PROJECTING THE DECLINE IN FERTILITY

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Introduction

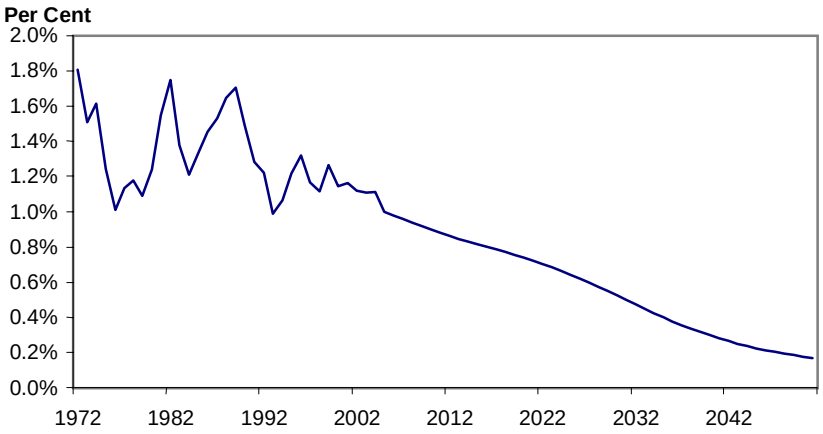
This paper explores the strategy used to by RIM to construct fertility projections.

Demographic Background

Australia's population as at June 1999 was estimated at around 19 million people. It is expected to grow to around 24 million by 2030 and 26 million by 2050. The rate of population growth fell from around 1.8 per cent in 1972 to 1.2 per cent in 1999 and based on RIM's latest projections, will grow by less than 0.2 per cent per annum by 2051 (Chart 1).

Due to a rapid decline in birth rates along with the ageing of the "baby boom" cohort, Australia will experience a largely unavoidable ageing of the population over the next half century. To illustrate the degree of ageing occurring in the Australian population, the aged dependency ratio[1] increased from 13 per cent in 1972 to 18 per cent in 1993 and is predicted to rise to 37 per cent by 2059. That is, since 1972, the number of people of age pension age has tripled compared with those of working age.

Chart 1. Historic and Projected Population Growth Rate - Australia



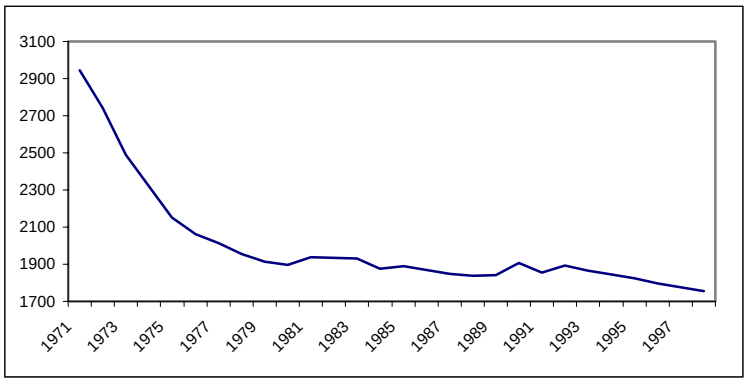
Source RIM 2000

[1] We use dependency ratios only as a descriptive device. We do not regard them as of use as direct input to analysis of the costs of population ageing.

Fertility

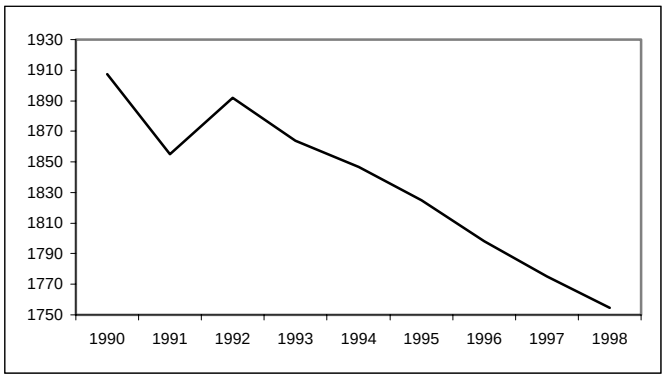
Australia's total fertility rate rapidly declined during the 1970s, stabilised during the 1980s and has shown a steady decrease as Australia entered the 2000s (Chart 2).

Chart 2. Total Fertility Rate - 1971 to 1998



Apart from the general decline in birth rates resulting from the trend towards smaller families, age-specific data reveal that a significant influence has been women deferring child bearing until their late twenties and later. A narrower view from 1990 highlights the strength of the decline with seven consecutive years of falling total fertility rates.

Chart 3. Total Fertility Rate - Last 9 years



Apart from the explicit population dynamics, the fertility rate is of importance because of its effect on labour force participation and retirement income in general. Most women temporarily leave the work force while their children are young. Any interruption to work experience can have a significant effect on the potential superannuation benefits accumulated, significantly lowering the possible superannuation payout, particularly if the interruption occurs early in a worker's career.

