Measuring the quantum of fertility during a long-term shift from early to late childbearing: Australia 1946–2007

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Introduction

When very low levels of cross-sectional fertility are sustained for a long period of time, the age structure of the population is likely to undergo changes that are not in the long term interests of the country concerned. Specifically, sustained low fertility can lead to sharp falls in labour supply at the same time as a country is experiencing rapid growth in the number of its aged persons. In this context, interpretation of the meaning of trends in cross-sectional fertility becomes an important focus of attention. Policy makers want to know if the very low cross-sectional fertility rates are going to continue into the future or whether there is a prospect of change. They want demographers to be able to answer this question.

So what are the influences on future fertility that demographers need to consider. Future fertility will be influenced by future social and economic 'shocks' that are difficult to predict. For example, it is commonly observed that cross-sectional fertility falls during economic downturns but the timing of these downturns is difficult to predict. This is also the case with other forms of cross-sectional shock such as war, family policy changes or the emergence of new contraceptive technology. Fertility may also change slowly overtime as the composition of the population changes (by education, by religion, by ethnicity, by workforce participation). These compositional changes are generally able to be projected relatively well, at least in the short-term, but, aside from changes in age structure, compositional changes are rarely used in projecting the future number of births. Future fertility will also be affected by changes in the nature of social institutions that impinge upon childbearing. Finally, of course, fertility changes because of changes in the attitudes and values of those of childbearing age.

Aside from unpredictable cross-sectional shocks, the other changes mentioned in the previous paragraph tend to be gradual or incremental and, as such, their direction is potentially indicated by recent trends in fertility. Thus, it has been conventional to project future cross-sectional fertility on the basis of recent trends perhaps supplemented by the 'opinions of experts' as to whether current trends are likely to change. This is what most government statistical agencies do when making projections of fertility.

The measures or indices conventionally used by statistical agencies to describe time trends in fertility are the Period Total Fertility Rate (PTFR) and its component age-specific fertility rates. The PTFR is a one-step improvement on the Crude Birth Rate in that it standardizes for the impact of age upon births and, using its component age-specific fertility rates, enables the future age distribution of the population to be taken into consideration in projecting births.

However, as demographers have often observed, the time trend in PTFR is also affected by changes in the timing of births by successive birth cohorts. If successive birth cohorts decide to have their children at younger ages than previous cohorts, the PTFR will tend to rise as births are 'brought forward in time'. The opposite occurs if successive cohorts delay their births to older ages. This is referred to as a 'tempo' effect. Understanding tempo effects is very relevant to the task of estimating the number of births in future years. Maire Ni Bhrolchain (2008) has a recent comprehensive working paper on the topic of the tempo effect. She argues that parameterized tempo-adjusted Total Fertility Rates that have been developed in recent years (Bongaarts and Feeney 1998, Kohler and Ortega 2002, Zeng and Land 2002, Rodriguez 2006) provide little assistance in assessing the trend of fertility or in estimating the future number of births. Instead, she argues, the investigator should examine the available data in much more detail. The work that we have been doing on Australian fertility trends over the past few years is consistent with Ni Bhrolchain's position (McDonald and Kippen 2007, 2008a, 2008b; Kippen and McDonald 2009).

We argue that fertility trends should be examined using three characteristics simultaneously: the age of the woman, her parity and the time interval since her previous birth (for similar views, see Murphy and Berrington 1993, Rallu and Toulemon 1994, Sobotka 2003, Rios-Neto and Miranda-Ribeiro 2007, Ni Bhrolchain 2008). In reality, age alone is a relatively weak predictor of whether or not a woman will give birth in a given year and, accordingly, projections of births that rely only on age-specific birth rates have performed badly across history. We have argued that more precise measurement of period fertility and projection of future births should involve simultaneous controls for the age of the woman, her parity and the length of time since her last birth. We have found, at least for Australia, that the probabilities of giving birth for women aged x with y existing children (where y>0) who had a previous birth z years ago have been very stable over a long period of time. The advantage that this relative stability implies for the projection of births should be utilized. Furthermore, as argued also by Ni Bhrolchain (2008), the composition of the population according to these three characteristics (applied simultaneously) also affects the number of future births and hence should be incorporated in the projection method.

Summarising tempo and quantum effects

In examining detailed trends in fertility, we have shown that it is important to work with data by single years of age, single parity and single year of duration since the previous birth. This implies a matrix of some 1500 cells of birth probabilities for each year. Comparing the trend in the individual cells of a matrix with 1500 cells over a period of 25 years is a mammoth task and carries the considerable danger that the wood will not be seen for the trees. Some form of summary approach is required. In this paper, we apply a standardization procedure to achieve this aim.

