

ESTIMATING TEMPO EFFECT AND ADJUSTED TFR

The conventionally reported indicator of the level of fertility in a given calendar year (the period Total Fertility Rate or TFR) reflects the interplay of two components: *tempo* (timing) and *quantum* (level) of fertility. The tempo component affects the TFR when the timing of childbearing over the life cycle changes. In Europe most countries are currently experiencing a postponement of births, which is also reflected in an increasing mean age of childbearing, especially at first birth. For instance, the mean age of first-time mothers in Sweden has risen from 24.2 years in 1974 to 28.6 years in 2004. The shift towards later childbearing results in a decline in the number of births during this period and therefore depresses the period TFR, even if the number of children that women have over their life course does not change. One can also think of this tempo effect in terms of an expansion of the interval between generations during which fewer births fall into each calendar year.

In order to come up with a measure of the level (quantum) of fertility in a given calendar year that is free from this tempo effect and is a better indicator for the average number of children per woman than the observed period TFR, the concept of “tempo-adjusted TFR” has been developed. A first adjustment method was proposed by Bongaarts and Feeney (1998) and, subsequently, several other methods have been suggested as well (e.g., Kohler and Ortega, 2002). The adjusted TFR as listed in this data sheet is calculated on the basis of the Bongaarts-Feeney (1998) formula which uses fertility data specified by age of mother and birth order of child. The adjusted TFR (*adjTFR*) in a year t for birth order i is computed as follows:

$$(1) \quad adjTFR_i(t) = TFR_i(t) / (1 - r_i(t))$$

where $r_i(t)$ is the change in the mean age at childbearing of birth order i between the beginning and the end of year t , which is estimated as follows (see Bongaarts and Feeney (2000: 563, fn. 1)):

$$(2) \quad r_i(t) = [MAC_i(t+1) - MAC_i(t-1)] / 2$$

where $MAC_i(t)$ is the mean age of the childbearing schedule of order i , calculated from age-specific fertility rates. The overall tempo-adjusted total fertility rate for all birth orders is computed as the sum of the adjusted order-specific total fertility rates.

To reduce instability in the estimated adjusted TFR, the datasheet gives the mean of the adjusted TFR for the three-year period 2001-2003 whenever available. The adjustment was performed for birth orders 1, 2, and 3, whereas the conventional TFR was used for birth orders 4+. Since only a small fraction of the overall total fertility is due to births of birth order 4 and higher (about 5 percent of the overall TFR in a typical European country), this procedure did not entail any significant underestimation of the tempo effect. For countries for which no such data is available the adjusted TFR is estimated on the basis of a regression relating the observed change in the mean age of childbearing to the size of the tempo effect, which is further described below.

Data used for Computing Adjusted TFR

Data on age-specific fertility by age of mother and ‘true’ (biological) birth order of child used for computing the adjusted TFR with the Bongaarts-Feeney formula were collected from Eurostat (2006) New Cronos database as well as country-specific data sources and estimates (Statistics Austria 2006 for Austria, Smallwood 2002 for England and Wales, NIPSSR 2003 for Japan, Vishnevskiy 2006 for Russia, and NCHS 2006 for the United States). The data pertain to the period 2001-2003 for Austria, Bulgaria, Cyprus, Czech Republic, Denmark, Finland, Greece, Hungary, Iceland, Latvia, Lithuania, Macedonia, the Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, and Sweden. For some countries, different periods were used due to limited availability of the most recent data: Estonia and Spain (2000-2002), Ireland (1999-2001), Japan (2000), Serbia and Montenegro (2001-2002), United Kingdom (1998-2000, data pertain to England and Wales only), and the United States (1999).

For countries where detailed order-specific data on births were not available, the estimates of the tempo effect were derived from data on the conventional TFR and the mean age at childbearing (MAC) in the period 2000-2002, using regression equation described in the next section (Albania, Armenia, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Croatia, France, Georgia, Germany, Italy, Luxembourg, Malta, Moldova, Switzerland, Turkey, and Ukraine). Different time periods were used for several countries with limited data availability: Albania (1996-1998), Armenia (1997-1999), Belgium (1994-1996), Bosnia and Herzegovina (1987-1989), Germany (1998-2000), Italy (1999), Malta, and Switzerland (1999-2001).

Using Regressions for the Estimation of the Tempo Effect

The application of the Bongaarts-Feeney (BF) formula requires the TFR and the mean age at childbearing (MAC) to be specified by birth order. These data are not available for quite a few countries in Europe (see above). The TFR and the MAC, however, are available for all births. The BF formula cannot be applied with these data because the MAC for all births is a weighted average of the order-specific MAC_i , where the weights are TFR_i/TFR (i denotes birth order). When fertility falls, the number of higher-order births usually drops faster than the number of lower-order births. Hence the shift in higher-order TFR_i can have a disproportionately high impact on the value of MAC. The order-specific fertility rates may even change in such a way that the MAC decreases in time when its order-specific components (MAC_i) stay unchanged or even increase.

However, we can still make use of MAC to infer approximate values for the tempo effect, given that certain assumptions are valid. We assume that fertility quantum is low, say below 2.0, and therefore the impact of the fall in higher-order fertility is low as well; that it does not change considerably during the period under consideration; that all MAC_i change in a uniform way; and that these changes are small, say an increase of not more than 0.1 per year. The assumptions can be considered as valid in countries with low fertility.

