BRITISH COLUMBIA LABOUR FORCE PARTICIPATION RATE PROJECTIONS

A COHORT ANALYSIS MODEL

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Introduction

Throughout most of the western world, there have been dramatic changes to the structure of the labour force over the last 60 years. These changes have arisen due to a variety of factors, including demographic, economic and social effects.

The most significant factor affecting the composition of the labour force has been the social transformation that saw the proportion of women entering the labour force experience a meteoric rise in the years following World War II through to around 1990, when female labour force participation rates started to level off. However, a number of other factors have also influenced participation rates, including changes in fertility rates, divorce rates, educational attainment, pension plans, flexible work plans, availability of services such as child care and maternity and/or paternity leave, wars, major economic events and so forth.

There are far too many things that can affect labour force participation to attempt to project each individually, but many of these demographic and societal changes are captured in cohort effects. In other words, people of the same generation are more likely to behave in a similar manner than are those who are younger or older. Therefore, it makes more sense to project age/sex-specific participation rates by age cohort, rather than extrapolating by age group. For example, someone born between 1960 and 1964 who is aged between 45 and 49 in 2009 is not necessarily going to be similar to a person born between 1930 and 1934 when they were the same age 30 years earlier.

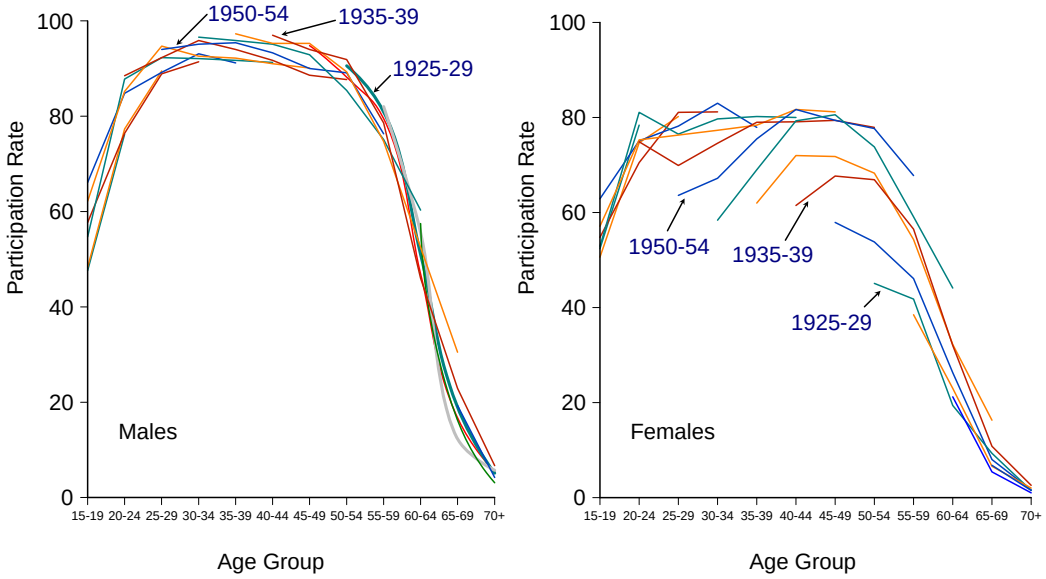
Cohort Analysis

To illustrate the concept of cohort analysis, it is instructive to examine historical labour force participation rates by age cohort. Figure 1 on the following page displays male and female participation rates for the five-year age cohorts spanning birth years 1910-1914 through 1985-1989.[1] It is apparent that male participation rates have changed relatively little compared to the substantial variation in female rates. There has been a slight decline in labour force participation for young and middle-aged males, with youth, in particular seeing a significant drop (likely due to higher school and post-secondary enrolment). On the other hand, participation rates for men over 60 have been rising. Although the changes to male participation rates are small compared to those of females, the combined impact has been a significant drop in participation from 77.1% of men aged 15 and over in 1976 to only 70.5% in 2009.

The story is quite different for females. For almost every age group, with the exception perhaps of youth aged 15 to 19, female labour force participation has risen. This is a reflection of the greater propensity of more recent generations of women to pursue a career compared to earlier generations. For women aged 15 and over, the labour force participation rate has ballooned from only 46.6% in 1976 to 61.5% in 2009.

[1] This data is synthetic as it does not necessarily compare the same individuals over time. Deaths, in- and out-migration will have changed the composition of each cohort. Implications that these mortality and migration effects may have on labour force participation rates are not considered in this model.