Our results show that the post-war history of fertility in Australia can be divided into two periods: 1946–1972 and 1973–2007. In the first period (26 years), changes in the timing of fertility contributed to a higher PTFR. Across the whole of this period, 61%

of the higher fertility (relative to 1946) was due to earlier childbearing while the remainder, 39%, was due to increases in the quantum of childbearing. In the second period (34 years), changes in the timing of fertility contributed to a lower PTFR. In this period, 33% of the lower fertility (relative to 1973) was due to due to later childbearing and 67% to a lower quantum. We also conclude that the second period has now ended in that the tempo effect on the 2007 PTFR has fallen to zero.

The nature of the tempo of fertility

We begin the description of the method with a definition of the tempo of fertility. Tempo is inherently a cohort concept. If a birth cohort at the end of their childbearing years has a particular parity distribution, the tempo of that fertility is defined by the ages at which the cohort had each birth or, expressed differently, the ages at which they had their first births and the time intervals between their subsequent births.

We argue, therefore, that 'tempo' for a birth cohort that has completed its child bearing is fully captured by the combination of:

1. the age distribution of the first births of the cohort
2. the duration distribution from the first to the second birth specific for each age at first birth
3. the duration distribution from the second to the third birth specific for each age at second birth
4. and so on until all parities of the cohort have been considered.

If these data were available for birth cohorts over a very long period of time, we could examine the changes in the distributions and conclusions could be drawn about changes in the tempo of fertility for successive cohorts. Unfortunately, for Australia, this comparative information is only available in incomplete form. However, as we have complete data in this form for some Australian birth cohorts, this provides an opportunity to apply a standardization procedure. We have adopted the experience of the 1965 birth cohort as our preferred standard pattern of fertility tempo.

Figures 1–4 display age-parity-duration-specific birth probabilities for the 1965 birth cohort.

Standardisation of the tempo of fertility

We have data available on the completed and incomplete parity distributions of birth cohorts in Australia from 1906 onwards. If we assume that the known tempo history of the 1965 birth cohort applied to all other cohorts up to the completion of their childbearing or to their age in 2006, we can estimate the ages and years in which the births of all other cohorts would have occurred if these cohorts had experienced the tempo of fertility of the 1965 birth cohort. We can then obtain estimates of PTFR for each calendar year that are based on the assumption that there was no change in tempo from that of the 1965 birth cohort. If this TSPTFR (tempo standardized PTFR) is then compared with the actual PTFR for any given year, the difference necessarily is a consequence of differences in tempo between the 1965 birth cohort and other cohorts. This shows us then how changes in tempo (relative to the tempo of the 1965 birth cohorts) affected PTFR in Australia across time. Effectively, this standardization procedure redistributes the births of all birth cohorts to calendar years that are consistent with the 1965 birth cohort's pattern of timing. The procedure is set out in detail in the following steps:

Step 1
Obtain completed or incomplete cohort fertility by parity for birth cohorts from 1906 to 1990.

Step 2
Adopt the tempo behaviour of some cohort as a standard. We use the Australian birth cohort of 1965.

The standard pattern has several components:

- Age-specific first-birth probabilities (denominator is women age x, parity 0)
- Age-duration-specific second-birth probabilities (denominator is women age x, parity 1, time z since first birth)
- Age-duration-specific third-birth probabilities (denominator is women age x, parity 2, time z since second birth)
- Ditto for as many intervals as we have.

Step 3
Age-duration-specific probabilities for each birth order are adjusted proportionately up or down to give the required number of first, second, third etc births for each cohort. This has the advantage of automatically shifting later or earlier j+1 births given shifts in the level of j births. This procedure locates each cohort's first births in a particular calendar year that is consistent with the standard rather than with the actual calendar year of their first birth.

Step 4
The outcome at this point is a new distribution of the calendar years of all birth rates of all cohorts that has been standardized to the timing pattern of the births of the 1965 birth cohort. These rates can be added across the calendar year to get the TSPTFR and compared with the PTFR. The difference between the PTFR and the TSPTFR shows the effect of tempo on the PTFR. The long term trend in TSPTFR shows the cross-sectional trend in fertility with tempo effects removed. We assert that time trend of TSPTFR provides a reliable measure of the time trend in the quantum of fertility. Across a period of time, the change in PTFR can then be divided into tempo and quantum effects.

Step 5
Given the method of calculation, it is theoretically possible to sub-divide the calculated tempo effect into components related to each parity or to each age. Figures 5 and 6 show the differences in period age specific fertility rates between the PTFR and the TSPTFR.

Simplified approaches

The method described so far requires a very considerable amount of calculation. In this section, we consider whether simpler approaches may yield sufficiently robust results. The first simpler approach is to scale the matrix of rates by age, parity and duration for the 1965 standard up or down according to the ratio of the mean completed fertility of the given cohort to the mean completed fertility of the 1965 standard. This then provides the estimated distribution across calendar years for the given cohort if the 1965 timing had applied. In other words, the method is the same except that the input here is the mean children ever born of cohorts rather than their full parity distributions.

The second approach simply applies the age at birth distribution of the 1965 standard to the mean completed fertility of the other cohorts. This is a method that would be easy to apply in a wide range of countries. The three tempo-standardised PTFR measures are compared in Figure 7.