Projection Strategy

There seems to be two approaches to fertility modelling and projections. The first is to assume the aggregate long run fertility based on either: an understanding of what is driving the fertility decline and how these processes will develop over time, or by drawing on what has happened in other advanced economies and making assumptions about the likelihood of similar events occurring in Australia. A transition path to this long run assumption is then imposed. In our view, this approach leaves a wide margin of error which may not be a very useful guide to the future.

A second approach is to attempt to find a functional form that fits the historic data, estimating the parameters and then using this estimated functional form to project future profiles. This approach raises many problems: The first being the problem of finding an acceptable function form. A recent study by Chandola et al (1999) notes:

> " Recent patterns of fertility in Europe show marked differences between countries. Recent United Kingdom and Irish fertility curves show "distortions" in terms of a "bulge" in early age fertility, distinct from the smoother curves of other European countries. These patterns may not be adequately described by mathematical functions used by previous studies to model fertility curves."

Further a fixed functional form often leaves policy analysts little room to introduce and experiment with structural and policy change.

The above highlights the general problem facing all projection exercises where an age profile exists. The problem is: - How to project age profiles when the functional form is unknown? There are many other issues to be addressed such as:

> How to impose special and/or prior views about the shape of the projected profile?
>
> How to:
>
> - capture discontinuities either assumed or known
> - structure/shape the profile based on the shape of an external profile
> - remove noise from the data (smooth noisy profiles)
> - combine single year profiles with group profiles
> - apply end point and other restrictions
> - address the open ended data problem
> - project ratios correctly
> - give more weight to certain parts of the profile

In view of these difficulties, RIM has developed non-parametric approaches to profile estimation, using discrete cubic splines, which address all the above issues (either separately or together).

There are five basic methodologies we use, all based on discrete cubic splines:

Interpolation - Interpolates non fixed width aggregate or grouped data for any data type (sum, average, end point)

Smoothing - Smooths, with preference weighting, any aggregate or group data to a disaggregated profile.

Profiling - Employs the shape of another dissaggregated profile to control the shape of the interpolated data.

Ratio Projections - Using either a disaggrageted numerator or denominator correctly interpolates aggregate or group ratio-data (eg participation rate).

Asymptotic discrete cubic spline or logistic projections combined linked to smoothed historic trends.

Fertility Projections

For fertility projections the general approach becomes

a) Aggregate fertility data (the profile) to appropriate group data.
b) Smooth the historic group data.
c) Project these group data forward using cubic spline and/or logistic methods.
d) Interpolate the projections single year of age profiles.

Fertility is projected by separately projecting age-specific fertility. Chart 4 illustrates the single year of age profiles that result from applying the interpolation methodology. Chart 5 shows the projected group age specific fertility rates. These projections result in a Total Fertility Rate(TFR) of 1.55 births per woman by 2059.

Chart 4. Age-specific fertility rates (births per 1000 women)

