Forecasting Births Using a Three-Parameter Model

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Forecasting births

- In most advanced countries over the past 50 years, statistical agencies have performed poorly in forecasting the future number of births.

- In the short–term (10 years or so), this is due primarily to poor methodology, not to unforeseen social change.

- In the longer term, accurate forecasting is impossible. How can fertility behaviour in the 2040s be forecast when the mothers of the 2040s are not yet born themselves?

Projecting births: the conventional approach

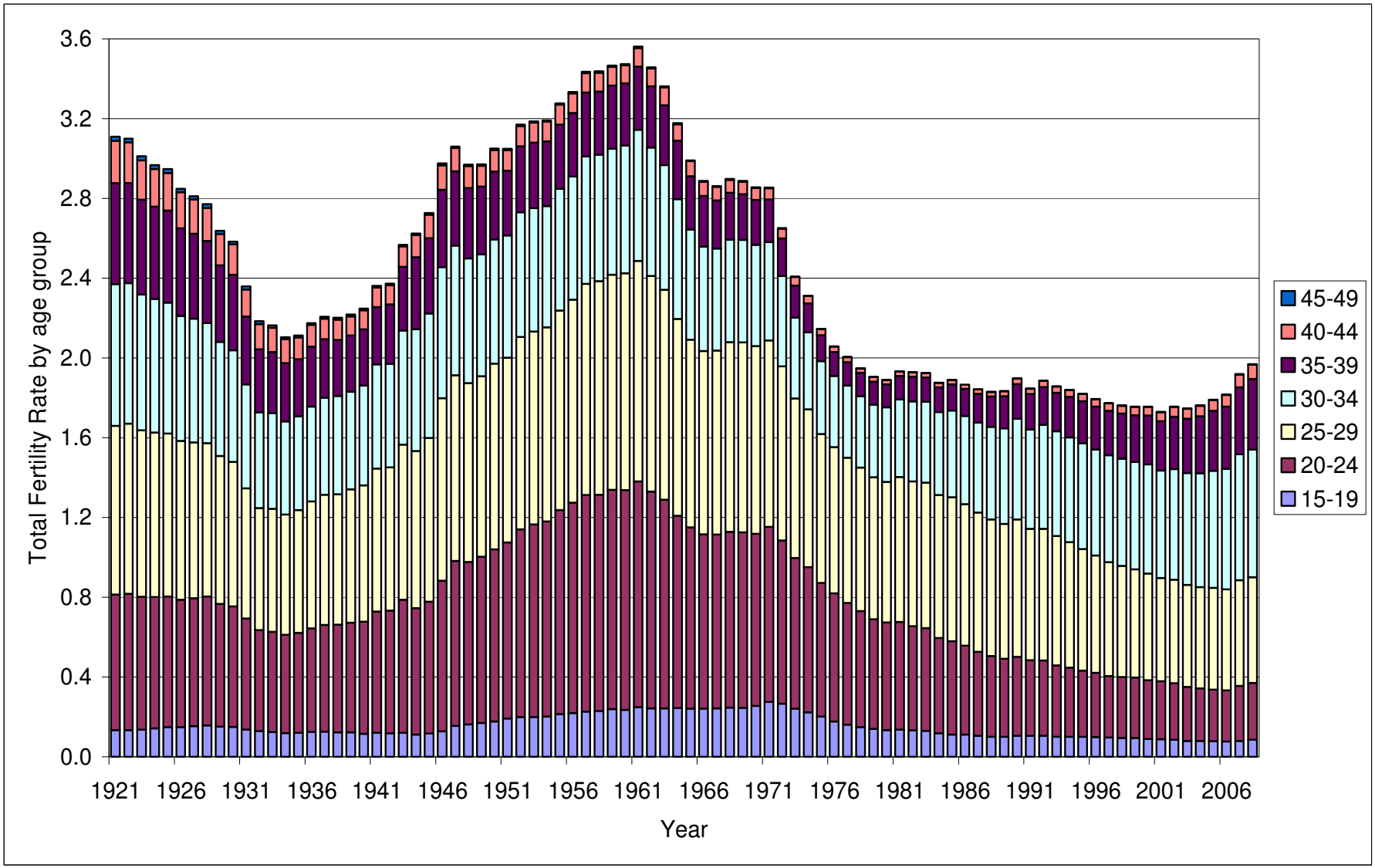
- The conventional method used for the projection of births employs just one parameter as a predictor of the likelihood that a woman will give birth: her age.

- Generally, the future level of age-specific birth rates is projected from past trends, or the opinions of experts are obtained (to cover potential behavioural changes).

- Much of this estimation revolves around (guesstimates or stochastic modeling) of the future course of a single summary measure, the Total Fertility Rate, the sum of the age-specific fertility rates in a given year.

Australia's Total Fertility Rate: 1921-2008

Note: Correlation of TFR and TFR(< 25) is 0.92



What influences the birth rate?

- In the long-term, the total fertility rate is affected by attitudes and values and changes in the socio-economic characteristics of the population.

- In the short term, it may be affected by macro-economic trends but when fertility is low, these effects are likely to be small.