The broad conclusion is that all three standardised measures are relatively close together suggesting that the last and simplest method may be adequate if detailed data are not available. This also means that most of the adjustment is driven by the ages at which births occur given the quantum of cohort fertility (mean parity). Duration seems to play little part and this is probably because, as observed above, the duration distributions to the next birth given age and parity of the previous birth have remained remarkably stable in Australia. The same result might not have been achieved before and after the impact of the Swedish 'speed bonus' when durations changed sharply (Neyer and Andersson 2007).

During the shift to later childbearing (1975 onwards), the most detailed measure was noticeably lower (by about 0.1 of a birth) than the other two measures which were in turn quite similar to each other. This means that in this period, the parity distribution of the cohorts made a difference compared to the other two methods that use only mean parity as the cohort input. We suspect without doing the calculations that this reflects the higher proportions that first births represented of total births during this period. In turn, the timing of first births is the major driver of tempo changes. The three measures appear to be coming together once again in the most recent years. This is probably due to a slowing down in the increase in age at first birth, or the ending of the tempo effect.

The impact of different standards

We have also examined the extent to which results are determined by the choice of standard. Figure 8 shows results for the simplest method based on applying the age at birth distributions of the 1910, 1930 and 1965 birth cohorts. The 1910 and 1965 cohorts had relatively late child bearing while the 1930 cohort had relatively early childbearing. Use of the early childbearing standard (1930) places standardized births a little earlier in time but it is clear given the extreme differences between these standards that the choice of the standard makes very little difference to the result. Thus, the results are robust to changes in the standard distribution.

Comparisons with other summary measures

In Figure 9, we compare the trend in the detailed TSPTFR with the trend in completed cohort fertility located in time using the mean age of fertility of the cohort. Not unexpectedly, the completed cohort fertility trend is not as smooth as the TSPTFR trend but the two trends are quite similar. The TSPTFR is smoother because it averages across successive cohorts. Individual birth year cohorts for idiosyncratic reasons may have higher or lower fertility than other cohorts around them. The averaging that is inherent in the TSPTFR may thus provide a better indicator of the direction of longer term trends than does the completed cohort fertility trend. Again, towards the end of the period of study, the two curves are coming together presumably indicating a slowing in the change in the quantum of fertility.

Finally, we add in a cross-sectional measure of fertility that we have defined in one of our earlier papers and named the Intrinsic Total Fertility Rate (McDonald and Kippen 2007). Where the conventional PTFR controls only for the ages of women, the ITFR controls simultaneously for age, parity and duration since the previous birth. Because it controls for more characteristics, it is a better measure of cross-sectional fertility than the PTFR, however, it is still affected to some extent by tempo effects, especially (at least in the recent Australian case) by changes in the timing of the first birth. The ITFR has been higher than the PTFR for the years from 1990 to 2004. In the early 1990s, its trend was also somewhat different to that of the PTFR, falling more sharply. However, in the past decade, the two measures have tracked each other closely with only a relatively small difference between the two. This is suggestive of an emerging stability of quantum and the disappearance of the impact of tempo changes. Indeed, this conclusion can be extended to all of the measures that we have used. They all seem to be heading to the same point, about 1.9 in 2007. All measures are shown in Figure 10.

Conclusion

It is beneficial to be writing this paper at the end of what appears to be a very long-term transition to older age childbearing and to a lower quantum of fertility. When the PTFR and the TSPTFR were a long way apart from each other (the late 1970s), we could have predicted that this gap must eventually disappear in some way – as it apparently will by 2007. But, in 1980, how well could we have predicted at what level of fertility the two lines would eventually converge? The answer must be, not very well as both were trending downwards at that point. However, by 1990, with the two lines having moved much closer together and the fall in both measures having begun to slow, the end point was becoming more evident – but we still would have placed it lower than it eventually was – at about 1.8 births per woman rather than at 1.9. Nevertheless, a projected end point of 1.8 would have been a better result than projections based only on the PTFR which would have had fertility falling to around 1.6 births per woman.

The rise in PTFR in 2006 and 2007 (and 2008 with TFR being around 1.97) is sharper than expected if we had expected a gentle and gradual coming together of PTFR and TSPTFR. Does this mean that yet another tempo effect (to earlier childbearing) might be commencing? We think that this is quite likely to be the case but the global financial crisis may slow the trend for the time being. To project cross-sectional fertility in the future, we would have to incorporate future tempo effects into the trend. This is a much more difficult task than the one that we have undertaken in this paper: removing tempo effects after the fact. Nevertheless, the analysis suggests that in projecting future cross-sectional fertility, it would be wise to consider the effects of potential changes in the tempo of fertility. This is more easily done by disaggregating fertility into its three major demographic components: age, parity and duration since previous birth. Tempo, we would argue, is dominated by changes in the timing of the first birth.