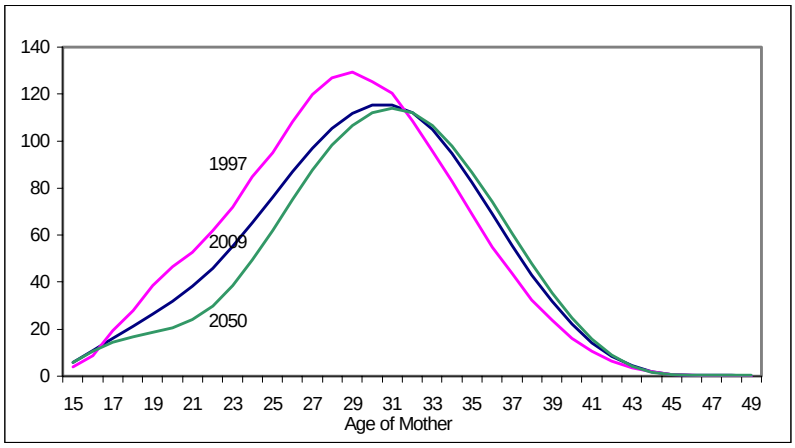
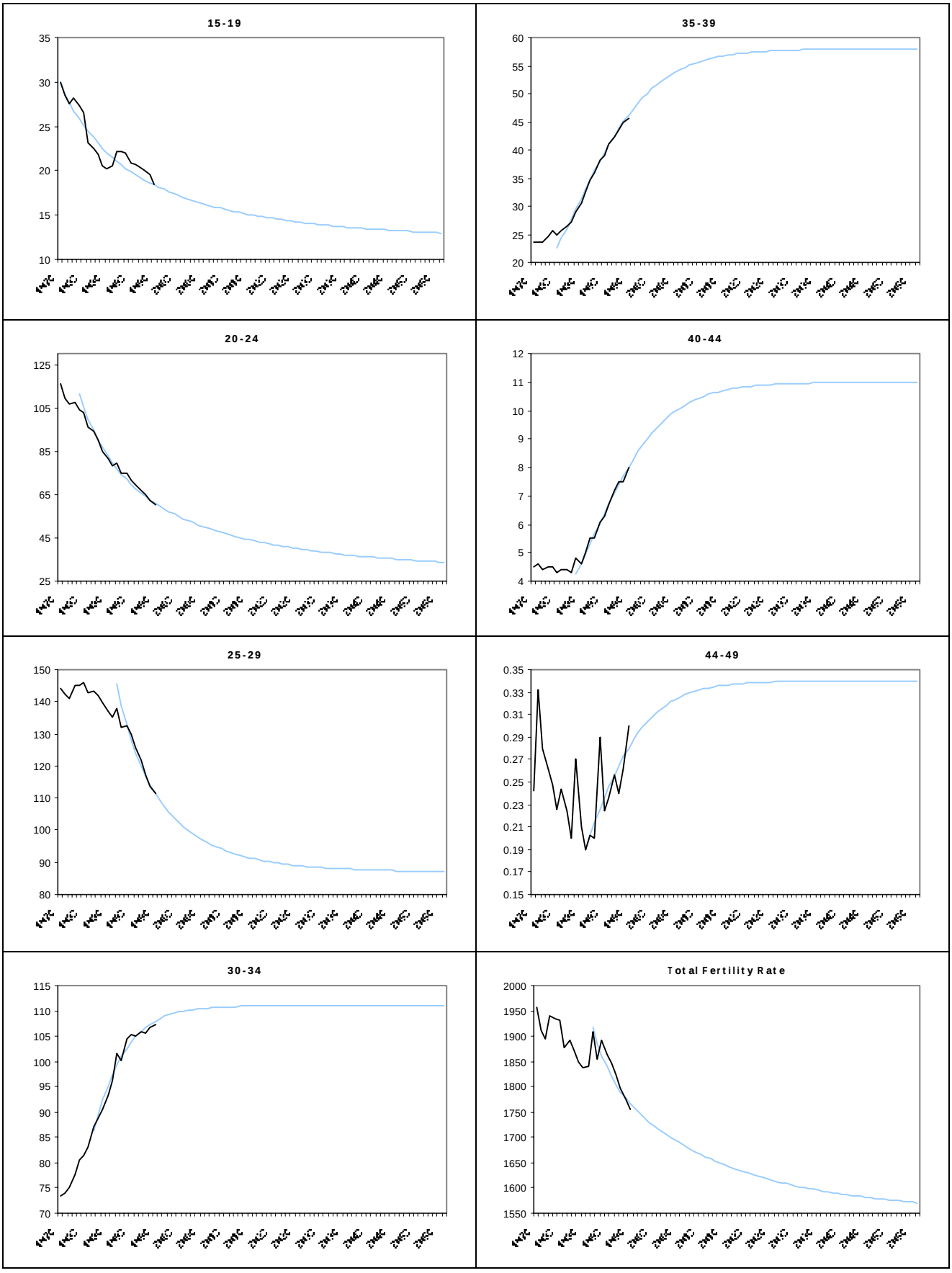


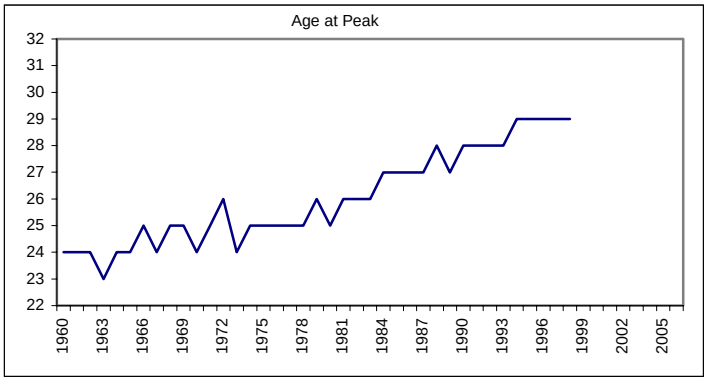
Chart 5. Group projections of age-specific fertility rates (births per 1000 women)



At first glance it would appear that the projected profiles are still somewhat arbitrary. However we ensure that the resulting age profile must be smooth and the growth paths must make a smooth transition from down before the 30- to 34 year old age group, to up at older age groups. Clearly there is still some uncertainty about the growth path for the 30 to 34 age group.

Fortunately we have very good single year of age data which can be projected to investigate this age group in particular. By applying the above methodology to single year of age data we obtain results shown in Chart 7 (over page). This chart shows the single year of age projections with the constraint that the long run age profile must be smooth. The transition process is clearly captured and gives rise to a stabilising of the age at which the peak of the age profile occurs at around 31 years of age. A simple projection of the historic age of the peak fertility supports this result (chart 6). Full details of the projections for each age are shown in the Attachment.

Chart 6. Projection of age at which the peak in the fertility age profile occurs.



Conclusion

Chart 8 shows these single year of age projections aggregated to the initial age groups for comparison. Although the basic story has not changed, the extra rigour of the analysis, with the imposed consistency and the use of more information, gives more confidence in the plausibility of the projections. This more detailed analysis gives a slightly revised projection of total fertility rate at 1.56 by 2051, which we believe, because of the detail in the methodology, is highly defensible.

Casual inspection of the data makes it clear that much of the observed trend in fertility is driven by: the increasing age that women are having their first child, the fact that the number of women having 3 or more children is falling: and the number of childless women rising. Clearly, this methodology can be further improved by separately projecting parity. Last, but not least, analysis by region might provide further insight.

