Labour Force Projections: A Case for the Greater Metropolitan Area of New South Wales to 2031

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Abstract

There is a fundamental gap in our understanding of the complexity and uncertainty in projecting and analysing the supply of labour at a regional level due mainly to the lack of longitudinal data and difficulties in determining suitable models for predictions. This study takes the Greater Metropolitan Area (GMA) of New South Wales as a case study to investigate feasible methods to project the future workforce in a region. The study applies a historical-comparative approach to deriving information about trends of labour participation and workforce status in the GMA from the panel datasets collected at national and state levels. It uses Growth curve models and cohort analysis methods for the projections of the rates of labour participation, part-time employment and unemployment among different age groups by sex. It demonstrates that the Growth curve models and cohort analysis methods provide effective methodologies and techniques to project the future labour supply at a regional level.

Econlit subject descriptors: J210, J100, C610

1. Introduction

The "labour force" consists of those persons who work for pay, for one hour or more per week, *or* who are actively looking for a job (i.e., unemployed). There are two principal factors influencing the magnitude of the labour force. One is the size of the civilian population of working age (predominantly aged between 15 and 64 years). The other is the participation rate – the proportion of the labour force of working age in the population. When considering planning decisions (e.g., on transport infrastructure and service in urban areas), government and private sector clients need reliable and up-to-date information on current and future travel patterns and employment and population trends. It is valuable to know not only the size (labour supply) of the potential labour force, but also what proportion of it is employed, and what ratio of employment is full-time or part-time. Both the quantitative ("how many?") and qualitative ("what sort?") dimensions of labour demand are relevant to transport or urban planning. The employed persons in the overall labour force will have different travel and other daily patterns from the unemployed and non-employed. Similarly, the full-time employed persons will have different travel patterns from those employed part-time.

Complicated modelling methods developed over past decades, such as computable general equilibrium models of the economy, use economic theory and large amounts of historical data in projecting the future shape of the workforce. These models and corresponding analytical approaches have been used in many OECD countries including Australia (Meagher, 1997; Meagher et al., 2000), Canada (Archambault, 1999), Germany (Meyer et al., 1999), the

Netherlands (Grip and Heijke, 1998), UK (Wilson, 1994) and USA (Horrigan, 2004). These models attempt a very difficult task, and despite their sophistication, they must be seen as best endeavours, rather than as accurate accounts of how the economy and labour market will unfold over time.

There is still a fundamental gap in our understanding of the complexity and uncertainty in forecasting the supply of and demand for labour. Any attempt to capture all of the factors in a comprehensive theory and to quantify their interactions seems fruitless and reduces the possibility of credible predictions. An important reason is because labour supply or demand is highly influenced by non-linear trends or exogenous factors such as technological innovation, social policy intervention and business cycles. Boswell et al (2004, p.35-36) have identified six important restrictive aspects in projections of labour demand or supply. These include: theoretical problems, especially with prediction in an area with so many determinants; methodological rigour, especially the problem of achieving a satisfactory level of disaggregation, and integrating models focused on different aspects of the economic system, which include: data availability; level of disaggregation; an adequate time frame; and the inclusion of scenario-mapping. Methodologically, the major problems are the unavailability of data and difficulties in determining suitable econometric models for predictions to achieve a satisfactory level of disaggregation. An additional primary problem is the lack of data on workforce variables required by most models to extrapolate from past trends. Associated problems include: inconsistencies in data collection, classification of data, and diversity of data sources. Detailed disaggregated time series of labour force data for regions are more often than not unavailable.

The present study aims to investigate feasible methods to project the likely workforce patterns, especially labour supply, at a regional level. It takes the Greater Metropolitan Area (GMA) of New South Wales (NSW), Australia as a case study area. The GMA encompasses the statistical divisions of Sydney and Illawarra and the Newcastle sub-statistical division. The components used to derive workforce status in analysis and projections of the labour force over a projection horizon from 2005 to 2031 are: (1) the size of the working aged population (consisting of persons aged 15 years and over of the total civilian population); (2) labour force participation rates; (3) part-time or full-time employment shares; and (4) the unemployment ratio – the proportion of unemployed persons in the labour force. As the Transport and Population Data Centre (TPDC) of the Department of Infrastructure, Planning and Natural Resources (DIPNR) of NSW has conducted its own population projections for all regions in NSW, this study concentrates the projections of the latter three components.

The paper is organised into six sections. Section 2 discusses the research methodologies of the study, which hinge on the historical-comparative approach to constructing workforce data and the cohort analysis method for projections. Section 3 deals with the data used for projections in the study, based on what we can know about the likely past patterns of the workforce in the study area through testing the similarities between the workforces in the GMA, statewide, and nationally. Section 4 describes the non-linear growth curve fitting models employed in the study. Section 5 presents the main results of the projections. The uncertainty in projecting the labour force participation rates and the impacts of different demographic and participation

assumptions are discussed. The key findings and discussions about the projection methods of this study are concluded in the last section.

2. Research Methodologies

Historical-comparative Approach

The general approach to the study comprises two parts: a historical-comparative method of deriving workforce status information, and a cohort analysis method for labour force projections. It is a fact that more data have been collected on the change in the workforce for Australia as a whole and its States than for specific regions. If the workforces of the GMA, NSW and Australia are sufficiently comparable along important dimensions, part of the national data or State-level data can be used to derive information previously unavailable about the workforce in the GMA. In doing so, this derived information, combined with unique local factors, can be modified and then used to project the size and shape of the future GMA workforce. For example, a challenge in relation to participation rates is that data on aspects of the workforce are only collected for the whole Australian population or for the whole of NSW, but not for the GMA. To the extent that we can establish a reasonable degree of similarity between the workforces in Australia or NSW as a whole and in the GMA, we can treat the aggregate data as approximations of likely past trends in the workforce of specific interest. The approach allows us to infer required information from the existing data already produced in

relation to Australia or NSW as a whole. That is, the GMA workforce experience can be inferred from the Australian/NSW experiences, while additional factors or variables that might result in the GMA deviating from aggregate trends need to be examined.

For the purpose of comparison, a series of important demographic and socio-economic characteristics are selected which are of interest to workforce projections. These characteristics are age, sex, full-time and part-time employment status, occupation, industry, and educational attainment of the workforce. Each character exhibits a different dimension of the workforce. Figure 1 visibly shows to what extent the GMA and Australian workforces are comparable. Some main findings from the brief comparisons are as follows.

- The age distribution of the GMA workforce is much the same as that for the whole country, but with the GMA having a somewhat higher proportion of its workforce in early prime-age (25 to 35 years). This is partly the product of an influx of young people from interstate looking for employment (with those leaving NSW tending to be from older age brackets).

- Below age 50, the GMA workforce has somewhat more young women and somewhat fewer older women than the Australian workforce.

- The age distribution of both the full- and part-time workforce is almost the same for the GMA as for Australia.

- The GMA has a slightly more educated workforce, with a higher proportion of graduates and a lower proportion holding a Certificate III/IV than the Australian workforce. The difference is particularly apparent for males.

- GMA workers are more likely than the Australian workforce to be in professional occupations and less likely to be in trades and labouring jobs, especially if they are male.

- GMA workers are more likely than the Australian workforce to be in the industries of business, property services and finance, and less likely to be in primary production and construction.

In summary, the GMA workforce looks very similar to the Australian workforce as a whole, with some small differences apparent in industry and occupational composition, and in workforce educational attainment. These minor differences are not sufficient to invalidate the proposed method of projection, based on a high degree of similarity between the GMA and Australia or NSW.

*** Insert Figure 1 about here ***

Cohort Analysis

Rationale Behind the Cohort Analysis

Instead of treating the workforce as a homogeneous single entity, meaningful projections require that we make allowances for sub-group variations within the overall workforce. The two most important are the age and gender distributions of the workforce. Without anticipating patterns of change in these two factors, it would seem impossible to project the future labour participation and workforce status in the context of a population progressively ageing and a workforce that has already become substantially feminised.

The young typically have low rates of participation while they complete education. The prime-aged have higher rates (depending on gender), and the elderly have falling rates as they begin to retire. But this leaves open the question of whether the participation within a single age category (e.g., 35-40 years) remains stable over time. In other words, will those who are in this age category in 2031 have the same relationship with the labour market as those currently in this age group? Will the young people of the future be as active as the current youth in combining full-time education with part-time employment? Will the women entering their childbearing years in the future seek a quick return to the paid workforce after maternity? The best predictions about these complex individual behaviours are available from cohort component analysis (George et al., 2004). People born in different time periods, which we designate as belonging to separate "birth cohorts" or "age cohorts", have varied labour market behaviours, and different expectations. Nonetheless, factors affecting a single peer cohort can have uniform effects on that group's labour market activity, including rate of labour participation.

Figure 2 compares male and female participation rates across the age spectrum for the GMA relative to the rates of both genders across all of Australia for a single time period. The figure shows that participation rates by gender in the GMA and Australia-wide are all but identical. The female participation rates in both regions decline during early prime-age as women commence motherhood, and, on average, do not recover to the male levels. There have however been rising female, and declining male, participation rates across a number of the specific age categories in the GMA and Australia/NSW over time (refer to Figures 4 and 5).