- **The major influence on fertility in the short term is changes in the timing of first births and the flow on effects to higher order births.**

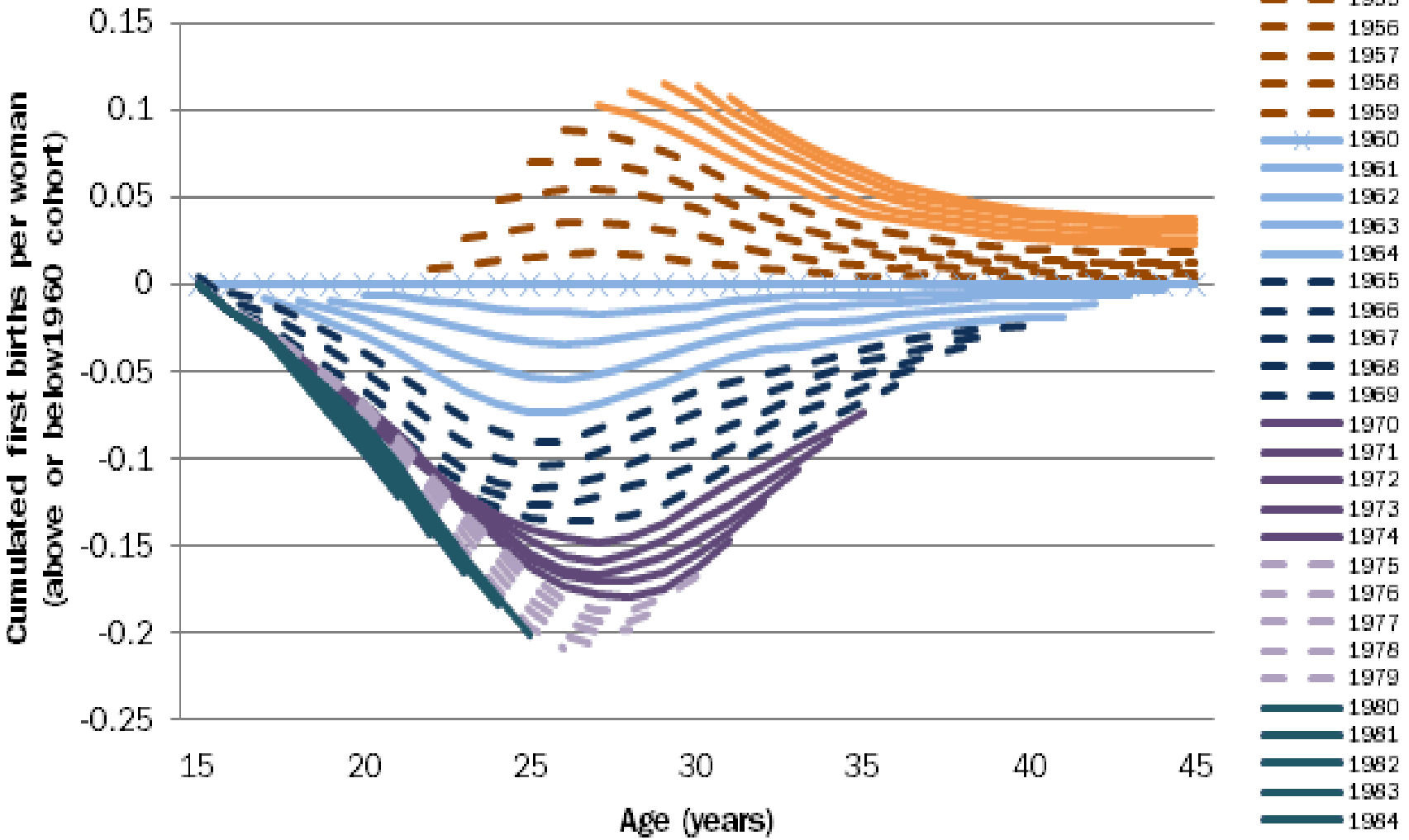
Short-term fertility trends

- The correlation between the Total Fertility Rate and Total Fertility under age 25 in Australia from 1921 to 2008 is 0.92 (see Figure 1).

- For the cohorts born from 1950 to the early 1980s, the proportion having a first birth by age 45 has fallen by about five percentage points, but the proportion having a first birth by age 27 has fallen by 35 percentage points (Figure 2).

- Demographers call this shift a ‘tempo effect’, or a change in the annual fertility rate due to changes in the timing of births rather than a change in the number of births that women have across their lifetime (quantum).

Figure 2: Cumulated first birth rates to given ages for Australian birth cohorts from 1950 to 1984 relative to those for the 1960 cohort (1960 = 0)