Chart 7. Age specific fertility projections

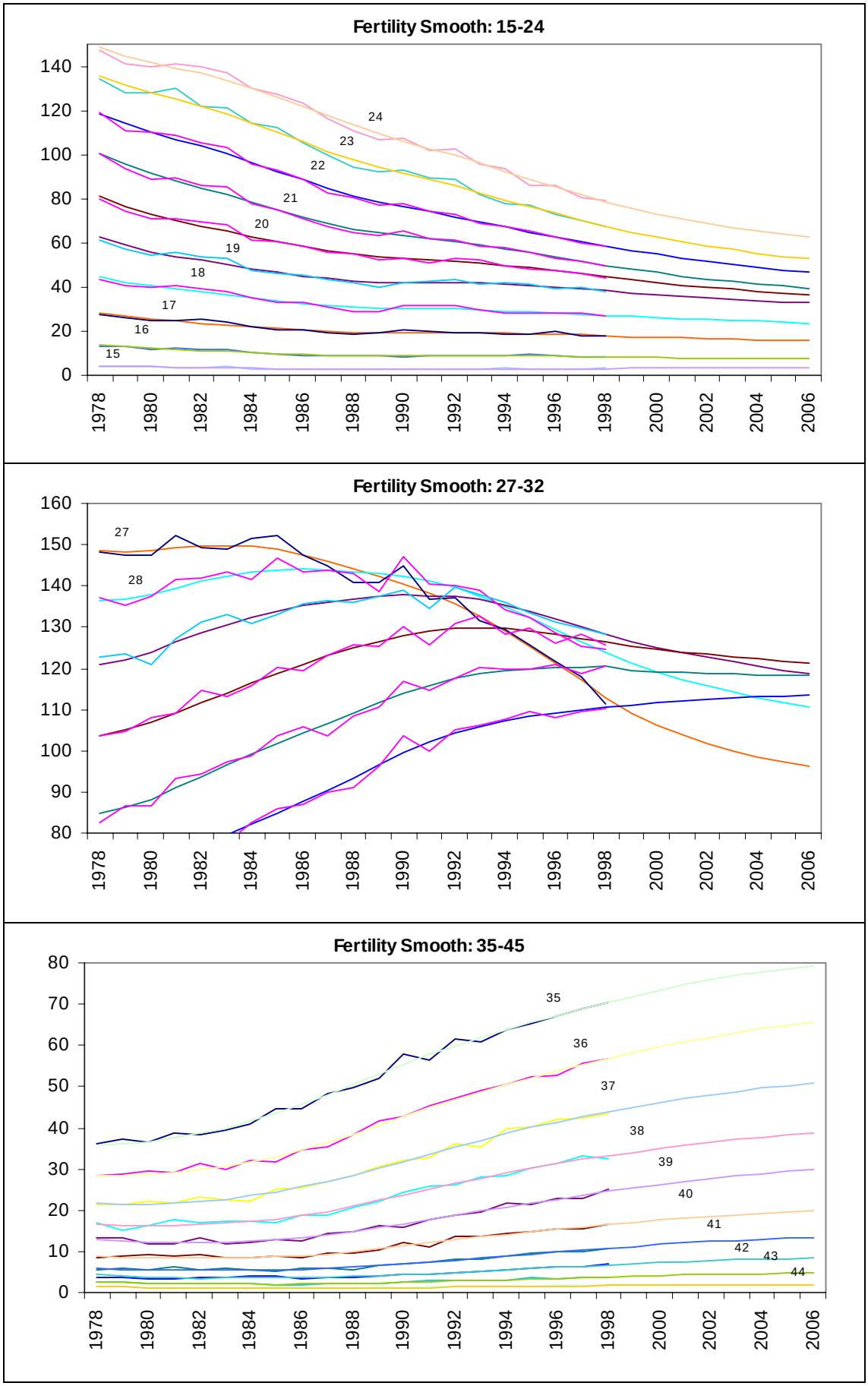
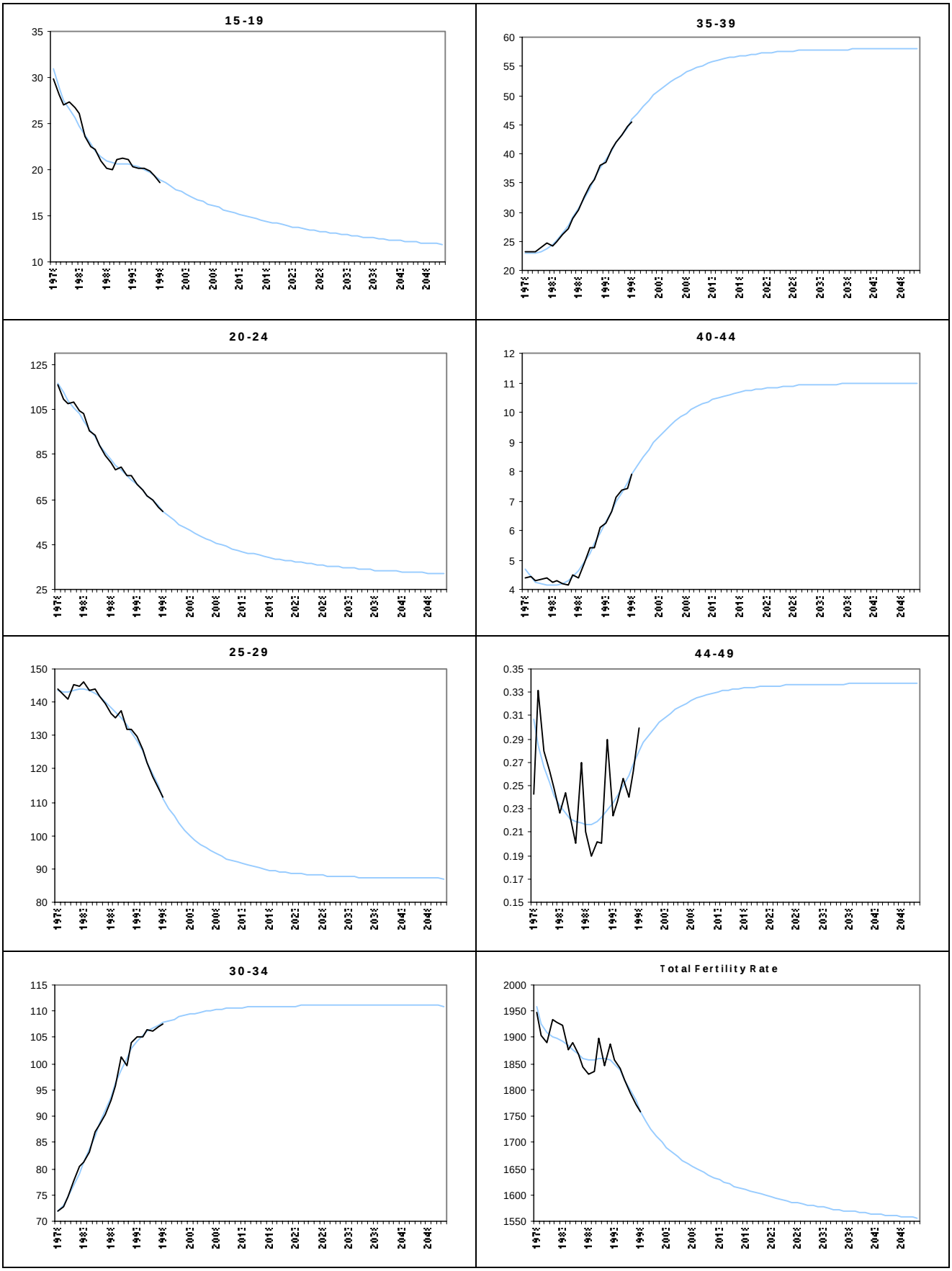