*** Insert Figure 2 about here ***

Using the most recently available female labour participation data in NSW, Figure 3 partly depicts changes in the labour participation rates for recent birth cohorts over part of their life course. Although there is an incompleteness looking at the whole life stages of these cohorts, the participation figures presented in cohort groups facilitate the demonstration of how labour participation differs among different cohorts. Younger people have lower participation rates than those at their prime working ages. Their participation rates are lower during the principal "child bearing/caring" years (between 25 and 35 years old). Their level of participation then rises as they achieve increased levels of education and work experience at primary ages. It commonly begins to drop again as people move closer to retirement age. Also the Figure shows the large increase in female participation in the workforce over time. Cohort effects are strong, especially on prime age groups. For example, the cohort born in the 1970s had a participation rate 8 percentage points higher than the 1960-64 birth cohort did when they were aged 30-34 years.

*** Insert Figure 3 about here ***

There are three reasons to expect that the future cohorts of older potential workers (aged 50 and over) will increase their participation rates. One is the greater commitment to paid work of younger cohorts of women, which is likely to persist as they age, as evident in the data. The second is that the life expectancy of the population continues to rise. It has risen by more than 30 years for both men and women since the 1880s. While part of this is caused by a decrease in infant mortality, a reduction in the probability of death for all but the oldest age groups for both genders also contributes (Productivity Commission, 2005). This is increasing the life expectancy of people in each decade of life, so that people contemplating retirement must now consider the need to support themselves for a greater number of years. This extension of life expectancy will cause some people to postpone retirement. The third reason is that government policy is shifting in response to the ageing of the population and is likely to shift further, inducing the postponement of full retirement and greater self-provision of income in retirement (Brian et al., 2005). This policy shift is likely to accelerate as the baby boomer generation moves through the retirement phase, starting in about 2006 and continuing until about 2020.

In this study we adjust upwards the projected labour participation of older age cohorts (especially males), taking into consideration the demographics and composition of the ageing population in the GMA and the recent adjustments to industrial regulations and social policy country-wide. Such an adjustment can properly reflect the impact on retirement of the behaviour

of the baby boomer generation, or the consequences of extended life. For young people, the increasing duration of education has delayed their entry to the workforce. The participation rates for youth of both genders are lower in the GMA than across Australia as a whole. But so long as part-time and casual work opportunities remain plentiful for young people, many of them will continue to combine education with partial labour participation. For this reason, for instance, we adjust the participation rates for the youngest female group to reflect the trend of climbing participation since 1997.

Cohort Analysis Methods

The method for analysing cohort effects on labour force projections involves two aspects: (1) extrapolating the trends of the outcomes of the rates of the main components (participation, full-time or part-time employment, and unemployment) of the labour force for all successive age cohorts in the past years into the future; and (2) applying the projected rates to the projected population to predict the workforce in the forecast time span. How to model the evolution of future labour force participation is a key issue in building a dynamic model to project participation rates (Burniaux et al., 2004). The pattern of the lifetime participation profile is determined by the pattern of participation in the labour force as a cohort ages. The whole working age population is grouped into 11 age cohorts in intervals of five years (i.e., 15-19, 20-24, …, 65+ years).

The evolution of aggregate labour force participation in the future will be determined by two factors. One is the change in participation for each sex-age-specific group. The other is the change in the demographic structure of the population at working age by gender. The patterns of the participation rates for each age-sex-specific group over time are irregular, making it hard to project their future paths. Some participation patterns for specific age groups have been quite stable, while other patterns have varied over time. Since the participation rates have different limited periods of increase or decrease, they are usually modelled as sigmoidal (S-shaped) curves; as are the part-time employment shares and unemployment ratio.

3. Data

The original data and sources used in the projections of this study include: (1) Labour force status by region, age (ABS cat. no. 6291.0.55.001), from September 1992 to April 2005, provided by the TPDC of DIPNR; (2) Labour force projections (including participation rates, part-time shares, and unemployment ratio) for Australia and NSW, from 2004 to 2051, sourced from the website of the Productivity Commission (http://www.pc.gov.au/study/ageing/finalreport/data/index.html); and (3) NSW State and Regional Population Projections: 2004 release, provided by the TPDC of DIPNR.

As real longitudinal data on the rates of labour force participation, part-time employment and unemployment are unavailable for the GMA, we used synthetic cohort data sets, derived from

the panel data over time, for the projections in this study. Several data deficiencies need to be emphasised. Data for labour force status and civilian population in the workforce were sometimes presented in 5-year age groups and sometimes in 10-year age groups. For example, within the labour force survey data from 1993 to 2004, the total labour force, unemployed persons, part-time employed, and total civilian population are available only for 25-34, 35-44, and 45-54 age groups, rather than separately for 25-29, 30-34, 35-39, 40-44, 45-49, and 50-54 age cohorts. Also the available data was original monthly data rather than yearly data. Moreover, data sets for earlier years (e.g., back to 1978) are unavailable or incomparable due mainly to the changed geographical boundaries applied to the ABS labour force surveys prior to 1992. Various data inadequacies produced an obstacle to accurate modelling of the labour force for given age cohorts over time.

We resolved the problem of the unevenly spaced age groups by using population interpolation techniques to break down the 10-year-age groups into 5-year-age groups. The interpolated quinquennial age groups of datasets laid the basis for cohort analysis. Because individual subgroups are crucial in the projections for this study, an aggressive smoothing method, the Grabill technique, was used. Grabill's coefficients substitute weighted moving averages for the observed values. These coefficients weight the "centre" of the moving average much less heavily than other sorts of coefficients such as Sprague's coefficients or Karup-King's coefficients (Popoff and Judson, 2004, p.703-706).

The average annual labour force, working age civilian population, part-time persons, and unemployed people were calculated from the original monthly data from 1993 to 2004. As a result, the participation rates, part-time shares and unemployment ratio in the GMA were estimated over the period from 1993 to 2004.

The data gaps in participation rates and part-time shares for earlier years (from 1979 to 1992) for the GMA were filled by estimates derived from other data. The annual participation rates and part-time shares for the GMA across the period 1993 to 2004 and for Australia and NSW over a longer period from 1978 to 2004 were smoothed using a Hodrick Prescott filter. In doing so, the statistical noise of the original data was largely removed, showing the general trends of participation and part-time shares in the long run. The smoothed data sets at the national, state and regional scales were compared for each age-sex cohort. There are high levels of correlation for most age-sex cohorts. For example, for some male groups (15-19, 45-49, 50-54, and 60-64 years old), the patterns of participation in the GMA are similar to those in NSW, while the patterns for the other male groups are similar to those in Australia (Figure 4). For all the female age groups, the patterns of participation in the GMA exhibit very close similarities to those in NSW (Figure 5). The average changes in the participation rates for all age-sex specific groups between the GMA and NSW or Australia from 1993 to 2004 were calculated. The variations of the calculated averages are small, at –0.017~0.012 for the male groups and –0.025~0.011 for the female groups respectively. The calculated averages were incrementally applied to the participation rates for the corresponding age-sex groups in NSW or Australia to obtain the estimates of the participation rates for the GMA over the period 1978 to 1992. The patterns of

part-time shares for all ages of the male and female population in the GMA are parallel to, but lower than, those in NSW and Australia. The estimates of the participation rates (or part-time shares) together with the participation rates (or part-time shares) calculated on the basis of the observed values form a complete time series for the GMA over the time span from 1978 to 2004, as shown in Figures 4 and 5.

*** Insert Figures 4 and 5 about here ***

We used the observed data series from 1993 to 2004 for the projections of the unemployment ratio. The available information about unemployment in the GMA does not allow us to judge whether the observed series can be extended back to 1979 in line with the correlation between the GMA, NSW and Australia since 1993, as there were no obvious similarities among them.

4. Projection Methods

Richards Curve Fitting Models

The class of functions called S-shaped curves is motivated by the fact that rates must be in the range [0,1] and therefore cannot grow as polynomials or exponentials. Since it is not possible to implement full modelling of all the economic, political, social, cultural or even natural influences on the participation rates and other workforce status, we fit data and extrapolating under the

assumption that the present trends capture the sum of these effects and will continue in the future. This means we do not predict changes from growth to decline or the other way around. Only curves that are monotone increasing or monotone decreasing should be considered. A monotone and bounded range [0,1] implies S-shaped curves. There are many types of S-shaped curves, including the logistic curve, for example. The logistic curve is symmetric in the speed at which it reaches its lower and upper asymptotes. For this reason it is considered too restrictive for some models (Jarne et al., 2005). Richards curves are the simplest curves that satisfy all the properties above yet do not require symmetry (Richards, 1959). Richards curves provide flexible representations with series describing economic, demographic as well as technological change. With Richards curves it is possible to model any growth in the sigmoid form and distinguish the three phases that underlie these evolutions: emergent, inflexion and saturation, as well as the periods of expansion and contraction of economic phenomena.