The effect of tempo on quantum

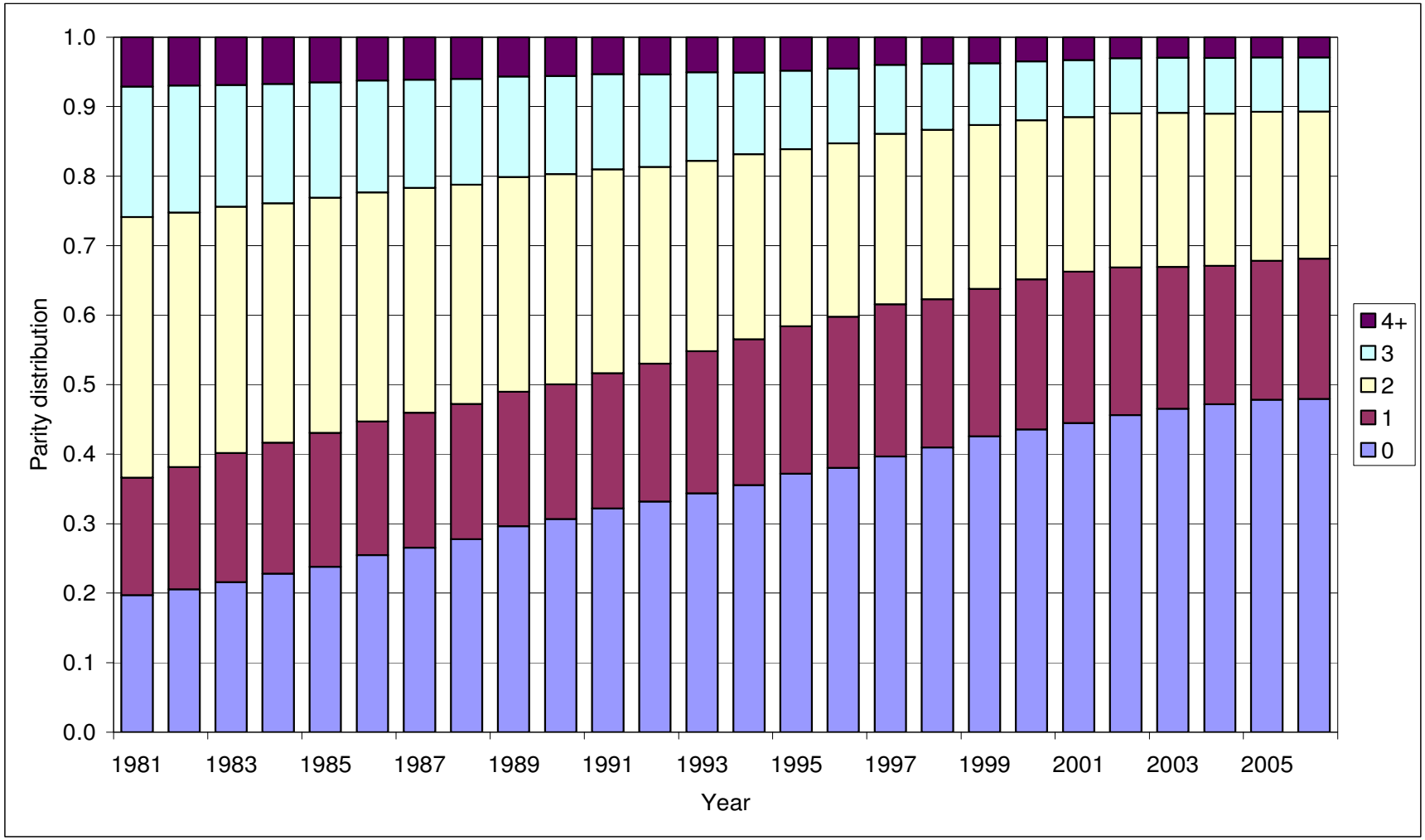
- A birth delayed may be a birth that never occurs:
  - because the relationship breaks up
  - because physiological capacity to conceive falls with age, or
  - because life goes on and priorities change.
- The reverse applies for births brought forward in time, the birth may never have occurred otherwise.
- So tempo can affect quantum.

The trend towards later first births

- Since the mid 1970s, births have been occurring later and later in women's lives.

- However, the recent evidence for Australia suggests that this trend has stopped.

The end of delay?
Parity distribution at age 30, Australia



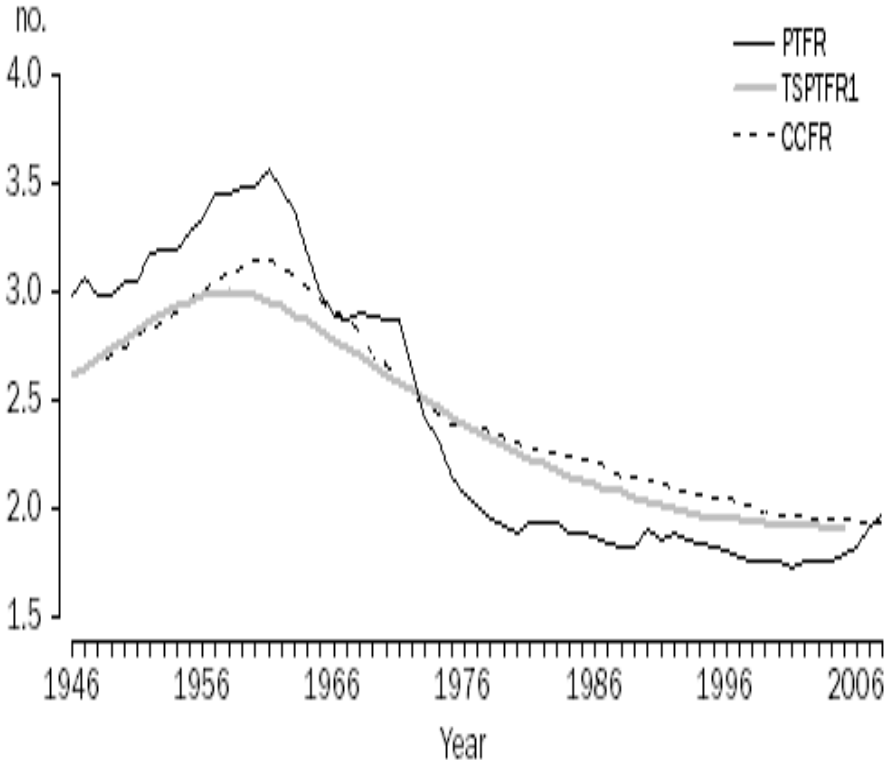
Adjustment for tempo after the fact

- After fertility is completed (around age 45), we can adjust the TFR for changes in the timing of births.

- In Figure 4, we show what the Total Fertility Rate would have been in each calendar year if all cohorts (birth years of women had had the same age pattern of births of women born in 1965 (TSPTFR) .

- The result looks very similar to the cohort completed fertility for each cohort (CCFR) graphed in time at their year of birth + the mean age of their childbearing.

Figure 4: Two contrasting periods of birth timing



PTFR - plotted 1946 to 2007
TSPTFR 1 - plotted 1946 to 2000
CCFR - plotted at year of birth + mean age of fertility

- 1946—1972: changes in the timing of fertility contributed to a higher TFR. Across the whole of this period, 61% of the higher fertility rates (relative to 1946) was due to earlier childbearing, while the remainder (39%), was due to increases in the quantum of childbearing.

- 1973—2007: changes in the timing of fertility contributed to a lower TFR. In this period, 33% of the lower fertility rates (relative to 1973) was due to later childbearing and 67% to a lower quantum.

- The second period has now ended as the tempo effect on the 2007 PTFR has fallen to zero.

