

# Birth Replacement Ratios in Europe: 1960-2000

Provisional Abstract for the EAPS European Population Conference, Liverpool 2006

Conference Theme: Fertility

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## Short Abstract

European reproduction trends are traced using a new period replacement indicator: the Birth Replacement Ratio (BRR). The BRR is a replacement ratio that compares the period number of births to the mean size of the mothers' generation at birth. In contrast with the Net Reproduction Ratio, differences between the Total Fertility Rate (TFR) and the BRR are not due to period mortality. They reflect cohort mortality, cohort out-migration and mothers' immigration. The application to a number of European countries between 1960 and 2000 shows interesting contrasts between the TFR and the BRR which trace the demographic history of the respective countries

## Extended Abstract

### Motivation

Standard demographic textbooks indicate that the Total Fertility Rate is a measure of period fertility, whereas the Net Reproduction Ratio, which takes into account the mortality of the potential mothers within a synthetic cohort, is a measure of reproduction. There are several limitations to the NRR as a measure of reproduction:

- (a) The synthetic cohort nature of the calculations makes more difficult its interpretation. In general there is an insistence in it being an index of potential trends, but there is no clear meaning to that,
- (b) In a low mortality setting, the difference between the NRR and the TFR (or rather the female sex ratio at birth times the TFR) becomes less important, and the TFR is generally used as a replacement indicator,

- (c) The NRR does not take into account migration. This is particularly undesirable in a context like the European, where the small rates of natural growth have often made migration the main component of population growth.

Remedies to some of these limitations have been proposed. For instance, Calot and Sardon (2001) propose replacement indicators that tackle migration within a synthetic cohort framework. The problem is again the difficult interpretation of the indicator, and its partial irrelevance, since they are best seen as conditional measures for alternative migration scenarios.

## Methods

Our proposal, the birth replacement ratio, tackles both limitations simultaneously while providing a natural generalization of the TFR to the study of replacement. It is well known that the TFR can be interpreted as the ratio of the number of births,  $B$ , to the mean size of the mother's generation,  $G$ , where  $G$  can be seen as a weighted average of the female population using fertility rates as weights (Calot, 1994)

:

$$G_t = B_t / TFR_t = \sum [ F_x(t) / TFR(t) ] \cdot E_x(t)$$

where  $x$  refers to age,  $t$  to period, and  $E_x$  to female population exposure.

Our proposal is to estimate a related mean size of the mothers' generation at birth,  $BG$ , given by:

$$BG_t = \sum [ F_x(t) / TFR(t) ] \cdot B^f(t-x)$$

where  $B^f(t-x)$  is the number of female births in period  $t-x$ . The BRR is therefore defined as:

$$BRR_t = B_t / BG_t$$

In contrast to the NRR, the BRR differs from the TFR due to all the components of population change, not merely mortality. In particular, mortality leads to  $G$  being lower than  $BG$  in a closed population. Out-migration also leads to a reduction of  $G$ , while immigration leads to increasing  $G$  and, therefore, increasing BRR.

Also in contrast to the NRR, it is a period indicator of replacement that tells us about the recent demographic history of the country, not about any potential growth in the future. It is not a synthetic cohort measure. This makes it easier to interpret.

The BRR can also be seen as an improvement over the TFR as a measure of period replacement (Calot, 2001). Whereas in the TFR the elements of comparison are different (births in the denominator and number of mothers in the numerator), the BRR compares births to births.

Given that the TFR is currently the most widely used measure of period fertility, we define the BRR using all births. A Net Birth Replacement Ratio (NBRR) can be defined by multiplying the NBRR and the female sex ratio at birth<sup>1</sup>.

The BRR can also be decomposed in its fertility, mortality, out-migration and immigration components. In particular, in a closed population  $G$  would be given by:

$$G_{\text{Mort}} = \sum 0.5 \cdot [L_x(t-x) + L_{x+1}(t-x)] \cdot B^f(t-x)$$

where  $L_x(t)$  refers to the number of years lived at age  $x$  in the female cohort life table for women born in year  $t$ . By comparing  $G_{\text{Mort}}$  and  $G$  we can net out the effect of mortality on the BRR from those of net migration.

## Data

We estimate the BRR for a number of European populations between years 1960 and 2000, providing also a decomposition of the effects of mortality and migration. We use the following data sources:

**Fertility rate by ages** (age reached during the year) and **Total Fertility Rate**.

Database: Population and Social Condition (EUROSTAT). International Statistics Yearbook (ISY), 2004.

**Births by year and female cohort life tables.** The Human Mortality Database (HMD). University of California, Berkeley (USA), and Max Planck Institute for Demographic Research (Germany). Available at [www.mortality.org](http://www.mortality.org) or [www.humanmortality.de](http://www.humanmortality.de).

## Results

In figure 1 we show the trends in the TFR and the BRR in eleven European countries. Only in some countries where net migration has not been very intense the relationship between TFR and BRR is similar to that between GRR and NRR: the BRR is slightly lower due to mortality, with differences becoming less important over time. In countries that have experienced important migration flows, difference between the TFR and the BRR can be large. Spain and Italy in the 1960s are examples where the large out-migration to other European countries meant that the replacement of generations was much lower than that indicated by the TFR. Note, for instance, how Italy's generations were below replacement almost all over the period due to large emigration. In contrast, in receiving countries the number of births provide a larger replacement ratio than that indicated by the TFR. The case of Switzerland is particularly appealing: birth replacement was consistently higher than the TFR due to a constant net immigration of potential mother's. The BRR was even higher than three during the 1960s. Countries where migration flows have changed the sign over the period provide an interesting contrast. In many of those countries there is a crossover of the BRR and the TFR as immigration becomes more important. We see instances of this in many countries, like Sweden, France, the Netherlands or Denmark. It is also interesting to note that Spain or Italy, recipients of recent large migration flows, are experiencing such a crossover just around the year 2000.

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<sup>1</sup> We will not pursue that comparison here. We refer to a companion paper, Ortega (2006), where it is shown that the NBRR and the NRR are approximately the same in a closed stable population.

## Further work

We expect to conclude further work:

- (a) Estimation of  $G_{\text{Mort}}$  and the  $\text{TFR}_{\text{mort}}$ , TFR which would be observed with mortality only.
- (b) Decomposition, for some countries at least, of the contribution to the BRR of fertility of the immigrant population, immigrant stocks and outmigration of the native population.

## References

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Figure 1: BRR and TFR in eleven European countries