Chart 8. Sum of single year of age projections of age-specific fertility rates (births per 1000 women)



Reference

Chandola T, Coleman D and Hiors R (1999), "Recent Euopean fertility patterns: Fitting curves to distorted distributions", Population Studies, 53(3), November 1999, pages 317-29.

Overview of Rim Demographic Models

Chart 1 shows the overall relationships between the RIM demographic models and the data sources used to construct and drive the models. Because of the link to JEFG the quarterly projections run off ABS data found in Australian Demographic Statistics (ABS 3101.0). These quarterly projections are then used as the jump off for the long-run annual projections.

The main models are:

FERTMOD - Fertility Model

This model projects fertility rates by age groups and interpolates to construct the single year of age profiles (see technical attachment).

LIFEMOD - Life expectancy Model

The life expectancy model calculates survival rates, number of survivors to a particular age, deaths at each age, life table populations and life expectancy for males and females by single year of age up to 115 years.

MIGDIST - Migration Distribution Model

The overseas migration model projects age-profiles by sex of permanent and long-term arrivals and departures and measures of category jumping.

POPMOD - Population Model

POPMOD provides annual projections of Australia's population by year for males and females by single year of age up to 115 years. The model is driven by the fertility, mortality and overseas migration models.

LFSMOD - Labour Force Status Model

This is long-run annual model of the Australian labour force designed to capture structural (trend) behaviour at fine detail. The model projects persons by labour force status, age, gender and income decile. (Marital status projections are used in STINMOD-OUTYEARS.) Labour force status is split by employed/unemployed, full-time/part-time, public/private, wage and salary earners/employers/self employed. Persons not in the labour force are split by retired/never in labour force/permanently disabled/temporarily not in the labour force. There is no short-run behavioural response in LFSMOD, the model simply runs off the observed underlying long-run movements of key, and hopefully stable, parameters, which are estimated as non-linear trends with consistent

asymptotic values. Apart from these time-varying parameter matrices, the model's only exogenous inputs are population projections from POPMOD, and a user supplied aggregate unemployment rate.

RETMOD - Retirement Model

This model provides annual projections of retirement by gender, age and income decile. More details of this model can be found in Bacon (1997) "Work, Retirement and Dependency", People and Place Vol 5 No. 2.