As a final point, it is notable, as has been often observed, that tempo effects can extend over a very long period of time. The 1946-1972 period that we use here does not show the full duration of the early childbearing tempo effect because in our commencement year, 1946, the PTFR was already well above the TSPTFR. Thus, the two tempo effects that we consider in this paper both lasted for at least 35 years. However, if the shifts first to earlier childbearing and then to later childbearing had been less extreme, the duration of their tempo effects would have been shorter. Predicting the duration of a tempo effect (effectively the end point of a cohort trend in age at first birth) makes long-term projection of births a very difficult task indeed.

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Figure 1. Age-specific first-birth probabilities ([first births from age x to x+1]/[women age x of parity 0]), 1965 birth cohort

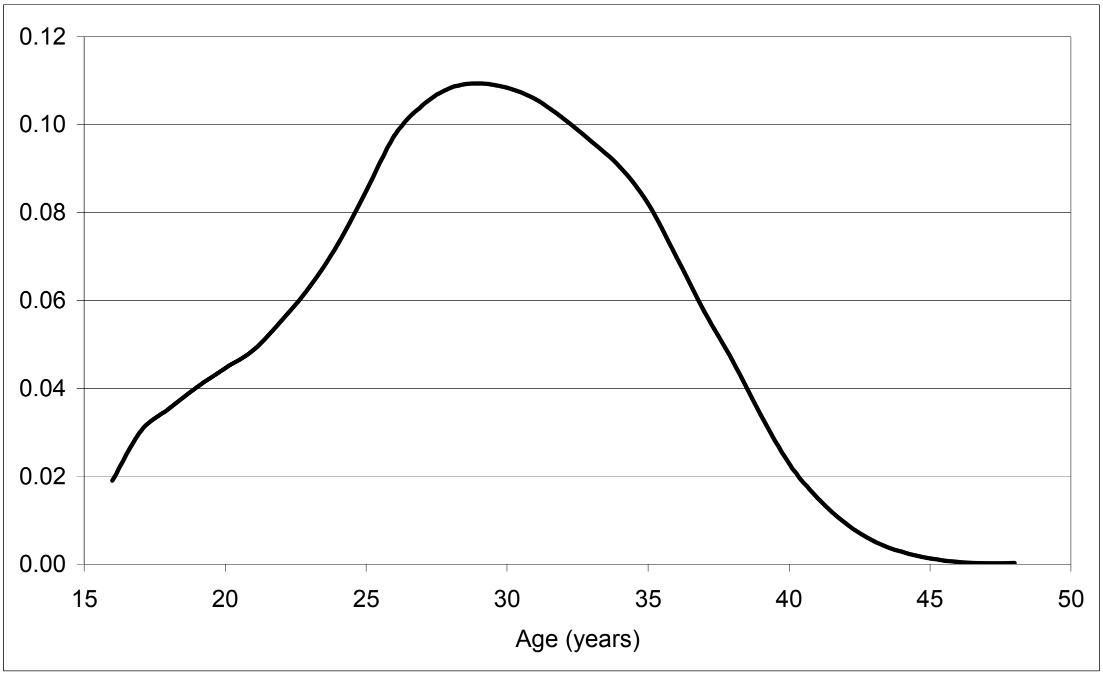

Figure 2. Age-specific second-birth probabilities by time since first birth ([second births from age x to x+1 and time z since first birth]/[women age x of parity 1 and time z], 1965 birth cohort