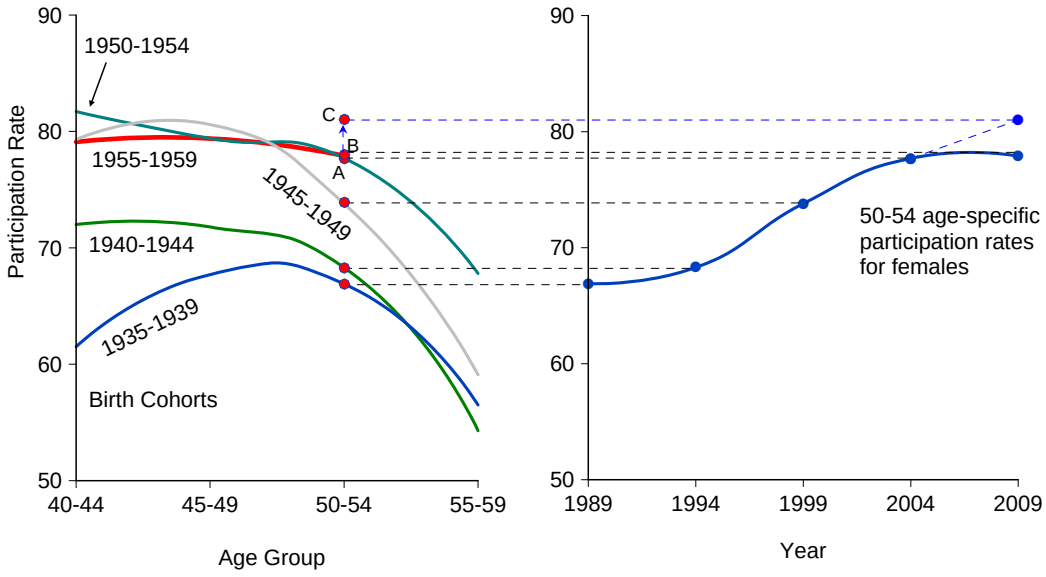
Figure 1: BC Labour Force Participation Rates by Cohort Spanning Birth Years 1910-1914 Through 1985-1989



Source: Statistics Canada

Given the variation in participation rates within different cohorts, a projection that incorporates cohort analysis is likely to produce far better results than an extrapolation of age-specific rates. Figure 2 effectively illustrates this using actual participation rates for selected female cohorts. The first panel plots participation rates for various cohorts by age, while the second panel illustrates the 50 to 54 age-specific participation rates for females. Point A represents the participation rate in 2004 of females born between 1950 and 1954 (i.e., when they were aged between 50 and 54). Point B is the actual participation rate in 2009 of females born between 1955 and 1959 (again, when they were aged between 50 and 54). Point C is the participation rate value that would have been derived for that same cohort if the 2009 rate was projected using a

Figure 2: Using Cohort Effects to Produce Better Projections



simple linear extrapolation of the age group data (i.e., the data in the second panel). It is clear that by ignoring the cohort effects, the resulting projection is too high. The difference in labour force participation between the cohort born in 1955 to 1959 versus the one born in 1950 to 1954 is much less pronounced compared to the difference in earlier cohorts. As a result, the extrapolation method overestimates the increase in the participation rate for this age group. Incorporating the cohort information yields a much more credible projection.

Entry and Exit Rate Methodology

One model that incorporates cohort information is the entry and exit rate method developed by the Organization for Economic Co-operation and Development (Burniaux et al, 2003) and later expanded upon in the Australia Government's Productivity Commission Research Report (2005). These studies were the basis for an earlier model developed by BC Stats (Harrower, 2007), which provides the foundation for this projection. The methodology calculates the rate of entry to, or exit from the labour force for each five-year age group for ages 15 and over up to age 69 and another category of those aged 70 and over. These entry or exit rates are applied to existing cohort participation rates to project their future participation. Five-year age groups are used instead of single-year ages because the reliability of the data beyond five-year groups is suspect. The data are derived from Statistics Canada's Labour Force Survey for the period 1976 through 2009.

To eliminate any bias that business cycle effects may present in the projections, the age-specific labour force participation rate estimates were smoothed using a Hodrick-Prescott filter.[2] The literature regarding this filter suggests that, for annual data, the smoothing parameter should be between six and seven (for example, see Maravall and del Río, 2001 or The World Bank, 2006). Accordingly, for this model, a parameter of seven was chosen.

Entry and exit rates were calculated using the equations specified in the Australian Government's Productivity Commission Research Report (2005). Equation 1 displays the formula used to calculate entry rates at time *t* for the cohort aged between *x* and *x*+4:

$$EN^{t}_{x,x+4} = (PR^{t}_{x+5,x+9} - PR^{t-5}_{x,x+4}) / (0.99 - PR^{t-5}_{x,x+4}) \qquad \text{(Eqn. 1)}$$

where *PR* denotes the participation rate and 0.99 is the maximum rate of participation.[3] Essentially, the entry rates are the difference in participation rates of a five-year age cohort at time *t* and time *t*-5 divided by the portion of that cohort that is available to participate in the labour force, but is not yet in the labour force at time *t*-5.

[2] The Hodrick-Prescott filter is designed to extract the trend from a time series by removing cyclical effects. Specifically, given a series y and a smoothing parameter $\lambda > 0$, it is a trend component τ that minimizes $\sum_{t=1}^{T}(y_t - \tau_t)^2 + \lambda \sum_{t=2}^{T-1}[(\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1})]^2$

[3] In line with Carone (2005), a maximum rate of 99% was used for both men and women. Burniaux et al (2003) used 99% for men and 95% for women. A rate less than 100% is used to account for the portion of the population that is unable to participate in the labour force for reasons such as a physical infirmity, for example.