Chart A1. RIM Demographic Modelling

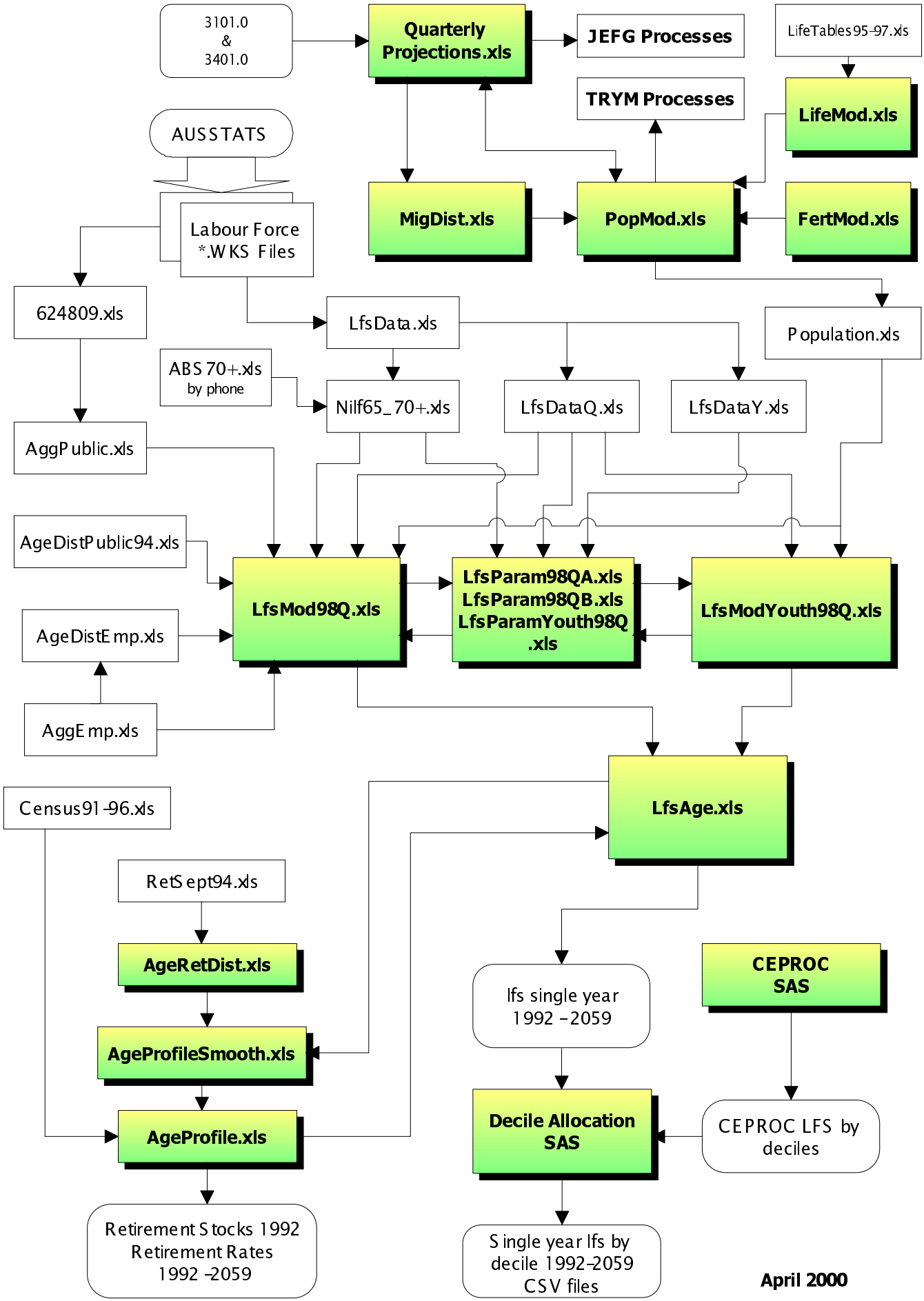


Chart A2. Projections of single year age-specific fertility rates (births per 1000 women)