The participation rates, part-time shares and unemployment ratio were modelled as Richards curves. These rates were predicted using non-linear least squares curve fitting techniques subject to limits on the long-term participation rates, part-time shares and unemployment ratio. Projections directly focus on finding the best fits of Richards curves to the data comprising participation rates (or part-time shares, unemployment ratio) for men and women in each age group for some years. The Richards functions take the form:

$$y_t = c + a \times (1 + b e^{gt})^{\lambda}$$
(1)

Some restrictions for the parameters were set up over the parameters $a+c$, b, c, g, and lambda

(λ). The reason is that the limits at upper and lower infinity are $a+c$ and c, so that in constraining these to [0,1], which ensures that the curve stays in this range, b is also constrained to [0,1]. Lambda is constrained to [-1, -20], g is constrained to either [-20,0] or [0,20], depending on whether the curve is nominally increasing (e.g., participation among females) or decreasing (participation among males).

The ceiling ($a+c$) is the maximum labour participation level either attainable in the past and present economic paradigm or to be reached in the future, whilst the floor (c) represents the minimum level, which might have been reached in the preceding paradigm or may be reached in the future. For most age groups, there was only one trend for the whole measured data set and the results for these cases were easily projected. Rechards curves for each age-sex specific cohort have different coefficients reflecting disparities in the workforce experience and conditions of people involved in the workforce. The changes and parametric values vary by age and sex.

Adjustment of Projections

Good fits have been obtained for most age/sex groups. However, for a few age groups (males aged from 55 to 65+ years, and females aged 15 to 19 years), the curves do not fit the observed participation data well. For example, for the older males aged 60+, a clear change in the pattern of labour participation can be discerned in the early 1990s, showing a turning point (i.e., an increase) in labour participation. In cases where the data shows a local minimum or local

maximum, there is a case for using only the data points that come later than the local extremum. The justification is that some cultural or political (or other) change occurred that could not be modelled. We can model the trends since this change occurred and use a Richards curve on the restricted data. This approach was used whenever relevant in the projections of both labour participation and part-time employment.

For each age group within each class (e.g., female part-time), an initial visual analysis of the evolution of a series over time helped in identifying whether the trend of the 10 most recent years is an increasing or decreasing trend, and in finding the first year when this trend started. The initial value and limits of the ranges for the various parameters is determined by whether the trend is increasing or decreasing. Adjustments to the predictions of participation rates and part-time shares have been made, as shown in Figure 6.

*** Insert Figure 6 about here ***

5. Projection Results

Labour Force Participation Rates

The male participation rates for the groups aged between 15 and 54 years are estimated to drop slightly over the period 2005 to 2031 (Figure 7). In contrast, the participation rates are expected

to rise by around 13 and 27 per cent respectively for those aged 60-64 and 65+ years over the same period, but still remain low compared to those of the male groups aged 25 to 59 years. The greater involvement by older males as well as older females reflects the trend towards the higher retention rates in the labour force for these age groups.

The projections show a tendency towards sluggish or stabilised growth of female labour participation for those aged between 15 and 54 years; and proportionally greater increases in participation for the female groups aged 55 years and older (Figure 7). For example, the female participation rates are predicted to increase by approximately 37, 57 and 38 per cent respectively for ages 55-59, 60-64, and 65+ between 2004 and 2031.

*** Insert Figure 7 about here ***

The aggregate labour participation rates for the whole population and both genders for the GMA are calculated by weighting the age-specific rates by their relevant age population shares. From 2005 to 2031, the overall aggregate participation rates are projected to reduce by 4.6 percentage points from 63.1 per cent in 2005 to 58.5 per cent in 2031 (Figure 8). The total aggregate male participation rates are projected to fall by 7.5 percentage points from the current level of 70.7 per cent to 63.2 per cent in 2031. The total aggregate female participation rates are projected to decline by 1.8 percentage points from 55.6 per cent in 2005 to 53.8 per cent in 2031.

Uncertainty in the Projections of the Participation Rates

There is an unanswered question as to whether the age-sex-specific trends underlying these aggregate participation predictions are likely to be realised. It is highly likely that female participation will remain stable for the prime age groups and continue to rise for those older people (aged 55 years and over). The reason is that the driving forces (e.g., increased education, flexibility of work and availability of part-time work) for growing female participation rates are still at work. Also, the projections of the study picked up the changing demographic patterns. For example, the baby boomer generation has seen its children leave home and "empty nesters" have moved back into the labour force increasing (predominantly) the female participation rate, but that change must be nearing the end of its cycle. In addition, the tendency of females to delay leaving the labour force to have children may have reached the end of its cycle and may even reverse in the next 10 years or so. But there is less confidence in the extent of stagnation in labour participation for males aged 15 to 59 years. The reason is that it is uncertain whether or not the historical forces resulting in decreased participation will continue in the long run. Despite the fact that our projection approach can pick up the cohort effects on participation, it unavoidably has some uncertainties for predictions over a projection horizon of 26 years. This demonstrates the need for sensitivity analysis.

Such analysis reveals that the aggregate participation rates are relatively sensitive to different

assumptions about trends in age-sex-specific participation rates, as shown in Table 1. Had age-sex-specific participation rates remained unchanged at their base levels in 2004 but ageing still occurred, the overall aggregate participation rates by 2031 would be 57.7 per cent, with 65.7 and 49.7 per cent for males and females respectively (Scenario B). It is only 0.8 percentage points below the overall aggregate participation rate under the "Base case". The variation (4.1 percentage points) of the aggregate female participation rate by 2031 is much higher than that of males (2.5 percentage points). This underlines the point that an important determinant of the future aggregate participation rate is the shift in the age structure of both the male and female population.

*** Insert Table 1 about here ***

Under Scenario C, which assumes that male participation rates for those males aged 15 to 54 years stayed at 2004 rates, the gain relative to the "Base case" in the total aggregate participation rate by 2031 would be around 1.6 percentage points. Several factors may halt the historical fall in the participation rates for these age groups. The factors include changes to labour market programs aimed at Disability Support Pension (DSP) beneficiaries (mainly males in unskilled occupations) and policies that reduce entry into DSP, coupled with general policies aimed at encouraging more active participation of males (DEWR, 2004).

Assuming that participation rates for both older males and females would largely increase (Scenario D), the overall aggregate participation rate would raise 3 percentage points above the

level under the "Base case". This is an extreme assumption (therefore probably unrealistic) for the oldest males and females, implying that participation rates for males and females aged 65 years and over in 2031 are between 1.3 and 3.5 times greater than the maximum apparent between 1993 and 2004 respectively.

Under Scenario E, the overall aggregate participation rate in 2031 is still 2.4 percentage points below the 2004 level, while it is 1.5 percentage points above the level under the "Base case" by 2031. Similarly, the aggregate participation rates for males and females are respectively 3.8 and 1.2 percentage points lower than the corresponding figures in 2004.

Had there been no change in the age structure of the population after 2004, participation rates would have risen by 5.3 percentage points for the total population or the gender-specific population (Scenario F). This margin illustrates that population ageing would have a large effect on the GMA's participation rates (Figure 9).

*** Insert Figure 9 about here ***

Part-time Share

At any time, the number of people who are actually employed is determined by the intersection of the number and types of workers that employers want (the demand) and the number and

types of people who are willing to work (the supply). Only occasionally do these two match – at which point we have full employment. When, as is historically generally the case, the supply of workers exceeds the demand for workers at the "aggregate wage rate", it is the quantity demanded that determines the numbers who are actually employed ("short-side dominates").

Part-time employment, as a proportion of all employment, has grown rapidly in the GMA (as elsewhere). That is, the employed part-time share has increased from 36.1 per cent in 1993 to 40.9 per cent in 2005 for women and from 9.7 to 14.5 per cent for men in the GMA. Women are more willing to take on part-time work than men, mainly because it is one way that they can balance work and family demands. It is worth noting that the proportion of men in part-time work has grown 4.8 per cent over the same period. This growth is driven mainly by the absence of full-time jobs, rather than the preference of men for part-time work. The absolute numbers of both men and women that work full-time has scarcely grown over the same period: almost all job growth has been in part-time work.

The rise in part-time employment has been largely driven by the pattern of jobs on offer, rather than by the preferences of workers. On the supply side of the dynamic workforce, there are three groups who are likely to have a preference for part-time jobs. These are: women with children, full-time students, and people approaching retirement. Women with children have joined the workforce for socio-economic reasons that are somewhat independent of other developments in the labour market. The rise in the pressure for extended levels of formal education has kept many young people in the classroom who would otherwise be looking for

full-time jobs. Many have sought part-time jobs to combine with full-time education, further expanding the pool of people wanting part-time work. A further addition to the supply of part-time workers is likely as the baby boomers move into the older age group (55-65 years), and seek part-time work as a form of partial retirement. As a result, the expansion in the desire by employers for part-time workers has somewhat coincided with an expansion in the supply of such workers. Over the next 30 years, there is likely to be a further expansion in the supply of older workers seeking partial retirement; but there is little certainty about the increase in the supply of students and females as part-time workers.

On the demand side of the dynamic workforce, demand for part-time or casual employment has outstripped supply and hence many people, especially males at prime ages (20-54 years) have taken part-time work when they would have preferred full-time work. The increased demand for part-time work has been partly driven by the shift from the production of goods to the production of services. Also influential is the extension of economic life to encompass "after hours" retailing and the intersection with workplaces in other time zones around the world. In addition, expansion in the relative share of part-time work can be driven by employer preferences.