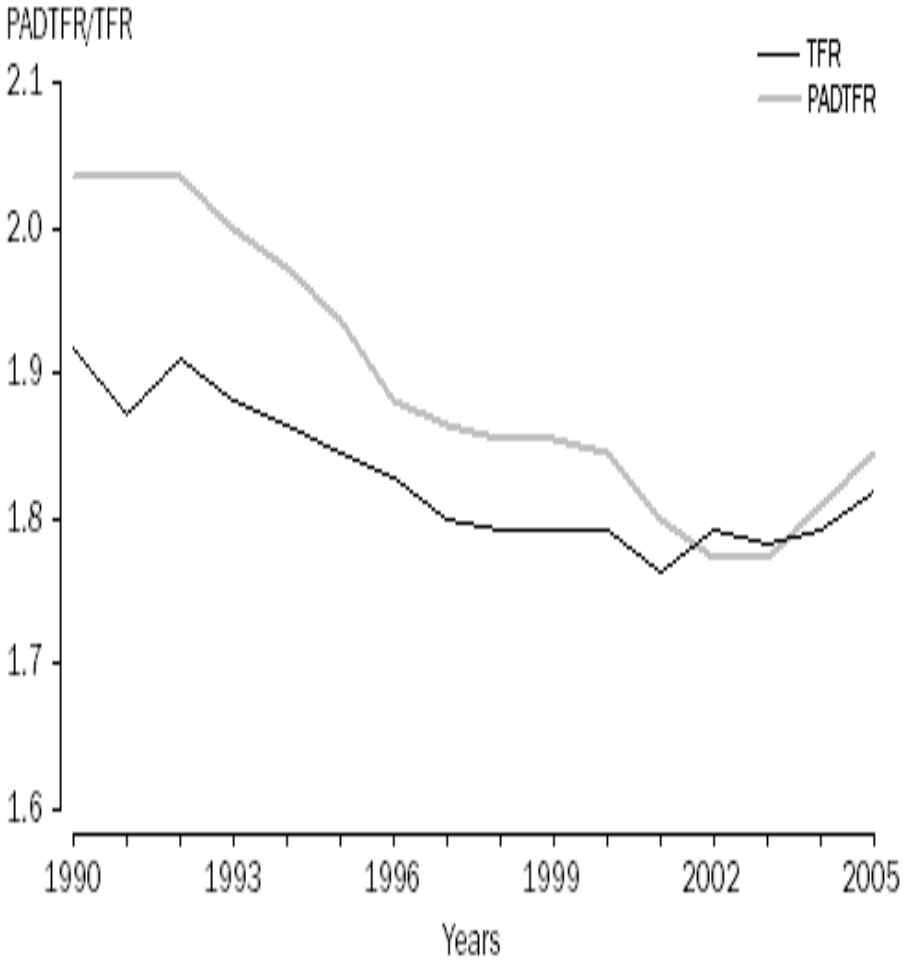
Adjusting for the tempo effect

- A woman's age is not a great predictor of whether she will give birth in a particular year.

- However, if she has already had her first birth, our analysis of Australian data has shown that her age together with the number of births that she has had already and the time since the previous birth are excellent predictors of the likelihood and timing of her next birth.

- Thus, we recommend a three-parameter model of fertility where the parameters are the woman's age, her parity and the interval since the previous birth (Figure 5).

Figure 5: The Age-Based Total Fertility Rate (TFR) and the Parity-Age-Duration TFR (PADTFR), Australia **-** 1990 to 2005



- TFR is the standard age-based Total Fertility Rate.
- PADTFR is the same measure but based on births and population with three parameters: age, parity and duration since previous birth.
- The trend in the past has differed between the two measures but is similar in recent years.

Forecasting births

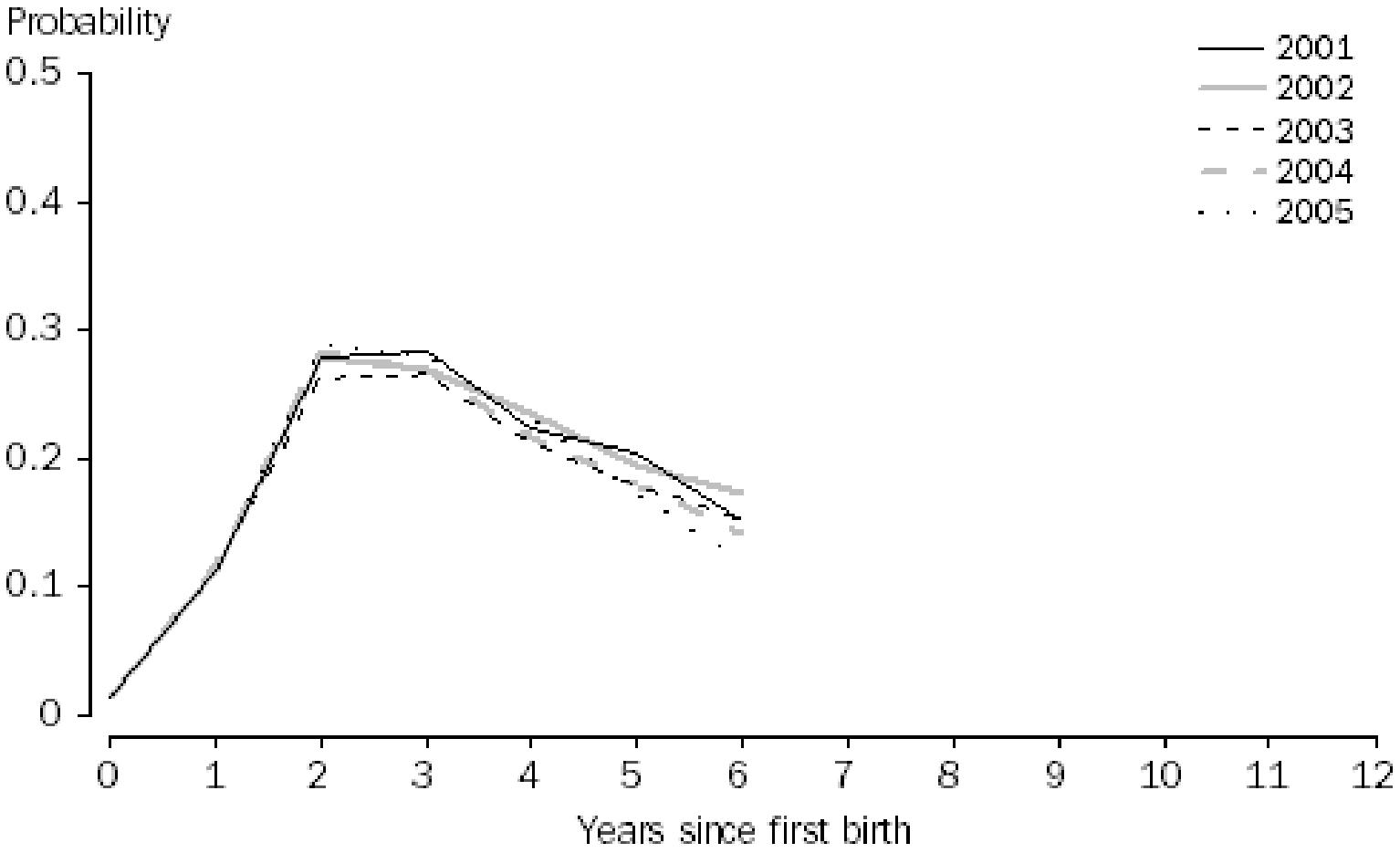
- We use the standard method to forecast births but we use **simultaneously** three characteristics of the woman: age, parity and duration since the previous birth.