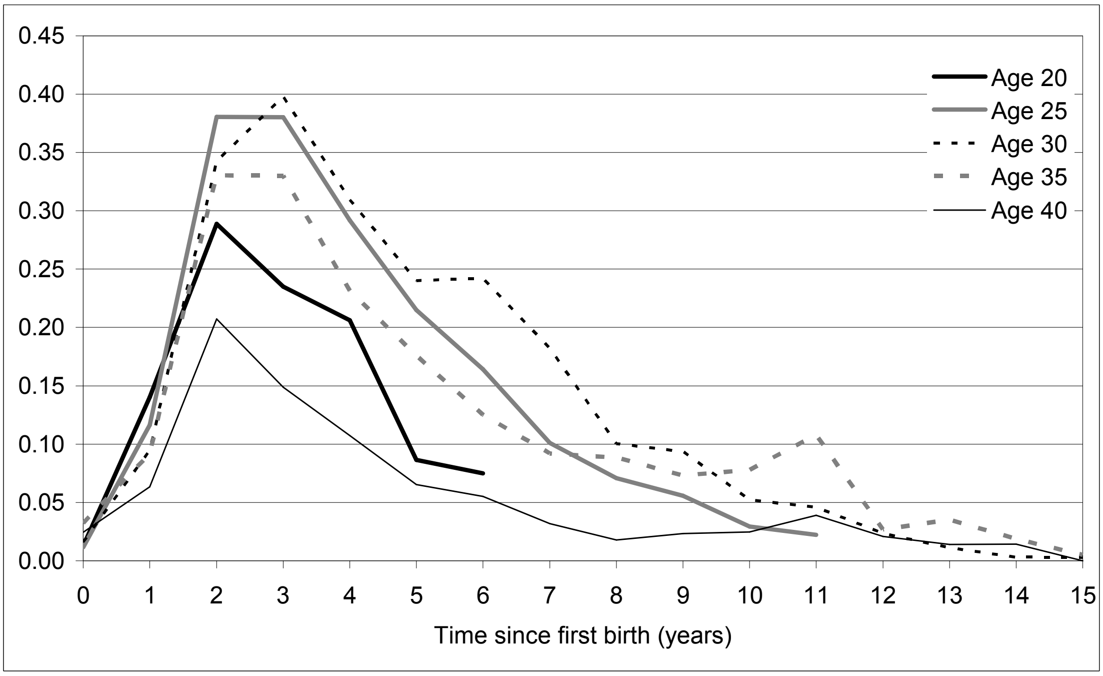

Figure 3. Age-specific third-birth probabilities by time since second birth ([third births from age x to x+1 and time z since second birth]/[women age x of parity 2 and time z], 1965 birth cohort

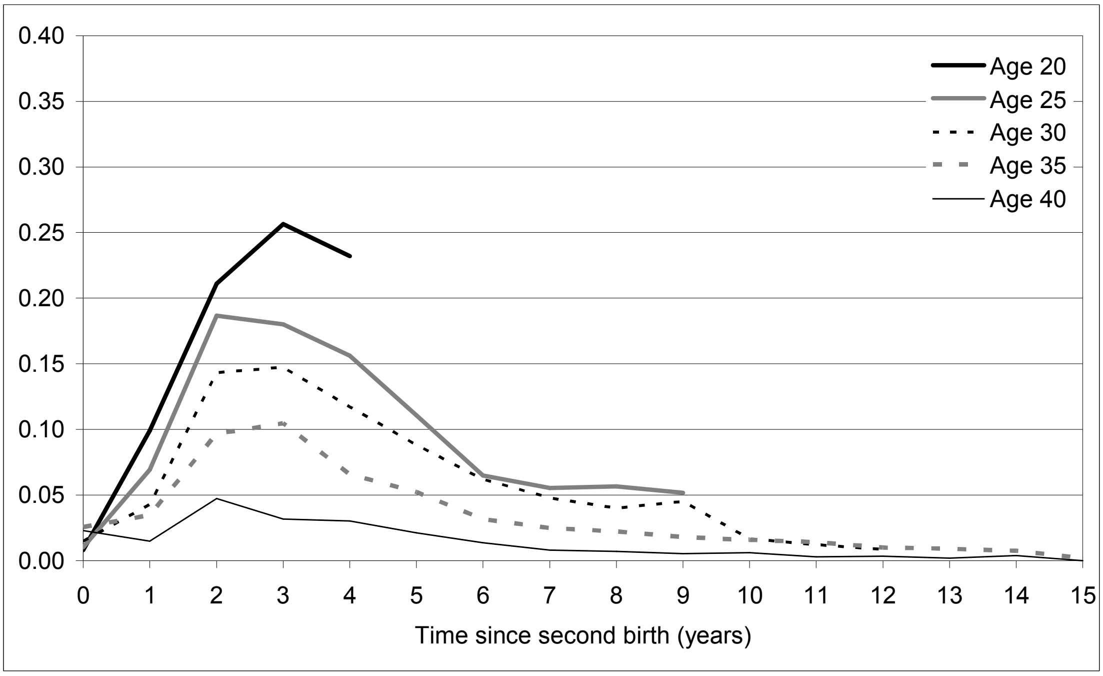

Figure 4. Age-specific fourth-birth probabilities by time since third birth ([fourth births from age x to x+1 and time z since third birth]/[women age x of parity 3 and time z], 1965 birth cohort