The overall aggregate part-time shares of the labour force in the GMA are projected to rise by 17.7 per cent, from 26.3 to 31 per cent between 2005 and 2031 (Figure 10). The aggregate part-time shares for males are projected to increase by 31.5 per cent (from 14.5 per cent in 2005 to 19.1 per cent in 2031), while the corresponding figures for females are projected to rise by

only 9.2 per cent (from 40.9 per cent in 2005 to 44.6 per cent in 2031). Males aged 20-64 years will contribute a higher proportion to the increase of the part-time ratio than other males.

*** Insert Figure 10 about here ***

The younger and older age groups of both males and females are projected to sustain the trend of greater involvement in part-time employment. For instance, over the period 2005 to 2031, the part-time share is projected to change from 59.1 to 69.1 per cent for males aged 15 to 19 years, from 25.1 to 36.4 per cent for males aged 20 to 24 years, from 24.2 to 34 per cent for males aged 60 to 64 years, and from 49.3 to 56.6 per cent for males aged 65 years and over. Correspondingly, for female groups, the part-time share is projected to change from 74.9 to 79 per cent for those aged 15 to 19 years, from 36.5 to 52.4 per cent for those aged 20 to 24 years, from 62.1 to 64.9 per cent for those aged 60 to 64 years, and from 73.3 to 82.1 per cent for those aged 65 years and older. It is predicted that the greatest increase of the part-time share will take place among both males and females aged 20 to 24 years, at 45 and 43.4 per cent respectively.

Unemployment Ratio

There are two principle factors influencing the aggregate unemployment ratio in the long run: first, the long-run unemployment rate associated with a stable or non-accelerating inflation rate; second, demographics which alter the weighted age-sex-specific unemployment rates.

Recent Australian history has seen a continuous shortage of jobs and surplus of workers, which shows up as unemployment. Even today, when there is much talk of skills shortage, there are still over 500,000 people who are in the workforce but do not have jobs. In addition, there are a large number of people who have a part-time job but want more hours of work. The ABS estimates that about 10 per cent of the current potential workforce is "under-employed" (ABS Labour Force Surveys, cat. no. 6203.0, various).

It is a fact that the GMA, like Australia, is experiencing an era of stable macroeconomic growth. In this context, we derived aggregate unemployment rates by projecting unemployment ratio for age-sex-specific cohorts first and then incorporating them into demographics and labour force participation rates. The overall aggregate unemployment ratio is projected to fall by 0.8 percentage points from 4.8 per cent in 2005 to 4 per cent in 2031 (Figure 11). The aggregate unemployment rates for males and females are projected to decrease by 1.1 percentage points (from 4.6 per cent in 2005 to 3.5 per cent in 2031) and 0.5 percentage points (from 5.1 per cent in 2005 to 4.6 per cent in 2031) respectively. The highest unemployment rates will be experienced by the youngest age group of people, who are positioned to a stage of accepting education and being in the transition from education to work. In contrast, the lowest unemployment rates will be experienced by males aged 55 to 59 years and females aged 60 to 64 years respectively, who have the alternative of retirement.

*** Insert Figure 11 about here ***

Labour force Supply

Assembling the components of labour supply (participation, part-time/full-time work and unemployment) provides a perspective on labour supply – the number of people in employment. Moreover, the employment-to-population ratio is projected to decline during the projection horizon after reaching a peak (some 0.60) in 2006 (Figure 12). The number of employed people is projected to grow by over a quarter of million in the nine years from 2004 to 2013 and then by a further some a quarter of million in eighteen years to 2031. In the next 26 years, the pace of labour supply growth is expected to be slower than population growth.

*** Insert Figure 12 about here ***

Complex Factors Influencing the Workforce Evolution

The relative power of demand for workers compared with supply in determining the actual number employed varies with the short-run business cycle. When projecting for a time horizon of 26 years, it is impossible to anticipate the course of the business cycle. In this study, we projected labour participation on the assumption that economy is operating close to full capacity, at about the current rate of unemployment. This assumption removes some of the complexity associated with changes in labour demand resulting from the long-run cycle of macro-economic growth or recession. Operating under this assumption however involves little evaluation of other

potential influencing factors on future labour demand, including technological change, mainstream consumer tastes, and regulatory policies. These factors are difficult to predict separately and even more problematic to factor into workforce projections. On current appearances, the direction of industrial relations reform is strongly heading towards individualistic employment relationships becoming more common, and this affords some smaller businesses a freedom in their employment practices that has not previously been available. Some may choose to hire more workers, giving effect to previously unmet labour demand. The longer-term effects however will remain dependent on the business cycle and for this reason we did not treat these changes as a substantial factor in the future shape of the GMA workforce. As to consumer tastes, while these undoubtedly influence employment levels and working arrangements, their major effect over the next 26 years is likely to be in terms of an impetus for continued growth in the consumer and information services industries, while the demand for (particularly unskilled) workers in the traditional goods and commodity sectors grows less rapidly, or possibly declines.

Research into the impacts of technological improvements on the workforce has shown that in the past two decades technological improvements are associated with demand patterns throughout the developed countries in complex ways (Kim, 2002; Autor et al., 2003). New technologies, especially computerisation, have been critical in shifting demand in favour of the skilled, producing increased wage inequality as well as changing where and how people are employed. The demand changes have been most apparent within technologically intensive industries (especially manufacturing), and this appears to be common across different countries

(Berman and Machin, 2000; Machin, 2001). In Australia, the so-called "knowledge economy" has developed alongside the improved quality and diffusion of information and communication technologies. Here, as elsewhere, a more "skilled" workforce, coupled with greater "flexibility" in its deployment, has been seen as the critical determinant of the speed with which technological changes can be adopted. Technological advancement will continue to shape the labour market in the next thirty years, particularly in a region like the GMA which is heavily reliant on employment from skilled professionals operating in the "high-tech" industry sector. Yet in the context of high and rising educational attainment in the workforce, and the evidence of a decreasing unemployment ratio, there seems little reason to see skill shortages or under-training as likely impediments to future jobs growth in the GMA.

The difficult question arising from our projection of labour supply in the GMA to 2031 is whether the demand for workers will be sufficient to absorb the projected increase in supply. As new workers enter the labour force and older ones stay on longer to postpone their retirement, will there be enough jobs to go around, in the right places, to fulfil the range of very different individual work preferences? A demand deficiency would mean higher unemployment (or involuntary earlier retirement) for some workers, and while many would find another job in a different area of the workforce, possibly after retraining, others would withdraw from the labour force, becoming "hidden" unemployed.

For the next 26 years, even with the onset of population ageing, we expect that total employment will continue to be constrained on the demand side, rather than on the supply side. That is, the

growth of the workforce will be hindered not by a shortage of suitable workers, but by a shortage of suitable jobs. In particular, this shortage appears likely to take the form of a slow growth in full-time job opportunities, relative to the more rapid continued growth of part-time and casual employment opportunities (even where workers would prefer to be full-time). Employers will continue to look for skilled workers possessing a balance of formal qualifications and informal communication, networking and team-working skills, and for the most part these demands will be met by an increasingly credentialed labour force. Where particular skills are in short supply, workers may have some power to determine their conditions of work, but the federal governments' concentration on attracting skilled, young, well-educated immigrants may also alleviate any excess demand for skilled workers. Yet where skills are plentiful or substitutable, workers may be forced to take jobs at levels below those for which they have trained.

This study has shown that the Australian/NSW and GMA workforces are highly comparable, although the GMA workforce is slightly younger and better educated than the Australian one, and more skewed towards professional employment in the business, finance and property industries. The differences are, of course, not random: the availability of jobs in these attractive conditions, high-paying industries attracts young and well-educated workers to the GMA in the first place. While the jobs remain available, it is likely that the necessary labour supply will continue to grow to accommodate demand. Whether the jobs do, in fact, remain available in the future depends mainly on the profitability and hiring decisions of employers, and perhaps on

decisions made by their owners or directors located in overseas headquarters, and ultimately by Australian and global economic conditions.

When we compare labour participation patterns in the GMA, NSW and Australia, we see in all locations the effects of population ageing, the evidence of increasing female, youth and elderly participation rates, and the contraction of prime-age male participation rates. And when we look at the types of jobs on offer in the GMA and Australia/NSW, we see very similar distributions of part-time (and full-time) employment, suggesting that employers in the GMA are moving with the national trend towards more flexible engagement of their workers. Looking to the next 26 years, the growth of part-time employment is projected to continue, and "non-standard" casual and contract forms of employment will take up an expanding share of the total jobs. Governments can shape the rate of change in this area, but most have been hesitant in the face of strong employer preference for working arrangements that break with traditional constraints (such as award rates of pay and binding unfair dismissal arrangements).

There is a difficulty in factoring changes in the business cycle, in social values and attitudes, and in consumer preferences and technology into any projections. Cohort analysis provides a powerful method to capture some of the underlying changes in labour supply, yet it is not without limitations, and its results must be used judiciously given what we already know about changing behaviours: for instance, the propensity of the ageing to seek a slow withdrawal through part-time work. Projections about labour supply can be made on a basis of compositional changes in the broad working-age population, but observed participation rates

have the capacity to vary widely over a twenty-six-year period. In addition, workers' choices about their labour supply are conditioned on their perceived prospects in the labour market. Nonetheless, it is necessary for planning that projections be constructed.