Under these assumptions, the tempo effect can be estimated from the BF formula as follows:

$$(3) \quad tempo = TFR'(t) - TFR(t) = \frac{\Delta MAC(t)}{1 - \Delta MAC(t)} TFR(t)$$

Here TFR and MAC refer to all births.

Formula (1) provides an approximate estimate of the level of tempo effect caused by a unit increase in MAC. Suppose the change in MAC during the year t was 0.1, and the observed $TFR(t)$ was 1.7. Then the tempo component of the TFR is approximately equal to 0.19. It can also be seen that larger changes in MAC provoke a greater increase in the tempo effect.

Formula (3) gives biased results for large changes in the mean age. The same is true for the BF formula and in these cases it should not be applied.

Formula (3) suggests that there exists a simple relationship between MAC on the one hand and the tempo effect on the other. Let us assume that for small changes in MAC the relationship is linear. Then, for small changes in MAC, the following regression equation can be considered:

$$(4) \quad \text{tempo}(t) = a + b.\Delta\text{MAC}(t) + \varepsilon$$

The dependent variable, tempo, is estimated for the year t using the original BF formula, and $\Delta\text{MAC}(t) = (\text{MAC}(t+1) - \text{MAC}(t-1))/2$. When there is no change in the MAC, the tempo effect is equal to zero. Therefore the intercept should be equal to zero.

We apply the regression using data for the following European countries and years:

- **Central-Western Europe (CWE):** Austria (1986-2000), Netherlands (1980-2000), West Germany (1986-1994)
- **Central-Eastern Europe (CEE):** Czech Republic (1980-2000), Hungary (1981-1999), Poland (1990-2000), Slovak Republic (1980-2000)
- **Northern Europe:** Denmark (1989, 1993-1995), Finland (1983-2000), Norway (1992-2000), Sweden (1980-2000)
- **Southern Europe:** Greece (1993-1998), Italy (1980-1996), Portugal (1990-2000), Spain (1981-1999).

Figure 1 gives the tempo effects observed during the 1990s, plotted to the corresponding changes in MAC in all these countries. The regressions were done without the exclusion of the intercept: it was left to the data to show whether it would be statistically different from zero. The slope for the CWE countries was found to be 1.9; the intercept is 0.003 with a p-value=0.76, i.e., statistically not different from zero. In the CEE region the slope is equal to 1.7, in Northern Europe 1.8, and in Southern Europe 1.5. The coefficient of correlation is around 0.8- 0.9, though it was considerably lower for the Southern European region. In Southern Europe the coefficient of determination was 0.46, and the F-test supported a statistical significance of the model for 34 observations. In each group of countries the intercept was found statistically indifferent from zero. The regressions were run with no constant, and in this case the slope coefficients were only slightly higher than those reported above. A regression for all European countries gives a slope of 1.76.

Conclusion: when the data for a specific country do not fit the application of the BF formula we use the mean age at childbearing for all birth orders to infer the tempo effect as follows:

- (1) estimate $\Delta\text{MAC}(t) = (\text{MAC}(t+1) - \text{MAC}(t-1))/2$ for the year t ;
 - (2) multiply $\Delta\text{MAC}(t)$ by the coefficient k to get the tempo effect for the year t ,
- where k is:

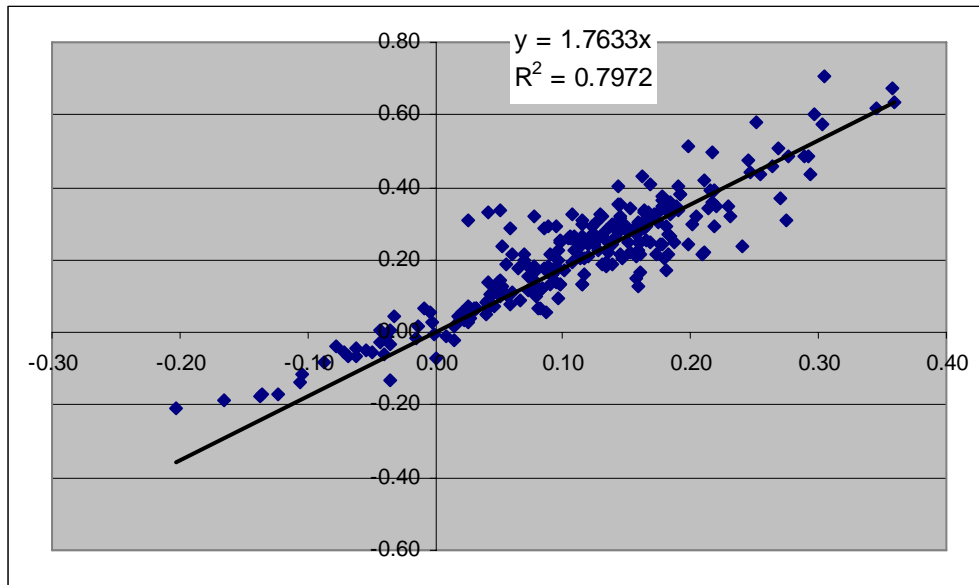
- 1.9 for countries situated in Central-Western Europe
- 1.8 for countries in Northern Europe
- 1.7 for countries in Central-Eastern Europe
- 1.5 for countries in Southern Europe

The value for k for some countries:

Albania and Turkey 1.5, as in Southern Europe

Bosnia and Herzegovina and Croatia 1.9, as in Central Europe.

Figure 1: Tempo effects observed in the European countries listed in the five regions above, plotted to the corresponding changes in the mean age at childbearing



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