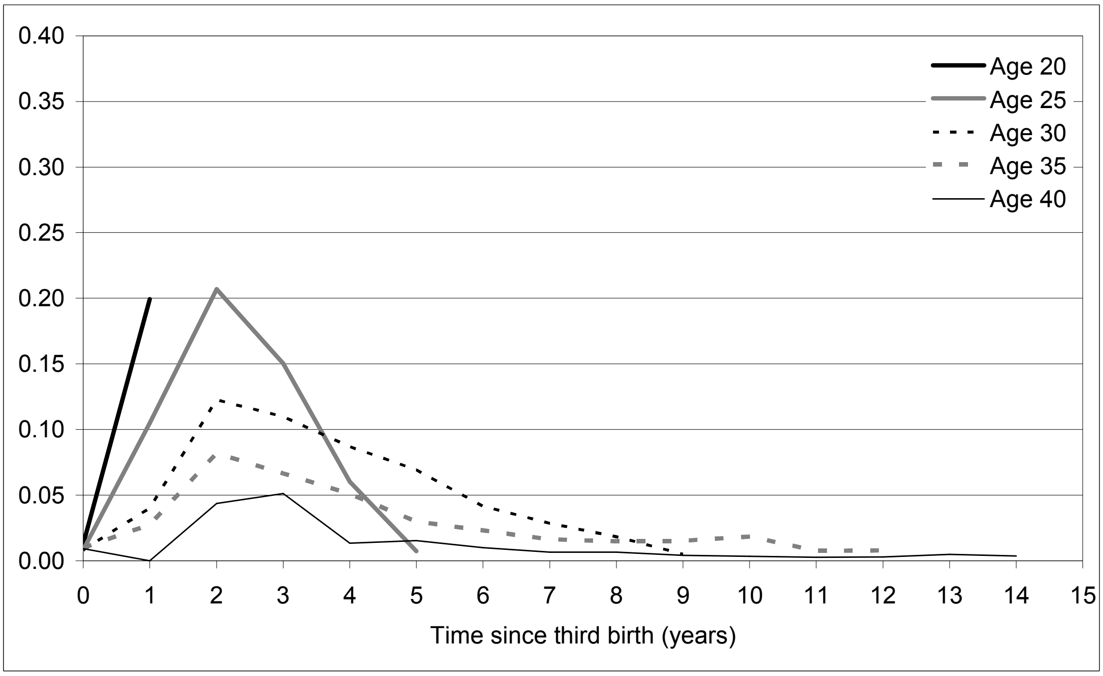

Figure 5. Period Total Fertility Rate (PTFR) by age, 1946–2007

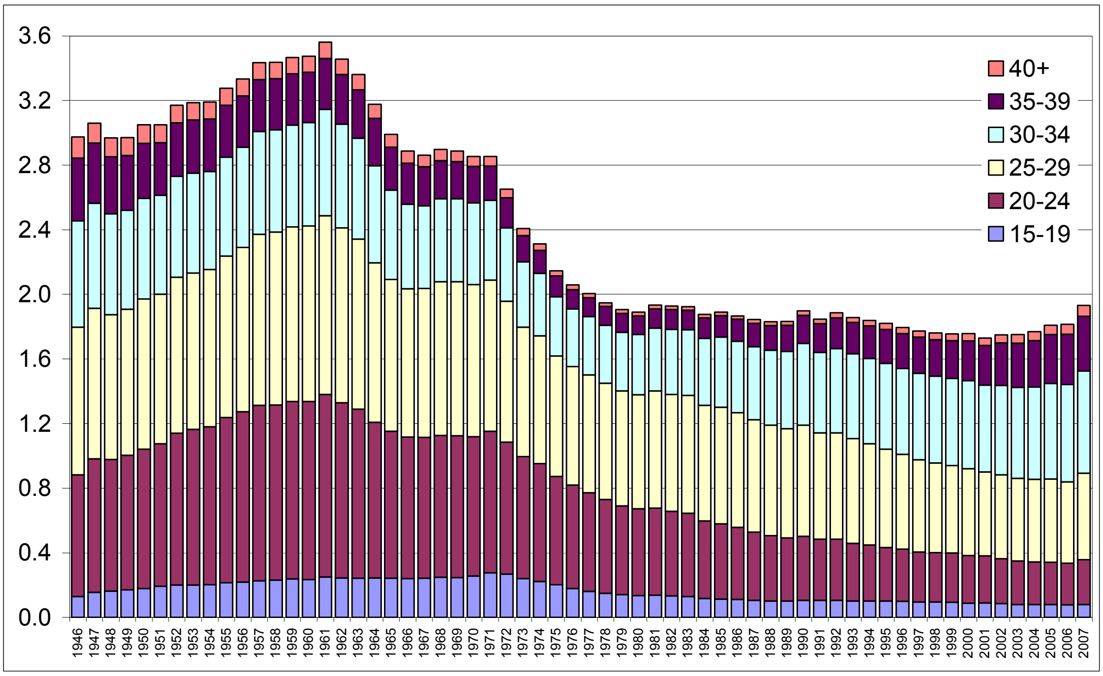

Figure 6. Tempo Standardized Period Total Fertility Rate (TSPTFR) by age, 1946–2000