6. Conclusion

Population ageing has a depressive impact on labour supply, greatly reducing the labour participation rates. The projections for female participation show consistent growth up to 2012 and then ongoing decline through to 2031 due partly to stabilised participation for females aged from 15 to 44 years, while participation of male prime ages continues to decrease. Rising participation observed since the early 1990s for both sexes aged 50 years and older is expected to continue, but this age cohort accounts for only about 12.8 per cent of the labour force by 2031. There are a few prospects that the demographic impacts on participation can be significantly offset through government policy interventions to encourage participation of labour broadly and males in particular. The incidence of part-time employment will continue to rise for most age cohorts in the GMA (particularly for younger and older people). The unemployment rate is likely to maintain its current historically low level for both genders, and there will be a sluggish increase of the number of people in employment. The pace of employment growth will be slower than population growth from 2013 to 2031.

Effective analysis and estimation of the evolving workforce are crucial to informed transport and

urban planning. For purposes of labour force projection, the division of the population into age groups by sex is an important methodological advance. It allows one to account for the differences in the participation rates, part-time/full-time share, and unemployment rate among different age groups at a particular time and to consider how rates change over time for individual cohorts. Growth curve models, especially Richards curves, and cohort analysis provide ideal methodologies and techniques to facilitate labour force analysis in an objective way, especially in dealing with the complexity and uncertainty of the changing labour market and varying workforce experiences of people at different stages of the life course. Using a historical-comparative approach, information about generic trends of labour participation and workforce status (e.g., employed or unemployed, full-time or part-time employed) at a lower scale of area can be reasonably inferred from available data sets collected at a higher scale of region, based on similarities of those comparable elements relating to the labour force. With sufficient and precise workforce data, the changes of future labour force at any scale can be reasonably analysed using non-linear curve fitting models and cohort analysis methods. Methods used in this study at a regional scale might be applicable to other areas at a similar or smaller scale. With sufficiently current data, changing size and shape of the workforce can be further mapped out, with a greater certainty of forecasts for a short-term period. The methodology of this study provides policy-making and planning departments with scientific specifications and an effective technical approach.

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Figure 1 Comparison of the GMA and Australian Workforces, 2001
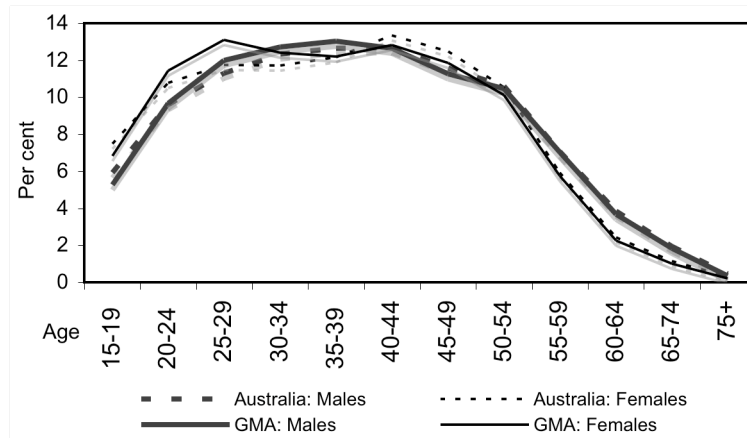
a. Age distribution by sex.
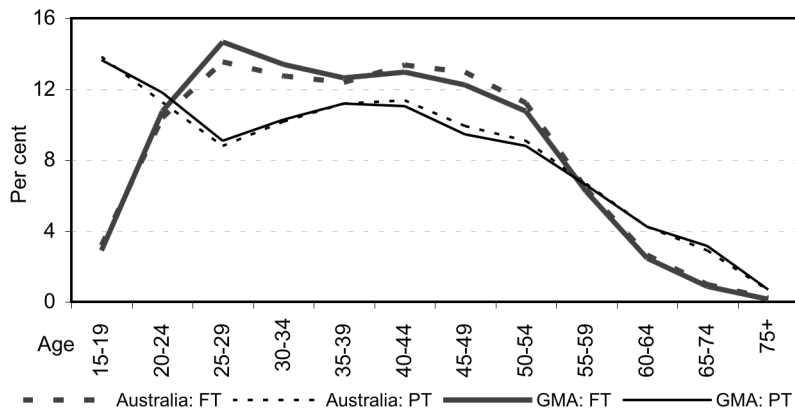
b. Age distribution by full-time/ part-time employment.
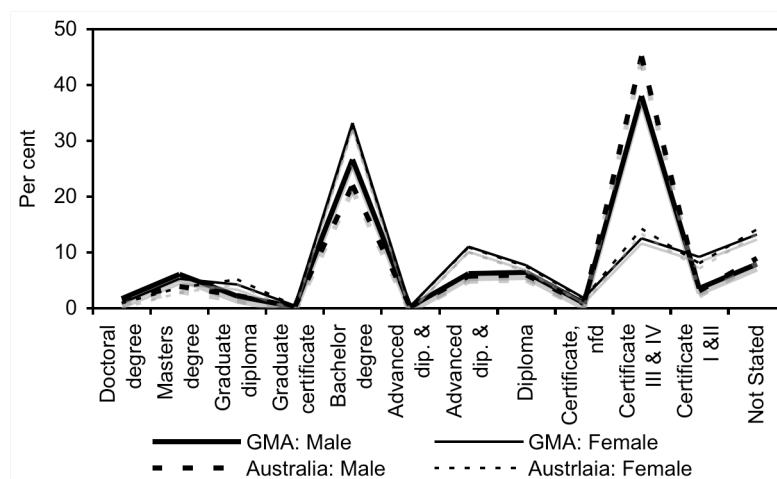
c. Workforces by educational attainment and sex.
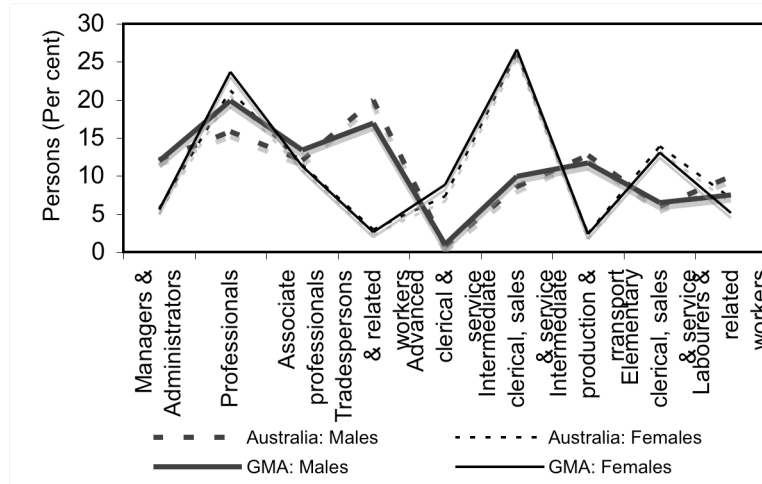
d. Workforces by occupation and sex.
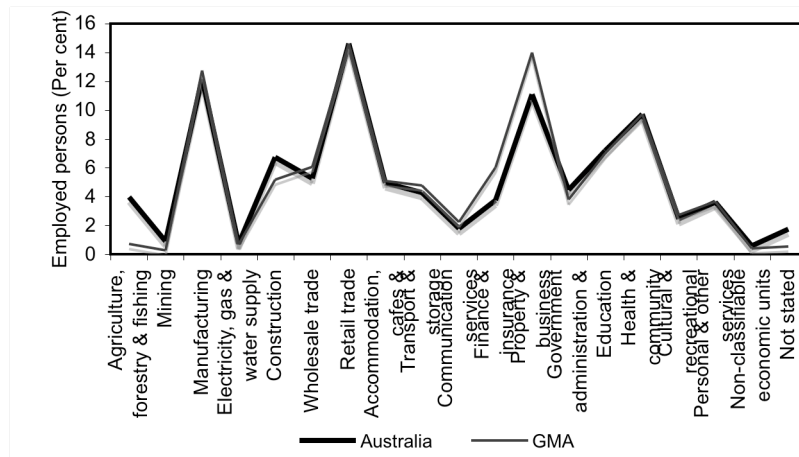
e. Workforces by industry of employment.

Data sources: Calculated from the Australian Bureau of Statistics (ABS) Working Population Profile (Cat. no. 2006.0); ABS National Regional Profile (Cat. no. 1379.0.55.001); ABS Usual Residents Profile (Cat. no. 2004.0).