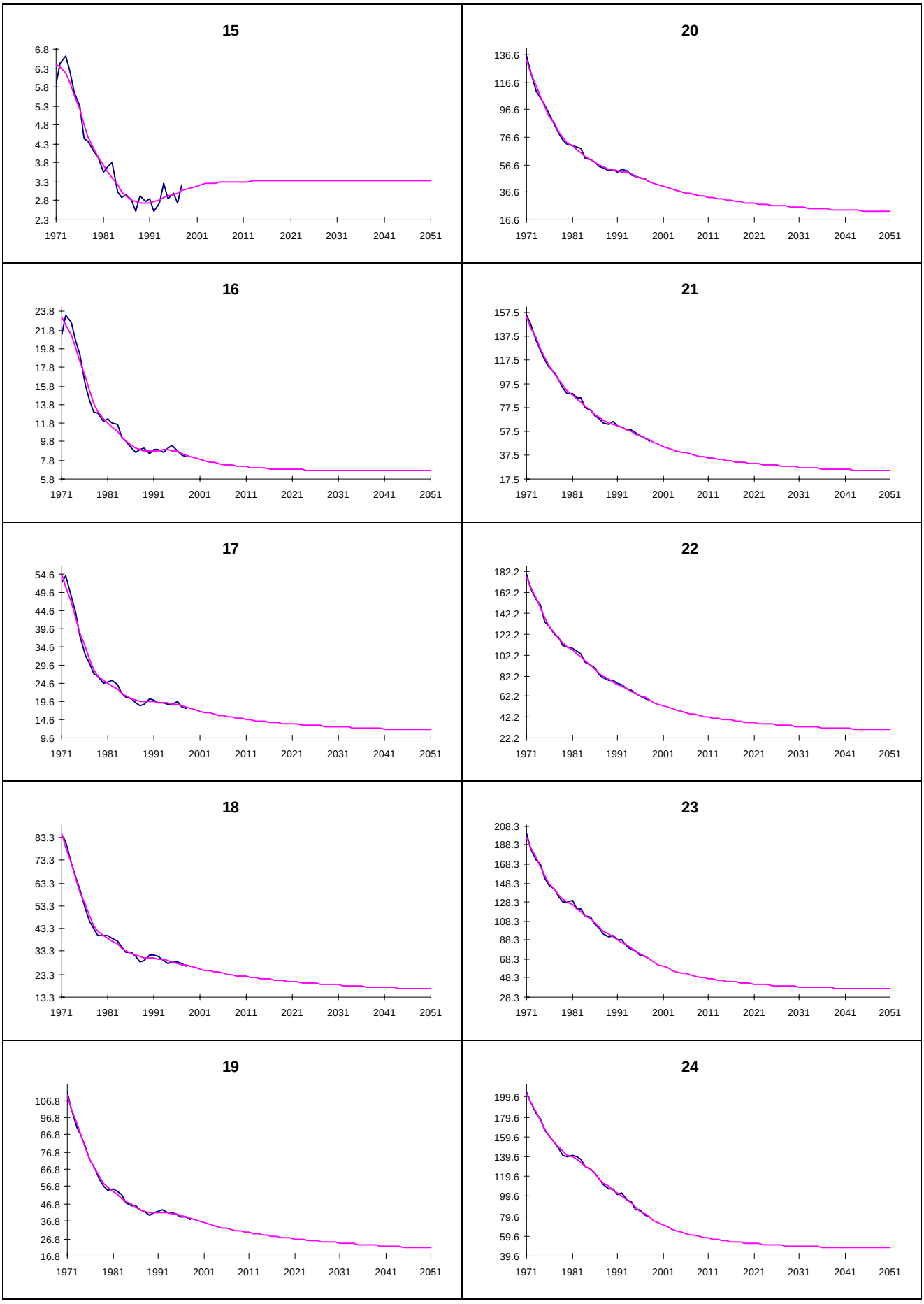


Chart A2 Cont. Projections of single year age-specific fertility rates (births per 1000 women)