As an example, consider the cohort of females aged 20 to 24 in 2009. The formula would be:

$$EN_{20-24}^{2009} = (PR_{25-29}^{2009} - PR_{20-24}^{2004}) / (0.99 - PR_{20-24}^{2004}).$$

The participation rate for females aged 25 to 29 in 2009 was 80.3% and the rate for females aged 20 to 24 in 2004 was 74.6%; therefore, the entry rate for females aged 20 to 24 in 2009 is:

(0.803 - 0.746) / (0.99 - 0.746) = 0.231.

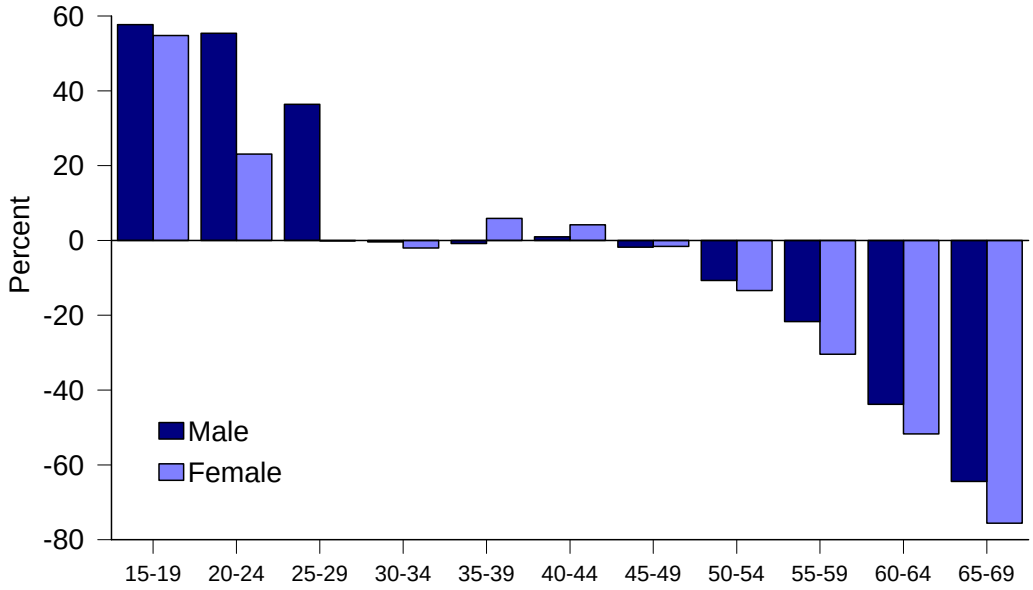
Equation 2 displays the formula used to calculate exit rates at time *t* for the cohort aged between *x* and *x*+4:

$$EX_{x,x+4}^{t} = (PR_{x,x+4}^{t-5} - PR_{x+5,x+9}^{t}) / PR_{x,x+4}^{t-5} \qquad \text{(Eqn. 2)}$$

In other words, exit rates are the difference in participation rates of a five-year cohort at time *t*-5 and time *t* divided by the participation rates of that cohort at time *t*-5.

Entry and exit rates were calculated for each age group, for both males and females separately. Since entry and exit rates both include negative values, it would technically be feasible to use only one or the other to project participation rates; however, doing so could result in some unrealistic values, including participation rates greater than 100 percent. For this reason, where an age group had a positive entry rate, an entry rate was used for that age group in the projection; otherwise, an exit rate was used.

Figure 3: BC Labour Force Entry (+) and Exit (-) Rates (2004-2009)



There are a few differences between the 2010 version of the British Columbia Labour Force Participation Rate Projection Model and the 2007 version. In the earlier version, consistent with other studies, entry and exit rates were kept constant from the last year observed. This basically

assumes that there will be no cohort changes in the future and that the participation rates of current cohorts will be emulated by future cohorts when they attain the same age. For the 2010 model, entry and exit rates were calculated throughout the projection using projected participation rate figures, so that existing cohort effects will continue to be reflected throughout the projection period.

In the 2007 model, rates were only projected every five years and then interpolation was used to fill in the intervening years. For the 2010 model, rates were calculated for every year using the appropriate five-year age cohorts.[4] One drawback of this method is that any business cycle pattern existing in the last five years of data is perpetuated throughout the projection. To remove these cyclical effects, the projected participation rates were smoothed using the Hodrick-Prescott filter.