Figure 2 Labour Force Participation Rates, by Sex and Region (January 2005)
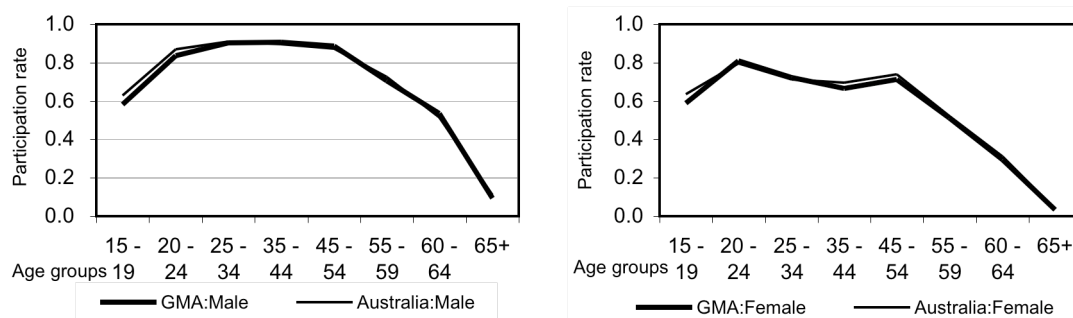
Data sources: Calculated from ABS Labour Force, Australia, Detailed (Cat. no. 6291.0.55.001) and the labour

force projections of the Productivity Commission (2005).

Figure 3 Comparing Female Participation Rates in NSW, by Age, for Three Cohorts
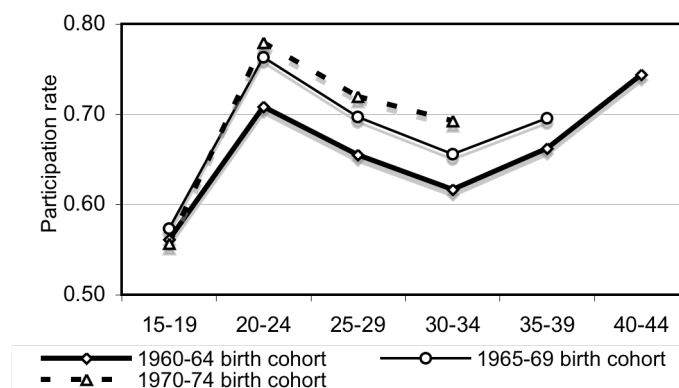
Data source: The labour force projections of the Productivity Commission (2005).

Note: Data on ages and birth cohorts are the midpoints of 5-year intervals.

Figure 4 Comparison of Labour Participation Rates and Derived Participation Data for Males
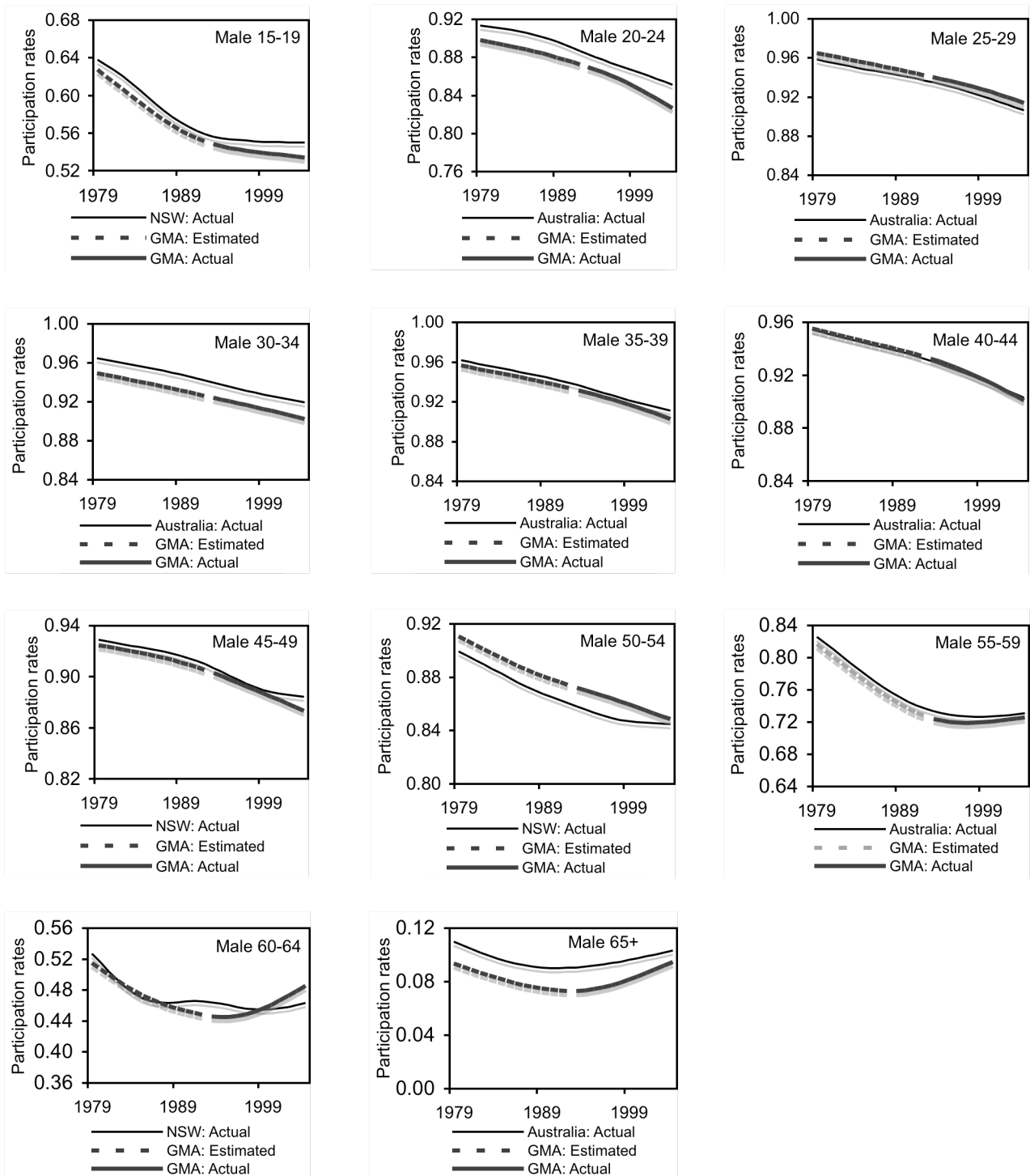
Data sources: Authors' estimates; ABS Labour Force Surveys (Cat. no. 6291.0.55.001); labour force projections of the Productivity Commission (2005).

Figure 5 Comparison of Labour Participation Rates and Derived Participation Data for Females
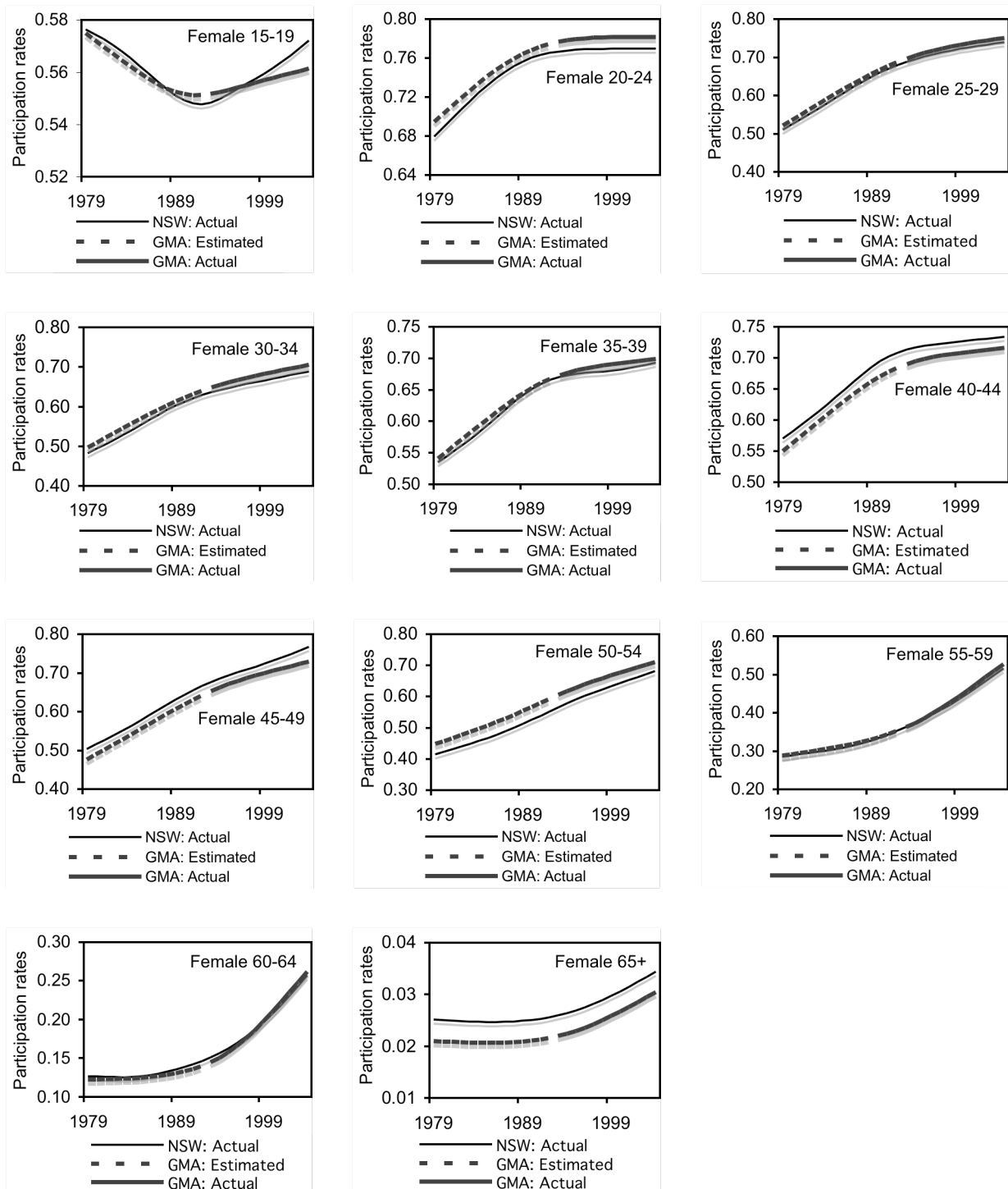
Data sources: Authors' estimates; ABS Labour Force Surveys (Cat. no. 6291.0.55.001); labour force projections of the Productivity Commission (2005).