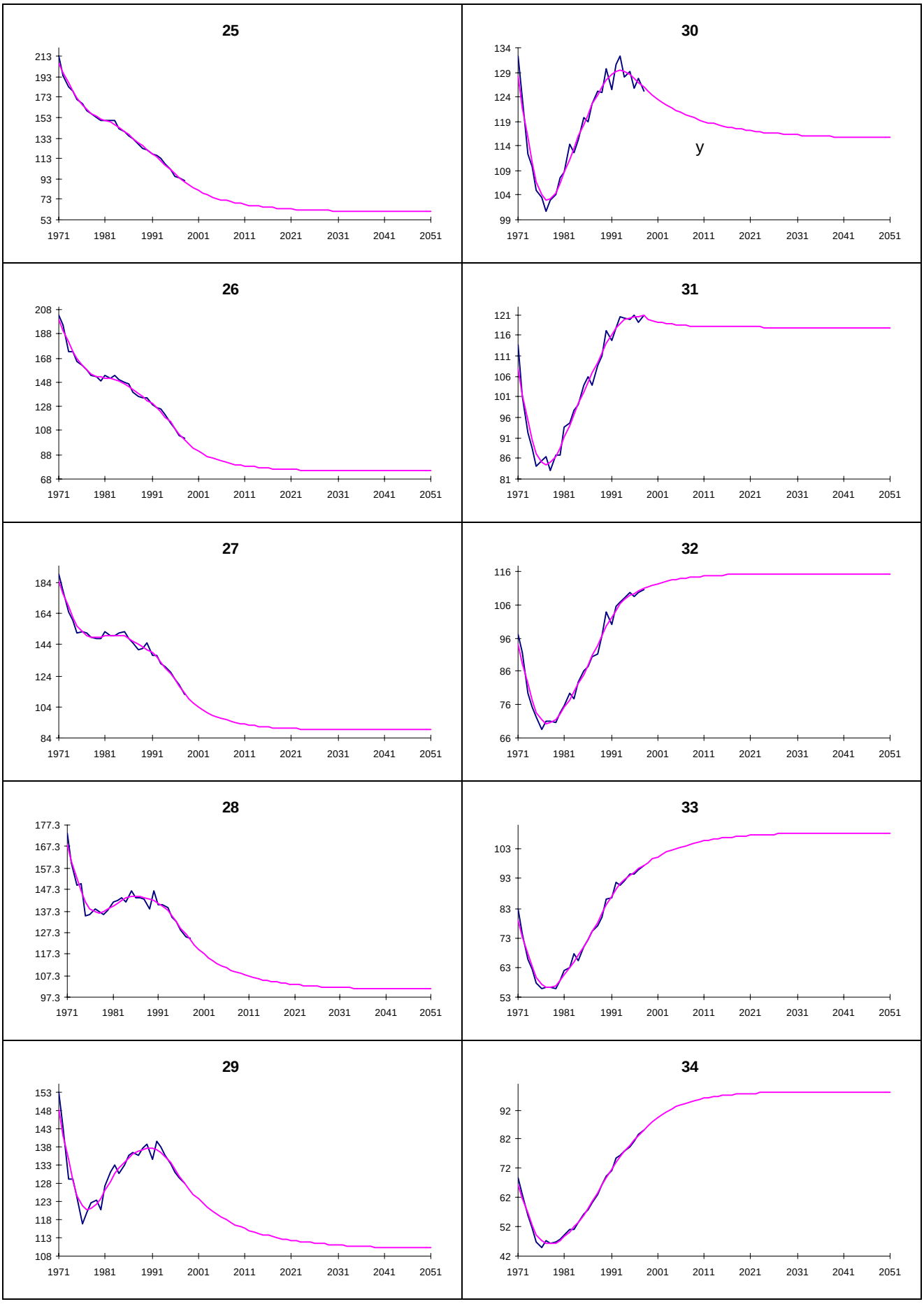


Chart A2 Cont. Projections of single year age-specific fertility rates (births per 1000 women)

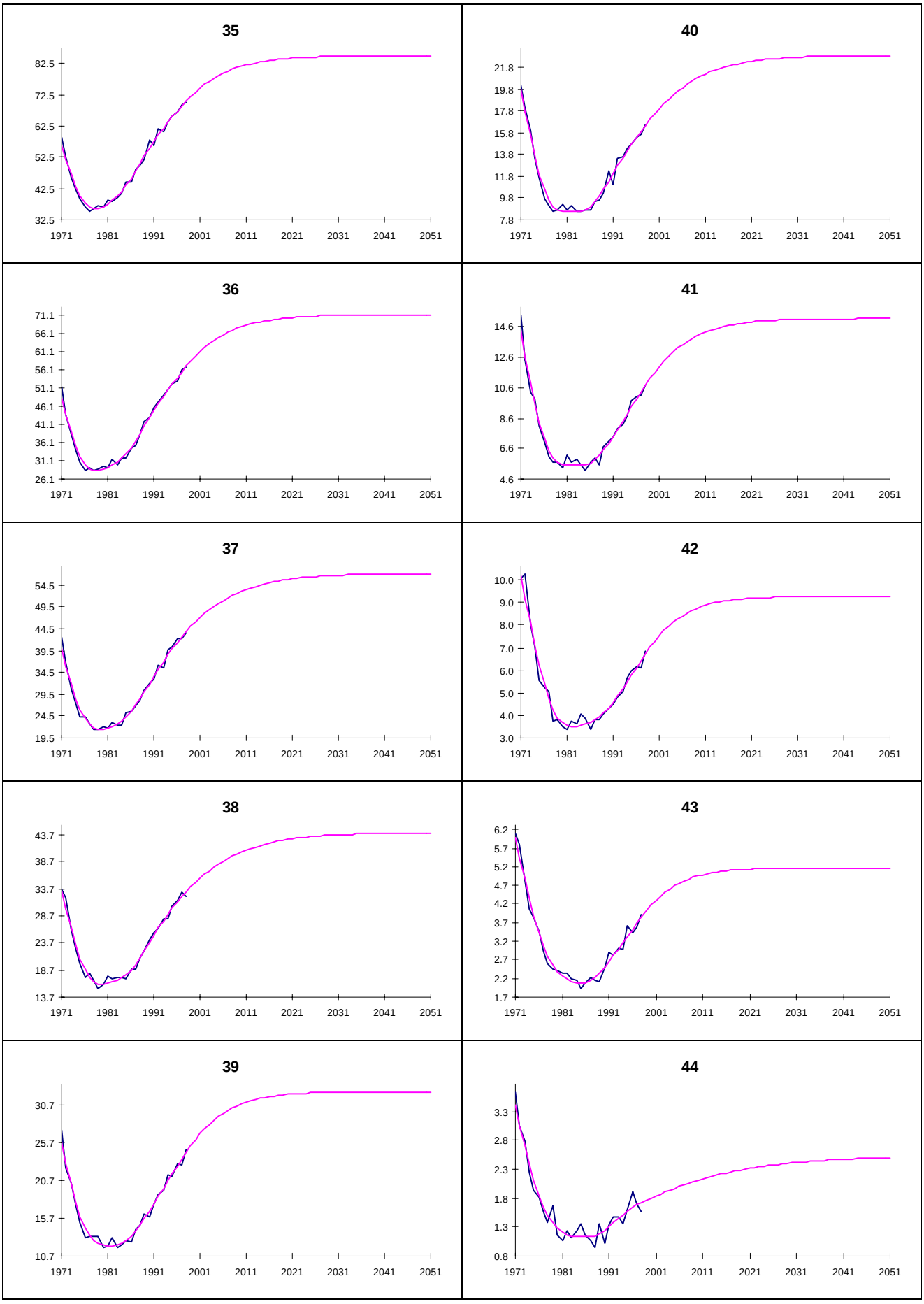


Chart A2 Cont. Projections of single year age-specific fertility rates (births per 1000 women)