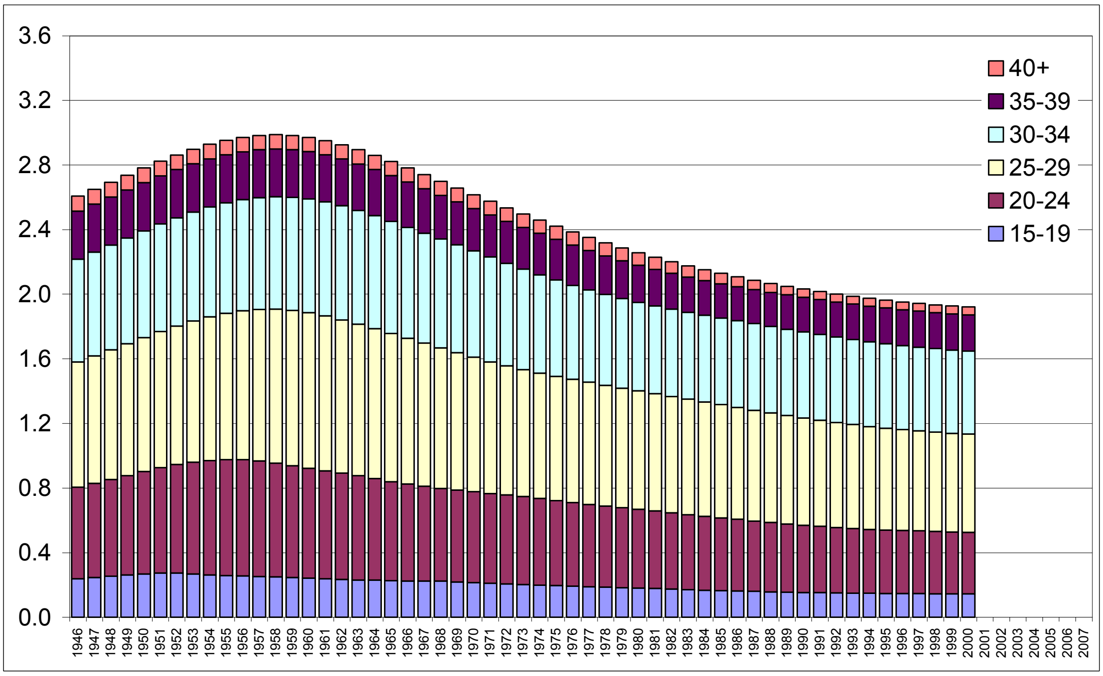

Figure 7. Period Total Fertility Rate (PTFR), 1946–2007, and three Tempo Standardized Period Total Fertility Rates (TSPTFR), 1946–2000

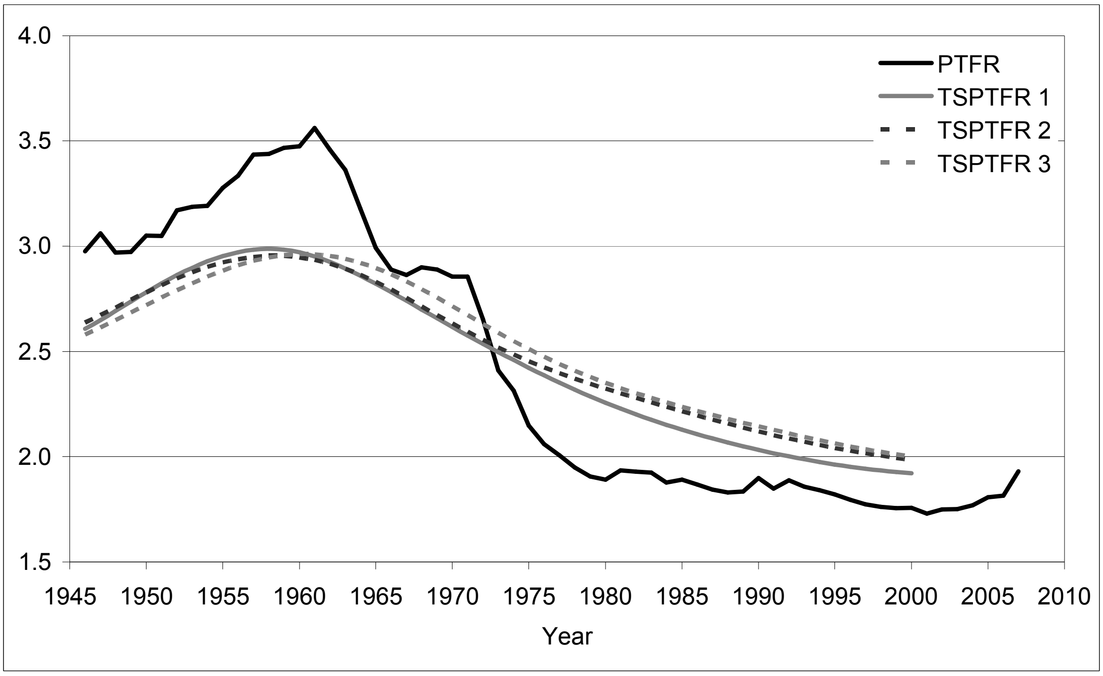

Figure 8. Tempo standardized Period Total Fertility Rates, using the age-at-birth distributions of the 1910, 1930 and 1965 birth cohorts as the standard, 1946–2000