Figure 6 Selected Adjustments Made to Male Participation Rates and Female Part-time Share
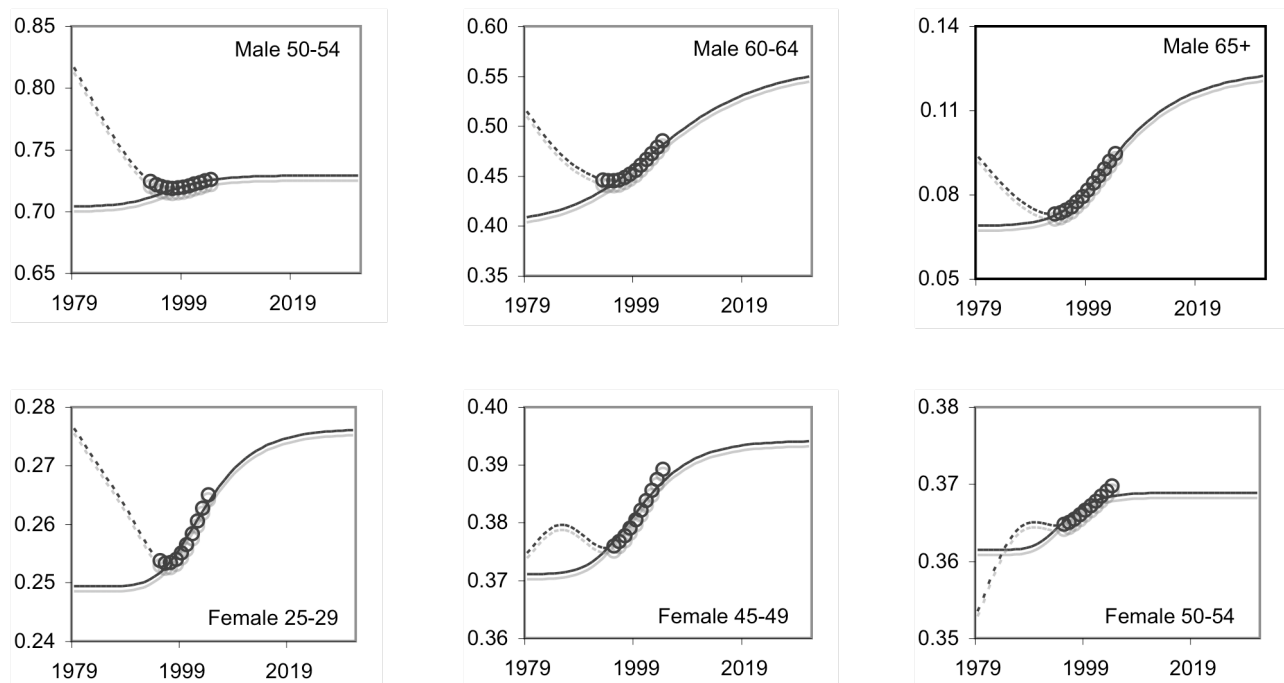
— Predicted part-time ratio

○ Measured data that was used to fit the Richards curve to the most recent trend

… Measured data that was discarded because it does not form part of the most recent trend

Data source: Authors' estimates.

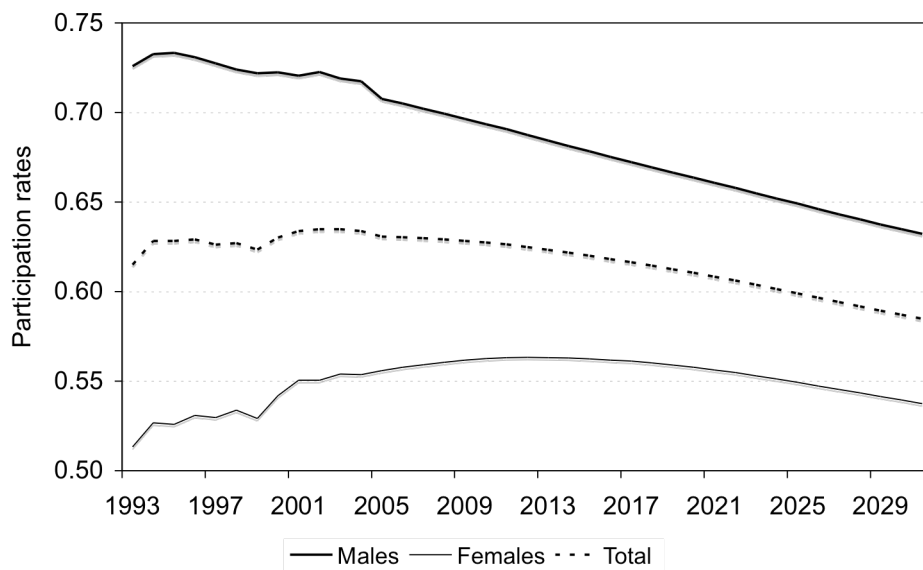**Figure 7 Projected Participation Rates by Age and Sex: GMA 1993-2031**
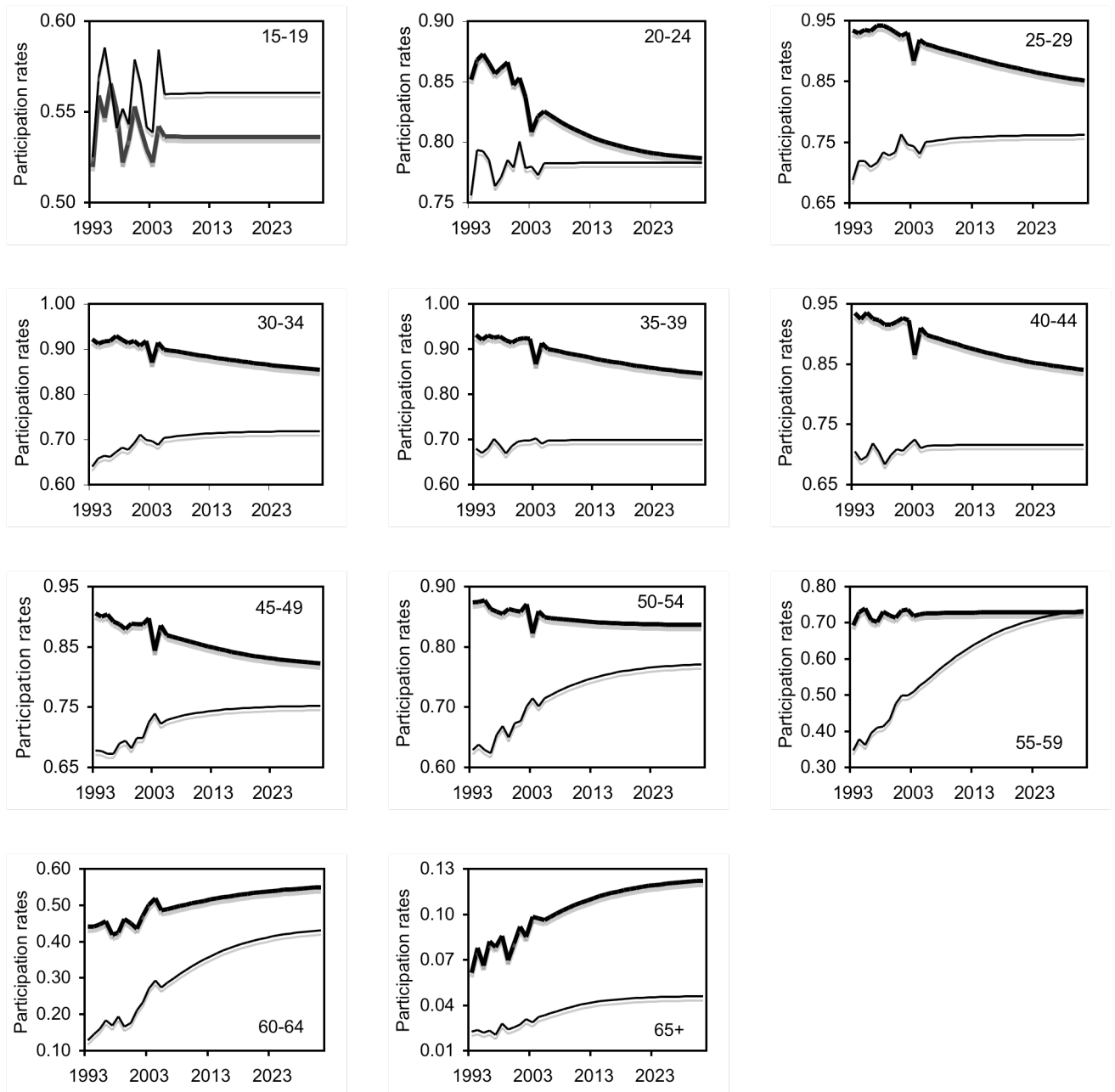

Male   Female

Data sources: Authors' estimates from 2005 using the cohort analysis method. Otherwise rates are derived from the ABS Labour Force Survey (Cat. no. 6291.0.55.001)

Figure 8 Aggregate Participation Rates: GMA 1993-2031

Data sources: Authors' estimates from 2005 using the cohort analysis method. Otherwise rates are derived from the ABS Labour Force Survey (Cat. no. 6291.0.55.001).