Once the entry and exit rates were calculated, the following formulas were used to project participation rates. Equation 3 displays the formula used when entry rates were appropriate (i.e., when entry rates were positive):

$$PR^{t}_{x+5,x+9} = EN^{t-5}_{x,x+4} \times (0.99 - PR^{t-5}_{x,x+4}) + PR^{t-5}_{x,x+4} \qquad \text{(Eqn. 3)}$$

In other words, the participation rate of a cohort at time *t* is equal to the entry rate for that cohort at time *t*-5 multiplied by the available portion of the cohort not yet in the labour force at time *t*-5 (this product is equivalent to the proportion of new entrants to the labour force) plus the portion of the cohort that is already participating in the labour force at time *t*-5.

Equation 4 shows the formula used when exit rates were the appropriate measure to calculate participation rates (i.e., when exit rates were positive):

$$PR^{t}_{x+5,x+9} = (1 - EX^{t-5}_{x,x+4}) \times PR^{t-5}_{x,x+4} \qquad \text{(Eqn. 4)}$$

More simply, the participation rate of a cohort at time *t* is equal to the participation rate of that cohort at time *t*-5 multiplied by one minus the exit rate of that cohort at time *t*-5. So if the exit rate was, say, 20 percent, the new participation rate would be 80 percent of the cohort's participation rate five years earlier.

These formulas were used to project age and sex specific rates for all the age groups from 20 to 24 through 70 and over. Note that while the 2007 model left participation rates for ages 70 and over at their most recent value, in this projection, the entry/exit rate method was applied to this age group as well. For males and females aged 15 to 19, entry rates cannot be calculated, so another method was applied. In the 2007 model, rates were held at their most recent value, but this has the potential to add bias as projections will reflect the base year's economic conditions. To reduce this bias, for males and females each, an average of the last seven years of participation rates for this age group was employed. The seven-year figure was chosen to ensure

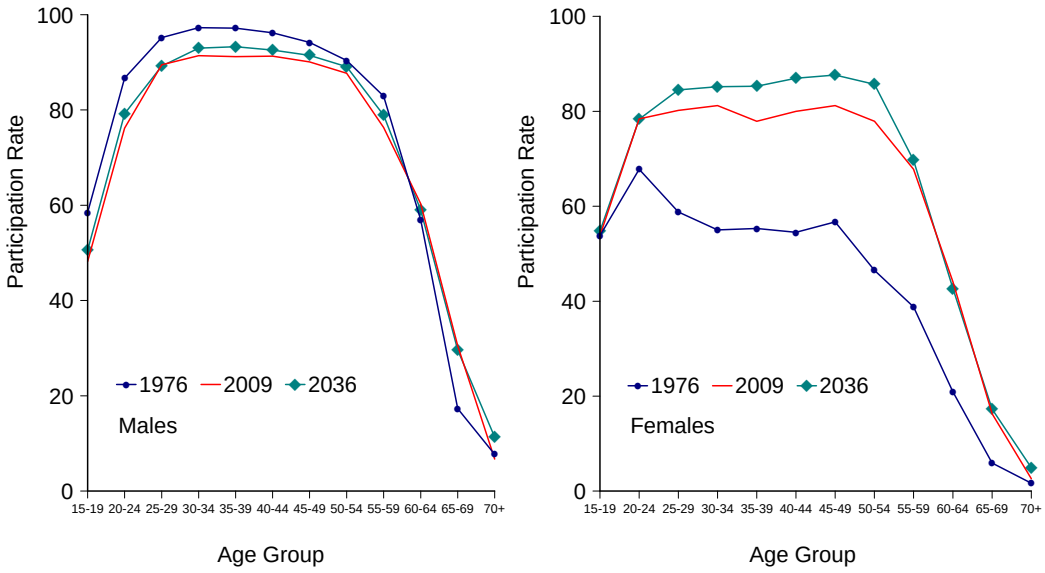
[4] For example, for 2008, labour force data for 2003 to 2008 was used to calculate entry and exit rates, while for 2009, data for 2004 to 2009 was used.

that it incorporated at least one full business cycle.[5] Once participation rates for each five-year age group were calculated, they were applied to a BC Stats population projection (PEOPLE 34), adjusted to remove institutional and non-civilian population to be consistent with Labour Force Survey population data, and participation rates for males, females and the total population aged 15 and over were calculated.[6]

Results

Based on the cohort entry/exit rate method outlined above, there is expected to be very little change in age-specific male participation rates over the next two decades. However, female age-specific participation rates are projected to increase for the 20 through 59 year old age groups, as the higher participation rates of younger cohorts will carry on as they age. Figure 4 displays the actual participation rate age profiles for 1976 and 2009 and the projected rates for 2036.