- The method uses birth rates by age, parity and duration since last birth but it also takes account of **the structure of the population** by these three characteristics.

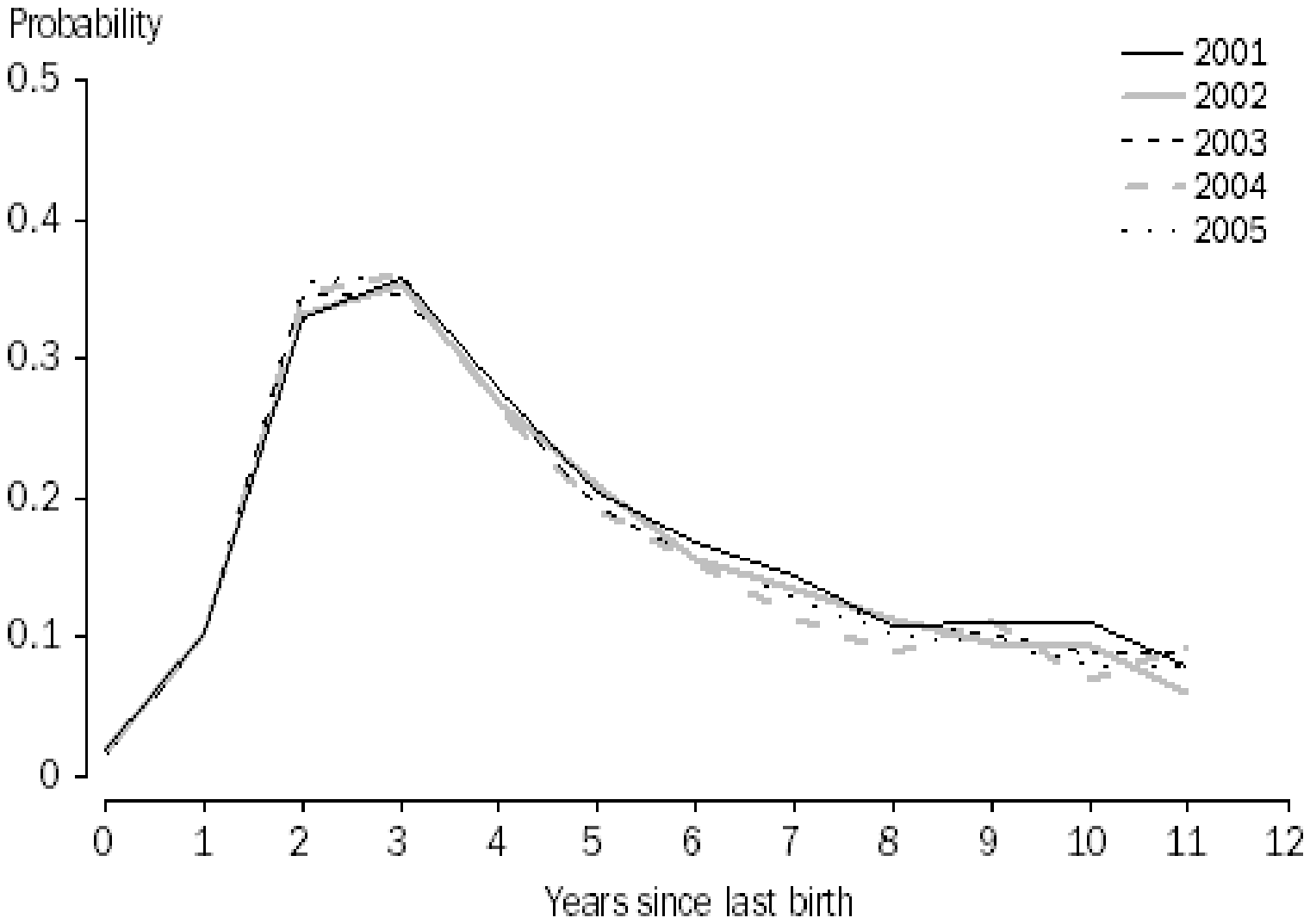
- Our research showed that the effectiveness of this method for forecasting births beyond the first birth is extremely high. We need then only a method to forecast first births.