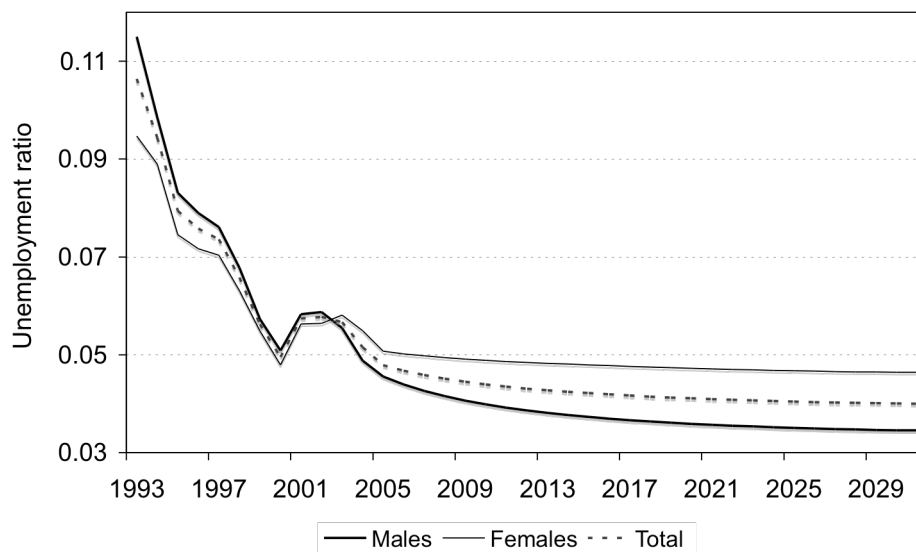**Figure 9 Aggregate Participation Rates Fall with Ageing: GMA 2005-31**
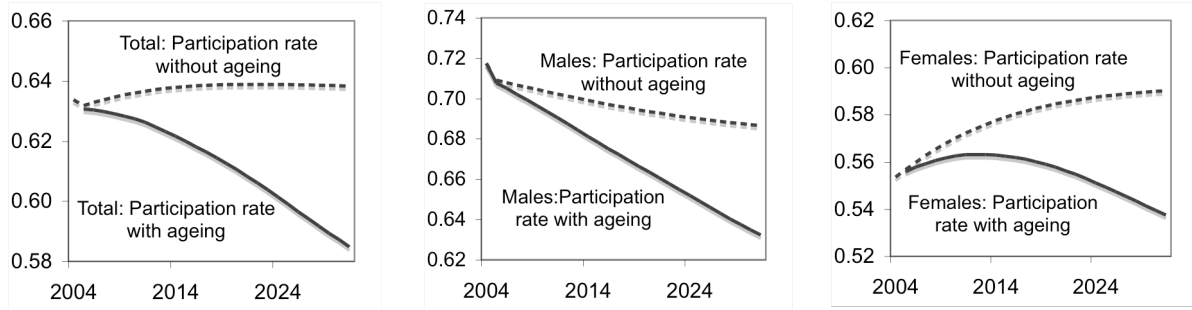
Data source: Authors' estimates.
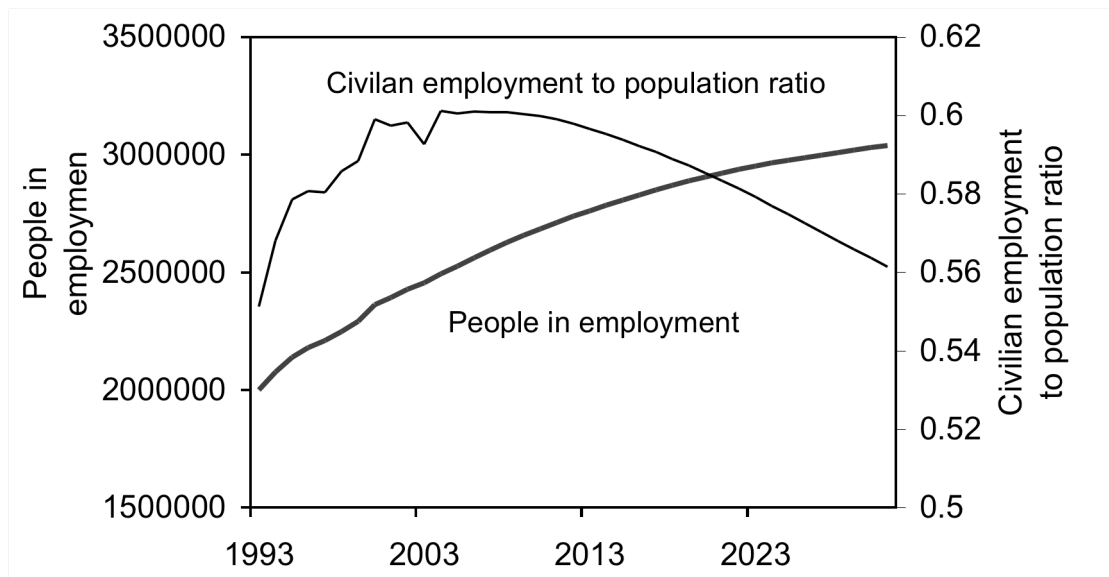
Figure 10 Aggregate Part-time Share: GMA 1993-2031
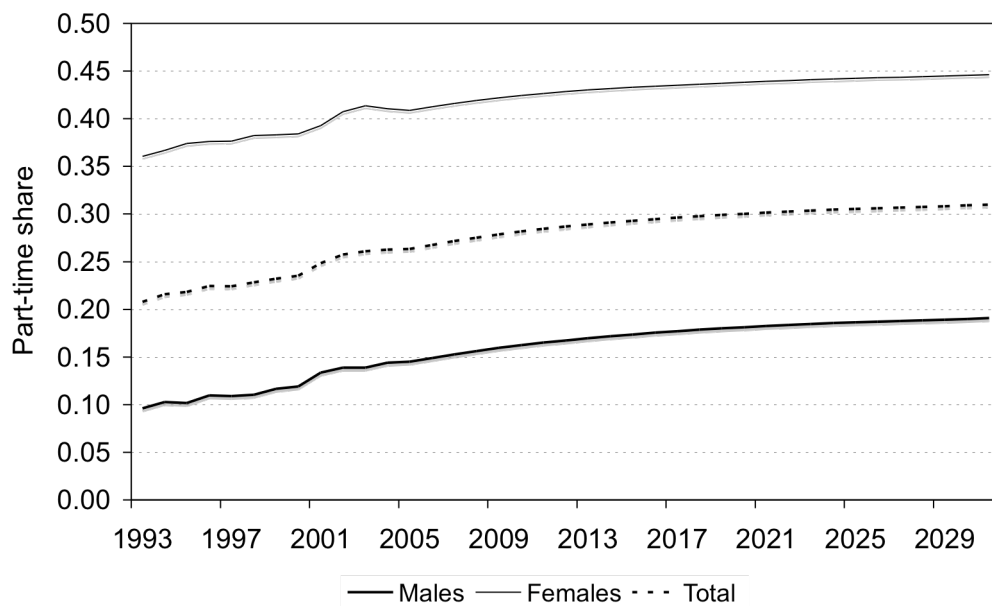
Data source: Authors' estimates.

Figure 11 Aggregate Unemployment Ratio: GMA 1993-2031

Data source: Authors' estimates.

Figure 12 People in Employment and Employment-to-population Ratio Changes: GMA 2005-31

Data sources: Authors' estimates on labour supply; NSW State and Regional Population Projections: 2004 release, provided by the TPDC of DIPNR; ABS Labour Force, Australia, Detailed (Cat. no. 6291.0.55.001).

Table 1 Aggregate participation under different age/gender scenarios: GMA in 2031

Scenario	Assumption	Aggregate participation rate (%)		
		Total population	Males	Females
A	Base case[1]	58.5	63.2	53.8
B	No change in age-sex-specific participation rates after 2004	57.7	65.7	49.7
C	Age-specific rates for males aged 15-54 years do not fall after 2004	60.1	66.5	53.8
D	Age-specific rates for both genders aged 60 years and over 10 points above 2031 base	61.5	66.1	56.9
E	Age-sex-specific rates reach the maximum level between 1993 and 2031[2]	61.0	67.9	54.2
F	No population ageing after 2004	63.8	68.7	59.0

Note: [1] Authors' projections.

[2] The data used for this calculation are the ABS actual participation rates from 1993 to 2004 and the authors' base case projections from 2005 to 2031.