Figure 4: BC Labour Force Participation Rate Projection Age Profiles

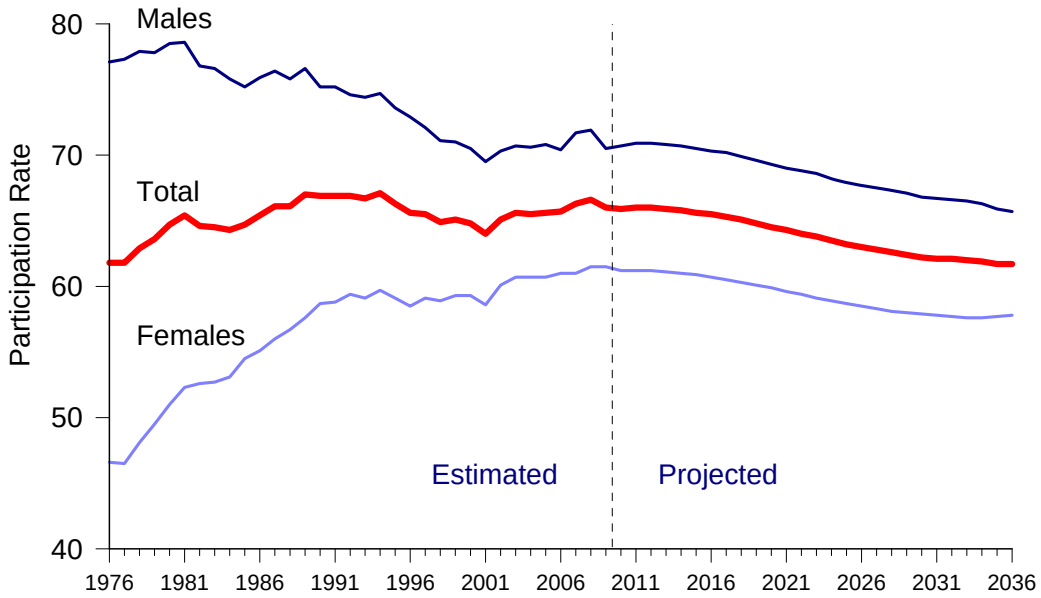


Despite the rise in age-specific female participation rates, the forecast is for overall labour force participation in British Columbia to trend down over the next couple of decades, with the gap between male and female rates continuing to shrink, albeit at a diminishing rate. The main reason for the overall participation rate decline is the demographic effect of an ageing population and the fact that participation rates for older age groups are substantially lower than rates for younger groups. Figure 5 on the following page illustrates the overall projection for males, females and total to 2036. The data are available in a tabular format in Appendix 1.

[5] It is generally thought that business cycles last between three and a half and seven years. For example, see the online Canadian Encyclopedia:
http://www.thecanadianencyclopedia.com/index.cfm?PgNm=TCE&Params=A1ARTA0001130

[6] The population data were adjusted by using a ten-year average of the ratio of Labour Force Survey population to overall population estimates.

Figure 5: British Columbia Labour Force Participation Rates, 15 Years and Over



Conclusion

The use of age group extrapolation methods to project labour force participation rates is likely to produce less credible results than a method that takes into account the wide differences in participation among cohorts. The entry and exit rate model developed by researchers at the Organization for Economic Co-operation and Development (Burniaux et al, 2003) incorporates these cohort effects and generates projections that are more plausible.

Based on the entry and exit methodology and population projections produced by BC Stats, overall British Columbia labour force participation rates are projected to trend down over the next 25 years mainly due to the combination of an ageing population and the reduction in labour force participation as people age. The drop in labour force participation could have consequences in terms of potential labour shortages and could even spur another structural change in participation rates, perhaps not as substantial as the extraordinary increase in female participation over the last 60 years, but one that could change the face of the labour force nonetheless.[7]

While the results of this model provide valuable information, there is more work that could be done. A further enhancement that could be investigated is the development of sub-provincial regional labour force participation rates. Such an addition, if possible given existing data limitations, could help improve regional employment projections and, potentially, regional population projections.

[7] It should be noted that the cohort entry-exit rate model is not really suited to projections beyond 10 to 15 years for this very reason; that is, we cannot predict the future cohort effects of those not yet in the labour force. However, we present data to 2036 in this report to represent a scenario in which no major structural changes occur as some researchers may find the data useful.

Appendix 1: Tables

Table 1: Actual and Projected Labour Force Participation Rates, 15 Years and Over

Year	Males	Females	Total
1991	75.2	58.8	66.9
1992	74.6	59.4	66.9
1993	74.4	59.1	66.7
1994	74.7	59.7	67.1
1995	73.6	59.1	66.3
1996	72.9	58.5	65.6
1997	72.1	59.1	65.5
1998	71.1	58.9	64.9
1999	71.0	59.3	65.1
2000	70.5	59.3	64.8
2001	69.5	58.6	64.0
2002	70.3	60.1	65.1
2003	70.7	60.7	65.6
2004	70.6	60.7	65.5
2005	70.8	60.7	65.6
2006	70.4	61.0	65.7
2007	71.7	61.0	66.3
2008	71.9	61.5	66.6
2009	70.5	61.5	66.0
2010	70.7	61.2	65.9
2011	70.9	61.2	66.0
2012	70.9	61.2	66.0
2013	70.8	61.1	65.9
2014	70.7	61.0	65.8
2015	70.5	60.9	65.6
2016	70.3	60.7	65.5
2017	70.2	60.5	65.3
2018	69.9	60.3	65.1
2019	69.6	60.1	64.8
2020	69.3	59.9	64.5
2021	69.0	59.6	64.3
2022	68.8	59.4	64.0
2023	68.6	59.1	63.8
2024	68.2	58.9	63.5
2025	67.9	58.7	63.2
2026	67.7	58.5	63.0
2027	67.5	58.3	62.8
2028	67.3	58.1	62.6
2029	67.1	58.0	62.4
2030	66.8	57.9	62.2
2031	66.7	57.8	62.1
2032	66.6	57.7	62.1
2033	66.5	57.6	62.0
2034	66.3	57.6	61.9
2035	65.9	57.7	61.7
2036	65.7	57.8	61.7