- Peter McDonald and Rebecca Kippen. 2011. *Forecasting Births*. Feature Article. Australian Census Analytic Program, Australian Bureau of Statistics, www.abs.gov.au

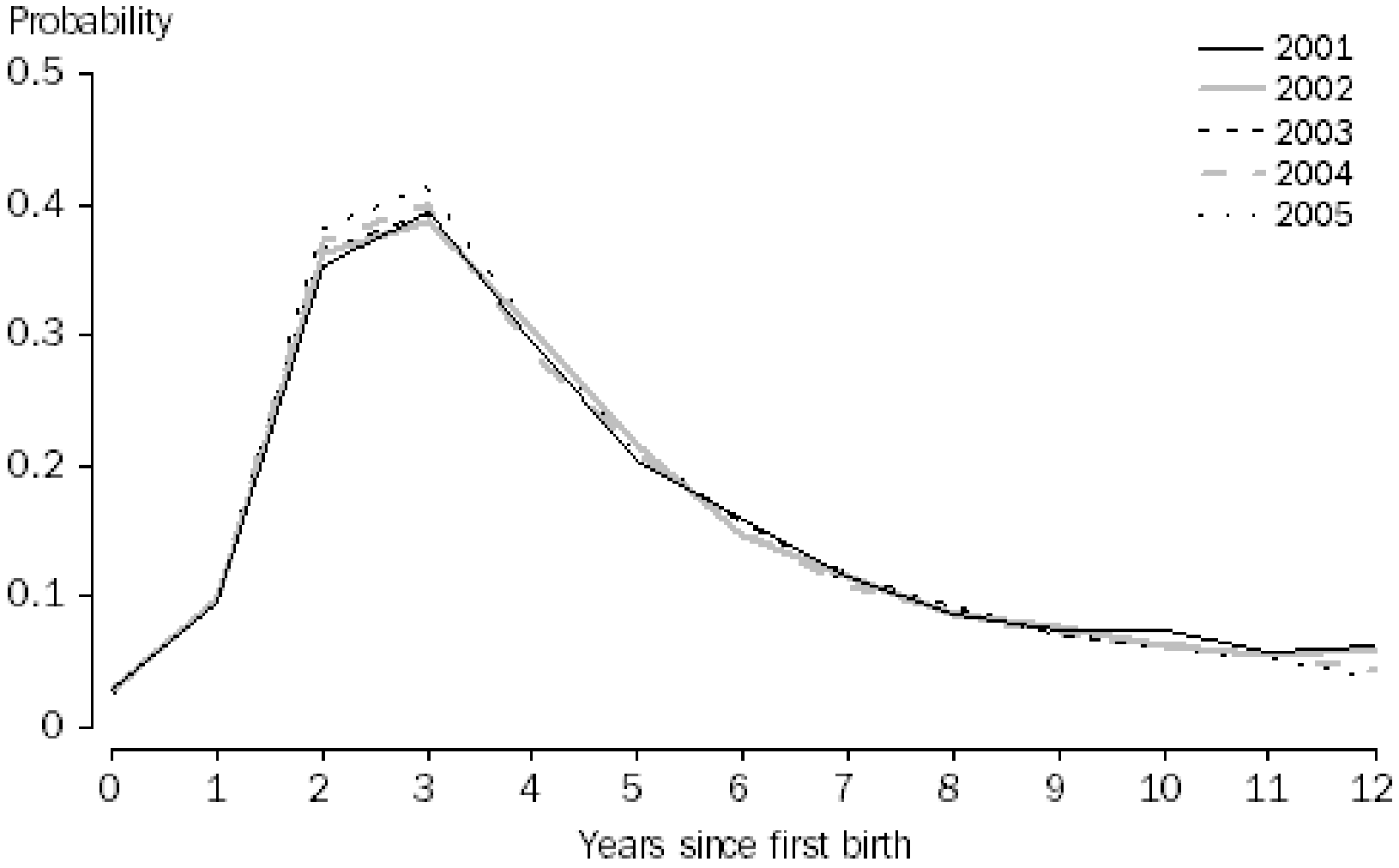
A.1 Probability of having a second birth by duration since first birth,
Women aged 20-24 years at first birth, 2001 to 2005