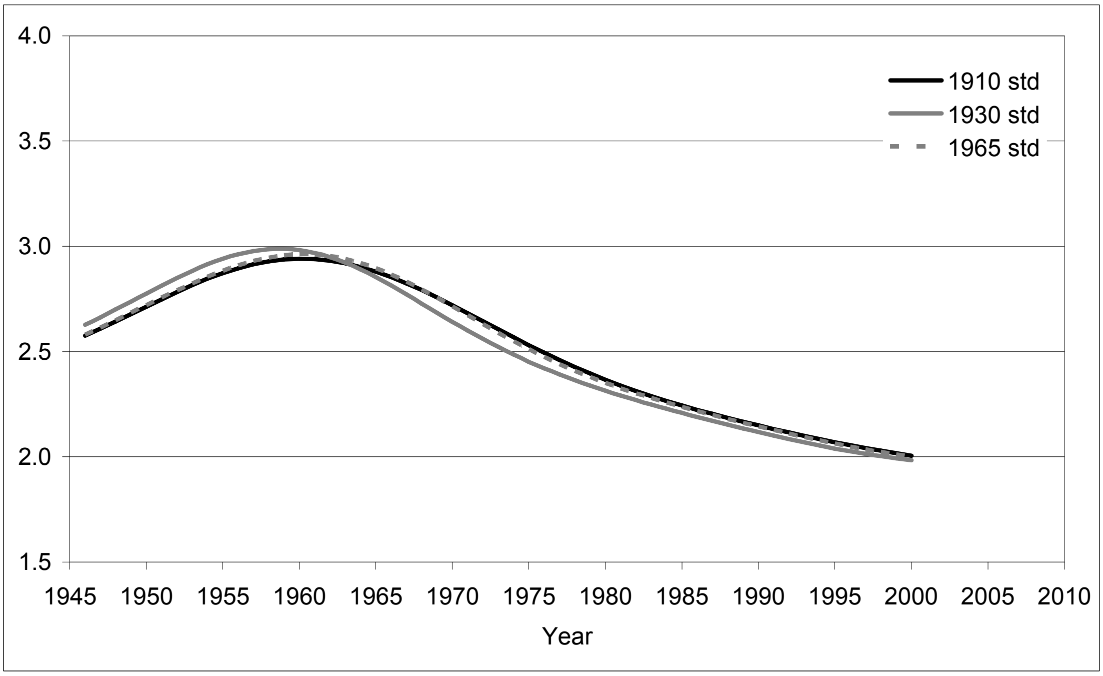

Figure 9. Period Total Fertility Rate (PTFR), 1946–2007, Tempo Standardized Period Total Fertility Rate (TSPTFR 1), 1946–2000, and Completed Cohort Fertility Rate (CCFR) by year of birth + mean age of fertility, 1946–2007

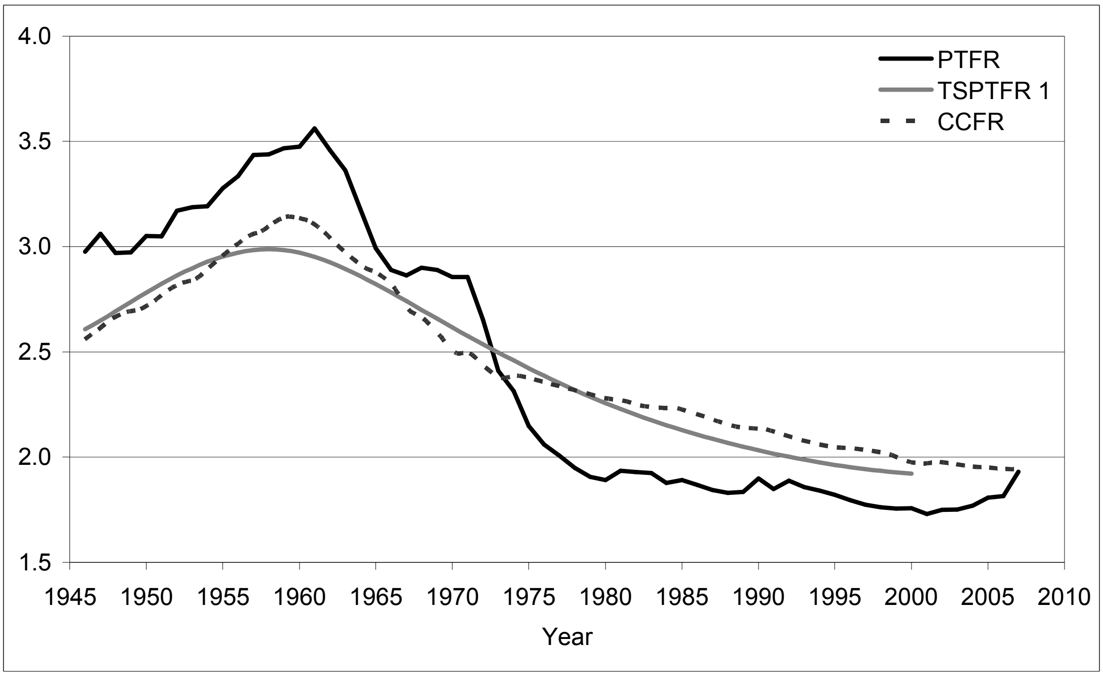

Figure 10. All previous measures, and Intrinsic Total Fertility Rate (ITFR), 1990–2004