Source: Statistics Canada's Labour Force Survey for historical data (1991-2009); BC Stats' Labour Force Participation Rate Projection Model for projected data (2010-2036).

Table 2: Actual and Projected Labour Force Participation Rates by Age

Males	2008	2009	2010	2011	2016	2021	2026	2031	2036
15-19	55.0	48.2	50.6	50.6	50.6	50.6	50.6	50.6	50.6
20-24	79.2	76.2	79.3	79.5	79.2	79.1	79.2	79.1	79.2
25-29	89.4	89.5	88.5	88.9	89.6	89.5	89.5	89.5	89.2
30-34	91.9	91.4	91.9	92.1	93.0	93.2	93.2	93.2	93.0
35-39	93.1	91.2	92.8	92.6	92.3	93.2	93.4	93.3	93.3
40-44	91.9	91.3	92.2	92.2	91.7	91.7	92.5	92.7	92.6
45-49	91.5	90.1	89.6	90.2	91.6	91.2	91.1	92.0	91.5
50-54	88.1	87.7	87.4	87.7	88.3	89.3	89.0	89.0	89.1
55-59	77.7	76.3	77.2	77.6	78.9	79.3	80.2	80.0	78.9
60-64	56.9	60.3	57.1	57.8	58.7	59.5	59.9	60.7	59.0
65-69	28.1	30.5	27.0	28.1	30.1	30.2	30.6	31.0	29.6
70+	8.4	6.7	8.5	9.0	11.0	11.5	11.5	11.7	11.3

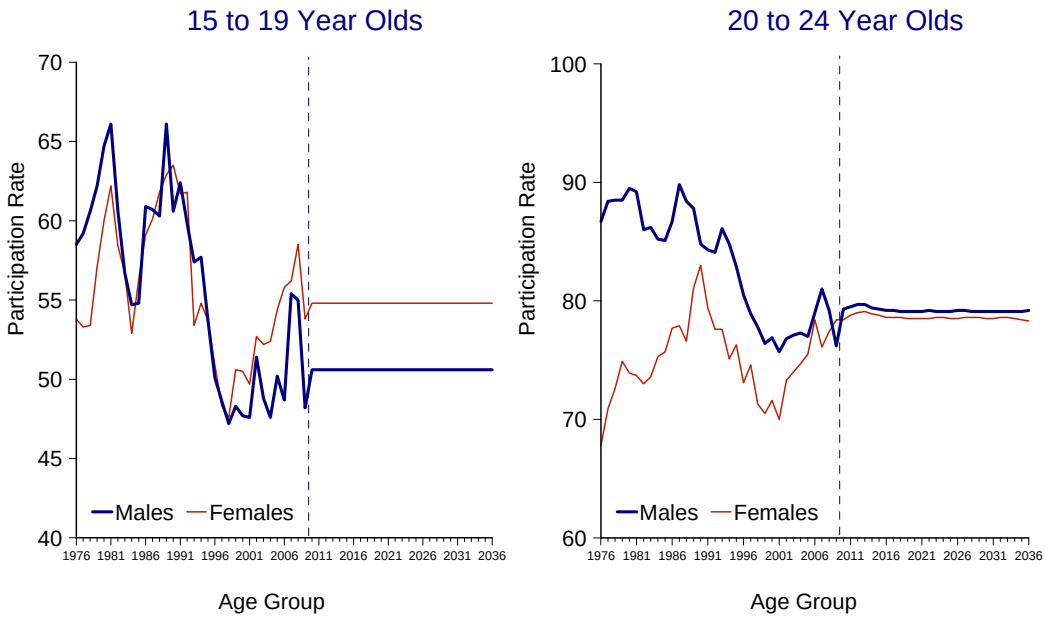
Females	2008	2009	2010	2011	2016	2021	2026	2031	2036
15-19	58.5	53.8	54.8	54.8	54.8	54.8	54.8	54.8	54.8
20-24	77.4	78.4	78.4	78.8	78.6	78.5	78.5	78.5	78.3
25-29	81.7	80.2	83.3	83.3	84.4	84.4	84.3	84.3	84.5
30-34	77.7	81.2	80.6	80.6	83.2	84.9	84.8	84.6	85.2
35-39	79.9	77.9	80.6	80.3	80.2	83.0	84.6	84.4	85.3
40-44	81.0	80.0	80.8	80.9	81.8	82.2	84.6	86.0	87.0
45-49	81.9	81.2	81.8	81.8	81.6	82.5	82.9	85.0	87.7
50-54	77.5	77.9	78.8	79.4	80.7	80.5	81.4	81.6	85.7
55-59	65.1	67.8	64.2	64.6	66.9	68.1	67.9	68.6	69.7
60-64	37.8	44.1	37.7	39.0	41.9	42.8	43.5	43.5	42.7
65-69	15.5	16.3	13.5	14.9	17.5	18.0	18.5	19.0	17.3
70+	2.5	2.6	3.5	3.6	4.2	4.7	4.9	5.0	4.9