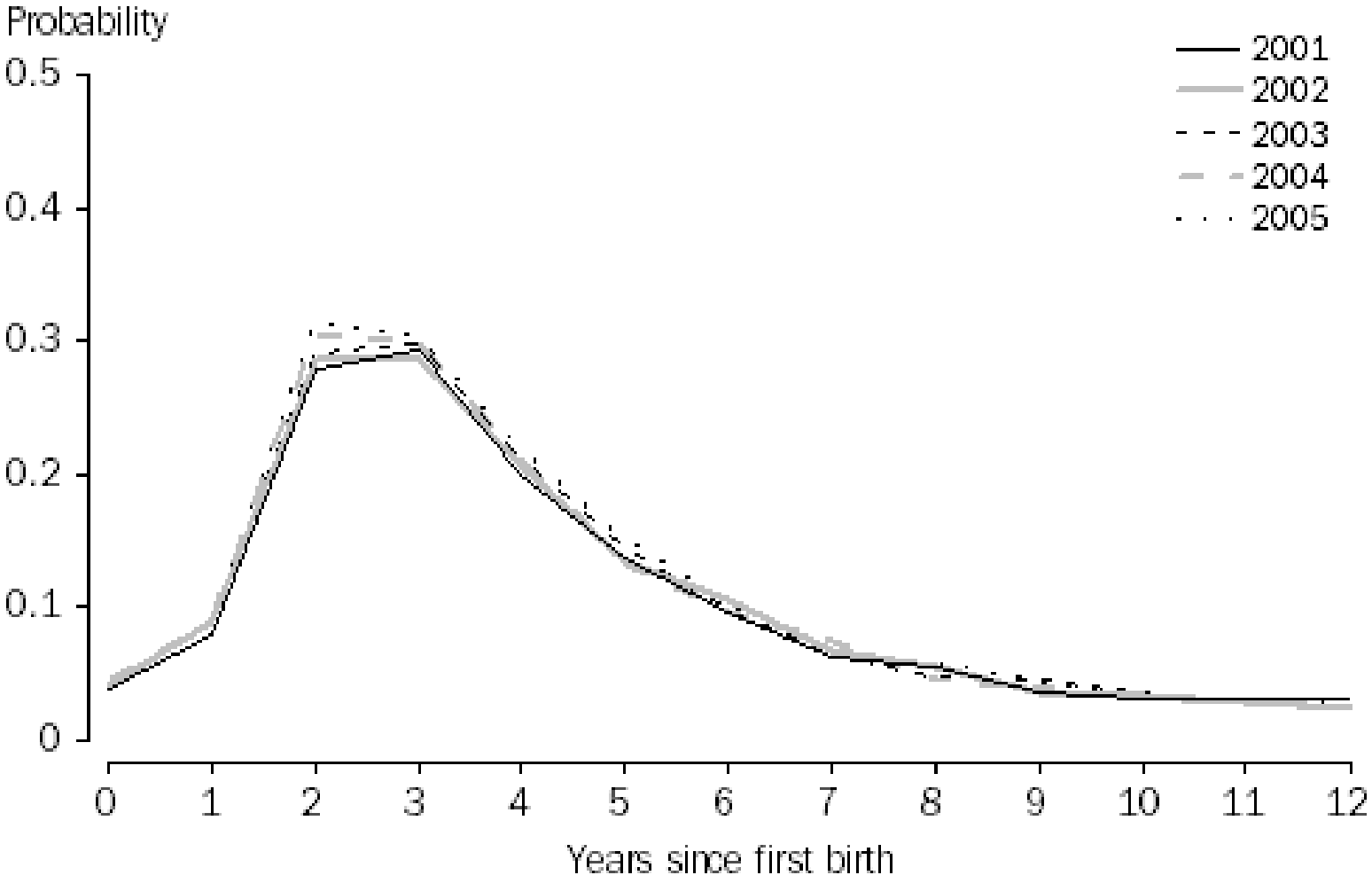
A.2 Probability of having a second birth by duration since first birth,
Women aged 25-29 years at first birth, 2001 to 2005



A.3 Probability of having a second birth by duration since first birth,
Women aged 30-34 years at first birth, 2001 to 2005



A.4 Probability of having a second birth by duration since first birth,
Women aged 35-39 years at first birth, 2001 to 2005



Forecasting first births

- To project the incidence and timing of first births, we suggest that this is done by single-year birth cohorts of women (cohort fertility).
- In the example that follows, in which we project births from 2000 to 2005, we simply assume that the most recent cohort pattern of the timing and incidence of first births (up to the year 2000) is continued into the future (the ‘no change’ scenario).
- After the fact, as already demonstrated, we know that this assumption was largely correct.

Figure 6: Actual age-specific fertility rates in 2002 and 2006 compared with those projected using the McDonald-Kippen method

