fertility behaviour in the recent past we also aimed to judge the performance of the different adjusted fertility ratios. Both the TFRp* and PATFR* take into consideration the distribution of the female population upon parity of their child in the year of observation, and also controls for the expected timing of child births, i.e. uses tempo correction. When women have finished their fertility period and we can use the observed, so-called Completed Cohort Fertility (CFR), it helps us to find out which corrected period fertility indicator performs better. In spite of the fact that CFR could be used only after a cohort has finished all of its fertility events, it still proves to be an effective tool to evaluate the accuracy of fertility rates for a past date. We explained in detail how CFR could be compared with TFRp* and PATFR*.

The tempo correction of PATFR* is more sophisticated and avoids the undervaluation of the fertility rate in times when Mean Age at Birth decreases. However, this advantage of the PATFR* indicator is counterbalanced by the frequent errors due to the way that this ratio is constructed. When calculating PATFR* we use the fertility table for women, where a mistake in the ratio regarding a certain parity is passed on by all the higher level parities, and altogether it could lead to a false result. Calculation of TFRp* avoids this problem, the count of the different parity ratios is independent from each other, and in most of the cases TFRp* performs better than PATFR*. So we suggest that TFRp* should be used mostly, with the exception of times when MAB permanently decreases, which case needs further consideration. We also intend to continue our research in this direction, to find a more sophisticated method of correction in the case of TFRp*, to be able to compound the advantages of each indicator and to avoid the pitfalls of both methods.

Appendix 1

The Kohler – Ortega Tempo and Parity Adjusted Total Fertility Rates (PATFR*), and the Bongaarts – Feeney Tempo and Parity Adjusted Total Fertility Rates (TFRp*) in Czech Republic, Hungary and Slovakia between 1970 and 2011

Year	PATFR*			TFRp*		
	Czech Republic	Hungary	Slovakia	Czech Republic	Hungary	Slovakia
1970	2.046	1.839	2.474	2.026	1.860	2.574
1971	2.068	1.813	2.427	2.013	1.844	2.518
1972	2.041	1.846	2.393	2.001	1.867	2.475
1973	2.259	2.038	2.435	2.120	1.893	2.494
1974	2.363	2.454	2.485	2.167	2.069	2.474
1975	2.305	2.232	2.559	2.154	2.066	2.441
1976	2.279	2.085	2.505	2.158	1.996	2.447
1977	2.234	2.041	2.353	2.144	1.961	2.381
1978	2.243	1.922	2.350	2.151	1.890	2.330
1979	2.142	1.935	2.305	2.126	1.892	2.284
1980	2.079	1.952	2.290	2.086	1.914	2.268
1981	2.053	1.960	2.249	2.074	1.952	2.281
1982	1.986	1.933	2.181	2.054	1.929	2.236
1983	2.001	1.898	2.206	2.049	1.910	2.237
1984	2.049	1.911	2.152	2.053	1.919	2.220
1985	2.084	2.085	2.218	2.080	2.040	2.242
1986	2.057	2.096	2.255	2.080	2.069	2.224
1987	2.044	1.983	2.185	2.047	2.004	2.195
1988	2.050	1.954	2.158	2.061	1.983	2.191
1989	1.963	1.911	2.114	2.014	1.988	2.142
1990	1.967	1.978	2.044	2.001	2.034	2.143
1991	1.945	2.037	2.052	1.967	2.037	2.117
1992	1.900	1.924	2.101	1.932	1.988	2.125
1993	2.013	1.903	2.068	2.013	1.996	2.137
1994	1.980	1.910	1.861	2.029	1.986	2.044
1995	1.814	1.838	1.703	2.001	1.972	1.926
1996	1.719	1.670	1.703	1.915	1.891	1.927
1997	1.666	1.632	1.675	1.870	1.844	1.973
1998	1.533	1.664	1.600	1.828	1.855	1.909
1999	1.517	1.585	1.655	1.819	1.837	1.879
2000	1.599	1.656	1.518	1.869	1.880	1.806
2001	1.581	1.663	1.430	1.831	1.868	1.690
2002	1.532	1.645	1.571	1.776	1.800	1.722
2003	1.610	1.630	1.530	1.774	1.804	1.714
2004	1.683	1.664	1.617	1.801	1.808	1.725
2005	1.723	1.591	1.645	1.807	1.740	1.739
2006	1.752	1.607	1.667	1.782	1.747	1.715
2007	1.788	1.494	1.666	1.842	1.661	1.709
2008	1.760	1.498	1.656	1.815	1.658	1.704

2009	1.663	1.650	1.822	1.739	1.718	1.702
2010	1.684	1.470	1.989	1.767	1.620	1.734
2011	1.682	1.243	1.461	1.673	1.461	1.626

Source: as written in footnote 1.

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