Source: Statistics Canada's Labour Force Survey for historical data (2008-2009); BC Stats' Labour Force Participation Rate Projection Model for projected data (2010-2036).

Appendix 2: Age-Specific Labour Force Participation Projections

The labour force participation of young adults has fallen significantly over the last few decades, and is correlated with higher school and post-secondary attendance. This is particularly true for men. The increase in student enrolment can probably be attributed to more than one factor, including poor job markets during weak economic times and demand for a highly educated workforce in a world where computers have become commonplace and many jobs require technical training.

Figure 6: BC Labour Force Participation Rate Projection - 15 to 24 Year Olds



As discussed earlier in this paper, the projection for 15 to 19 year olds could not use the same methodology as other age groups, because entry rates are not available for this age category. Instead, an average of the last seven years of available data was used and this figure was left constant throughout the projection. The participation rate for males was set at 50.6 percent, while the female participation rate for 15 to 19 year olds was set at 54.8 percent.

The fact that female participation in this age group is higher than male participation is unprecedented. It is likely related to the types of jobs in which most of the employment growth for this age group has been concentrated over the last decade. The retail, accommodation and food sectors have been responsible for much of the job growth for youth, and the occupations in these sectors have traditionally been dominated by female workers. Employment opportunities for teenagers have been less abundant in male-dominated occupations, such as those in the resource sectors.

For 20 to 24 year olds, there is very little change expected in participation rates throughout the projection. Male and female participation rates are expected to remain fairly close, with males having only a slight edge. Enrolment in post-secondary education is likely the primary reason that rates for this age group are lower than those for people between 25 and 54.

For 25 to 29 year olds, labour force participation is expected to remain fairly flat over the next couple of decades, with the gap between men and women remaining fairly steady at five percentage points. The downward trend for men and the rise in rates for women both appear to have stabilized for this age group. In the 30 to 34 year old group, rates for males are expected to bounce back slightly, then level off, while female participation rates are projected to climb slightly further before reaching a plateau.

Figure 7: BC Labour Force Participation Rate Projection - 25 to 34 Year Olds

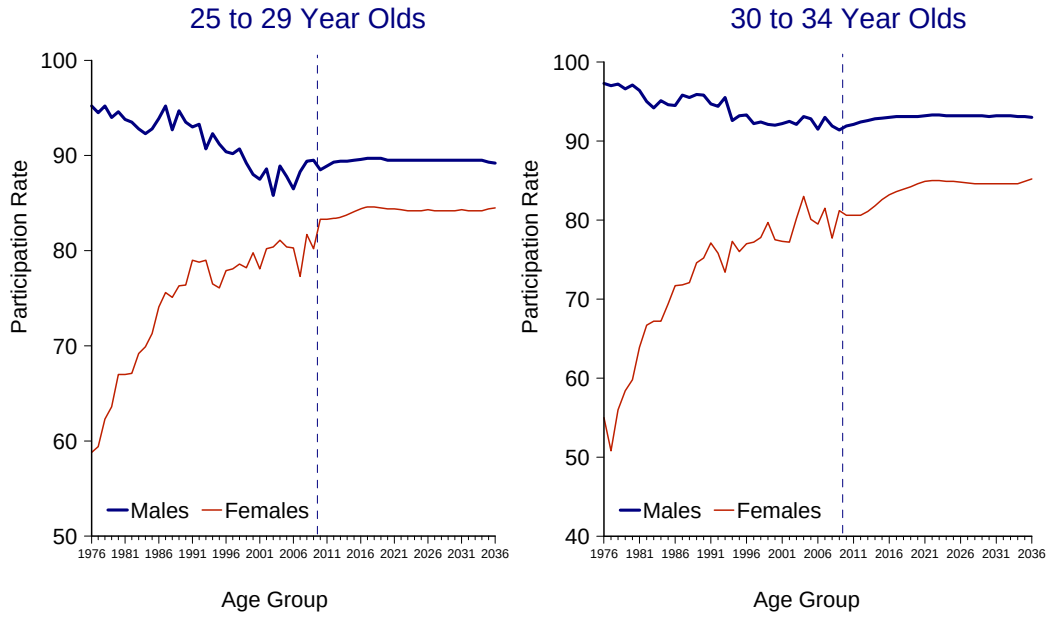
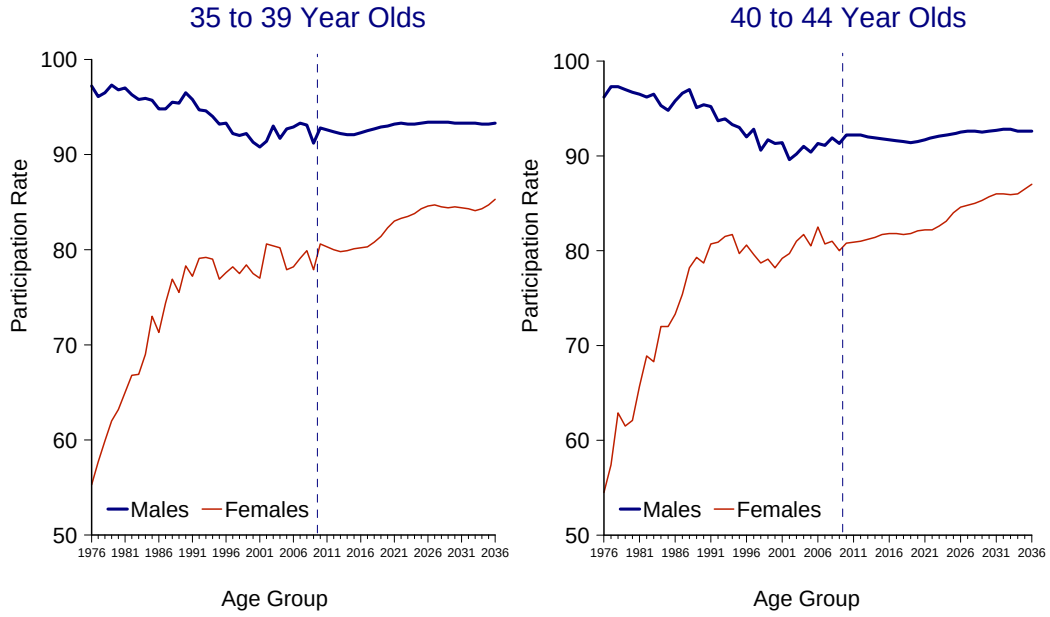