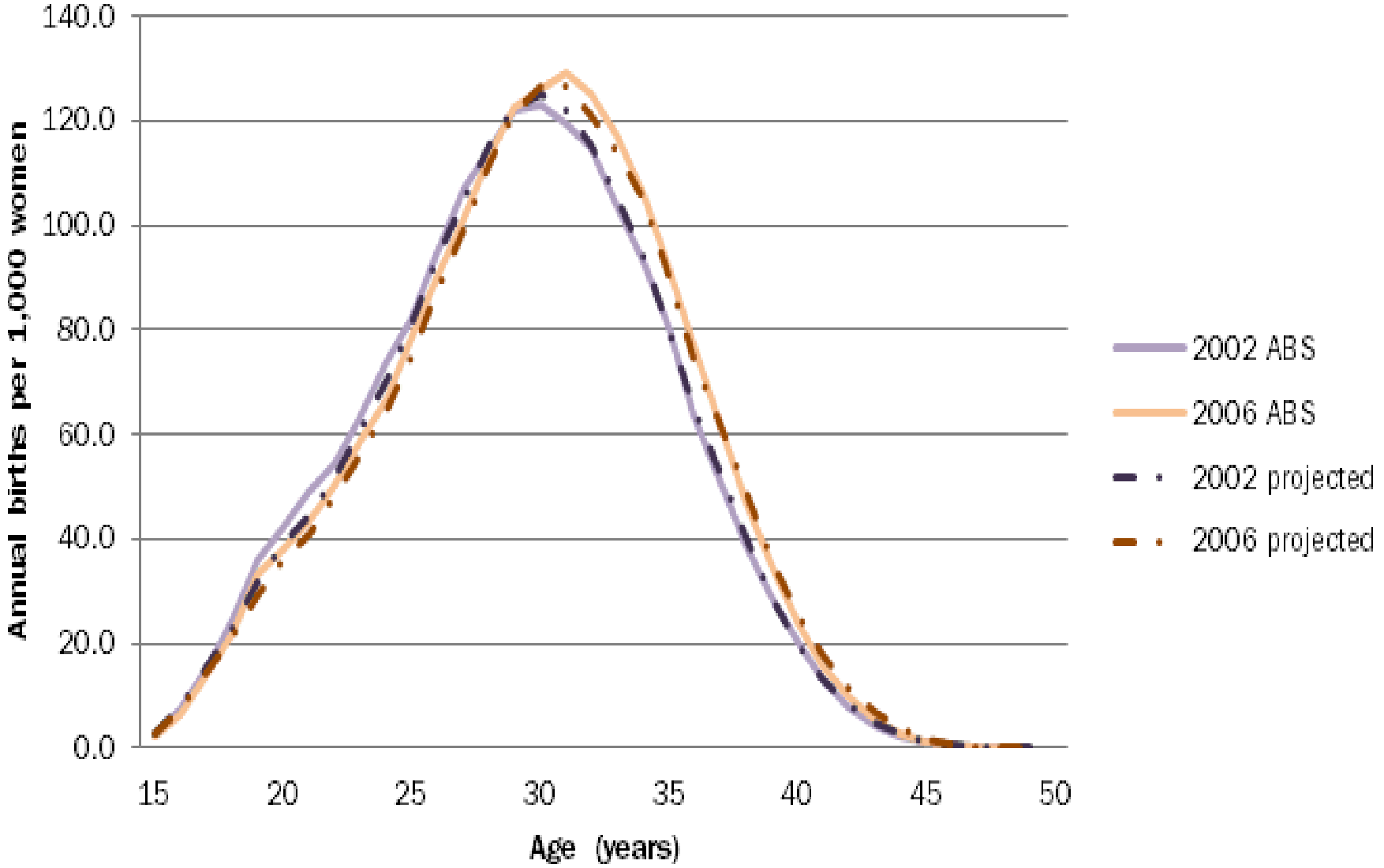
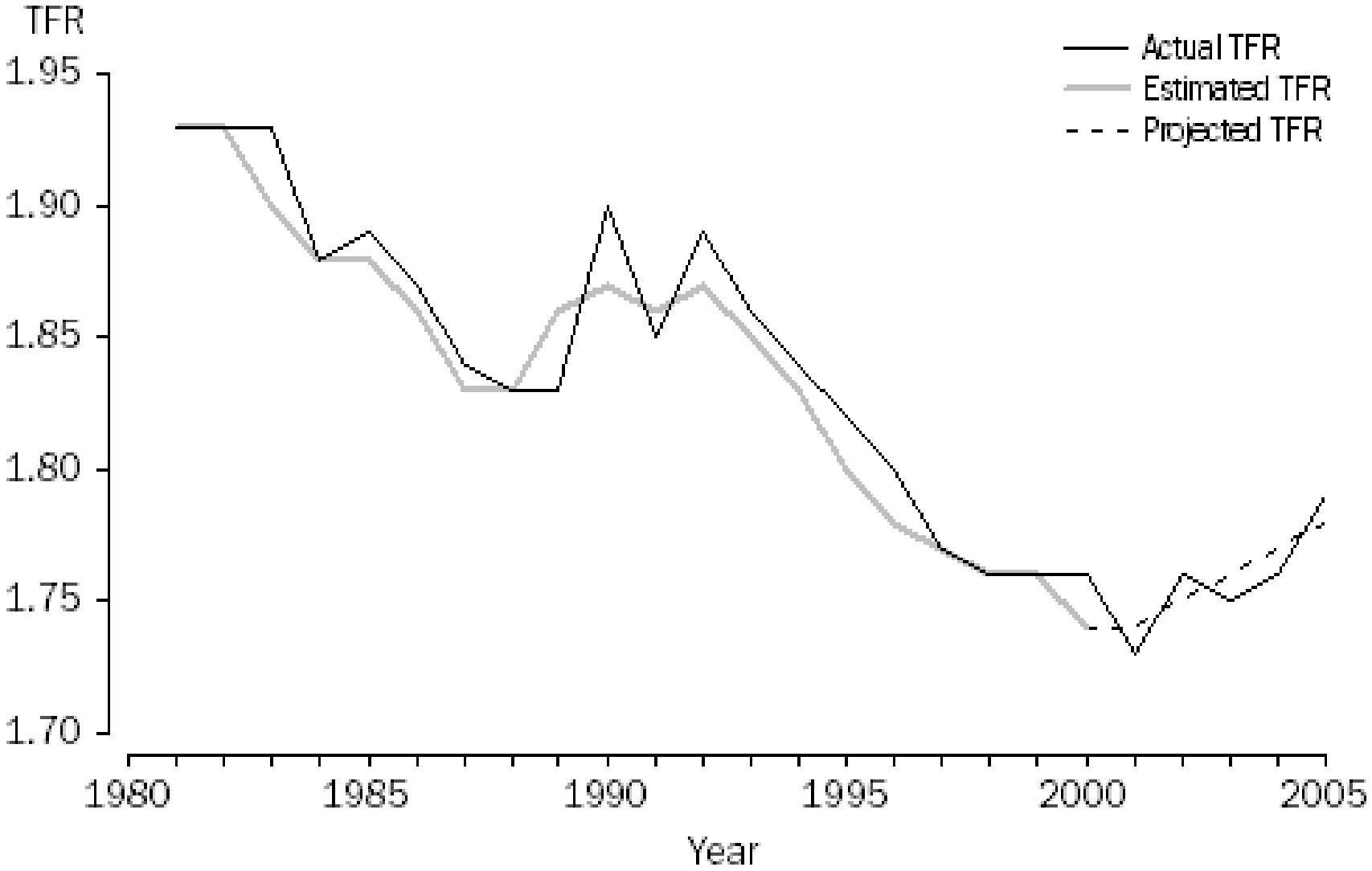


Figure 7: Actual, Estimated and Projected Total Fertility Rates
Australia **-** 1980 to 2006



Evaluation

- Note that the method (a ‘no change’ in the detailed fertility patterns scenario) correctly forecasts the turning point in the simpler, Total Fertility Rate measure.

- This means that the entire change in trend in TFR was due to the existing population structure in 2000, measured using three parameters.

- Forecasting turning points is unusual.

- The exercise also indicates that the Australian TFR almost inevitably was going to rise during the period after 2001 – because of the accumulation of delayed births.

Predictive models of age at first birth

- How might we estimate the future trend in the incidence and timing of first birth before the fact?
- We could use a simple time-series, cohort predictive model using characteristics such as education.
- However, as we have seen, there have been enormous swings in age at first birth in Australia in the past 60 years. These swings have been driven primarily by attitudinal change (or fashion). Can the fashion change again? Yes.