Figure 8: BC Labour Force Participation Rate Projection - 35 to 44 Year Olds



The story is similar for 35 to 39 year olds with male rates rising slightly before levelling off and female rates continuing to experience a fairly significant increase before hitting a plateau. This

growth in female rates is the result of younger cohorts with higher labour force participation moving into higher age groups. This phenomenon can be seen in the 40 to 44 and 45 to 49 year age groups as well. The gap between males and females narrows somewhat from the 35 to 39 age group to the 50 to 54 year old group as women move out of their child bearing years and some return to the labour force.

Figure 9: BC Labour Force Participation Rate Projection - 45 to 54 Year Olds

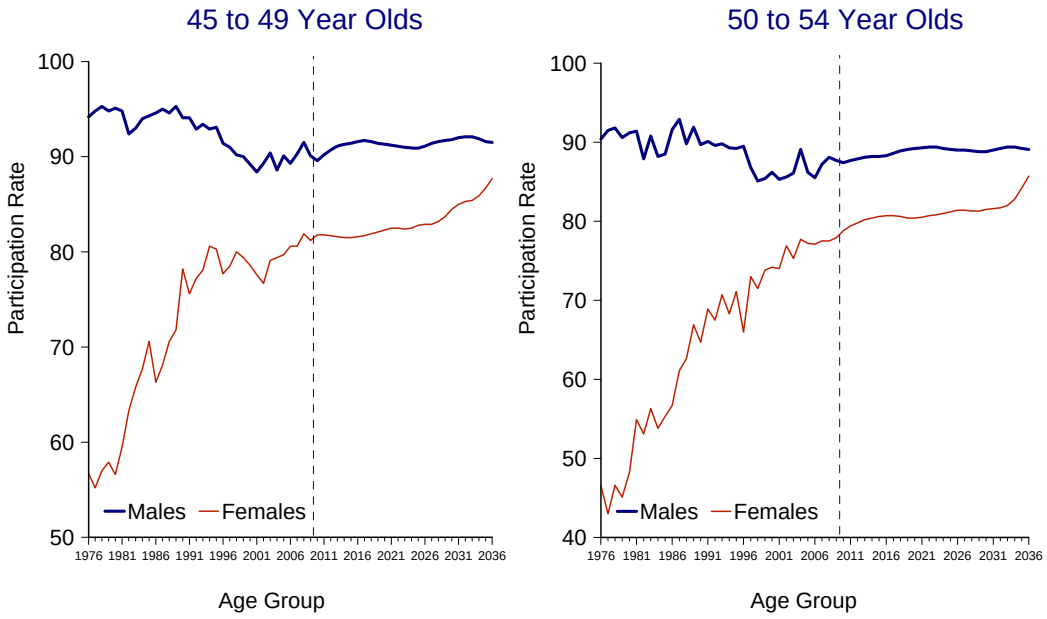
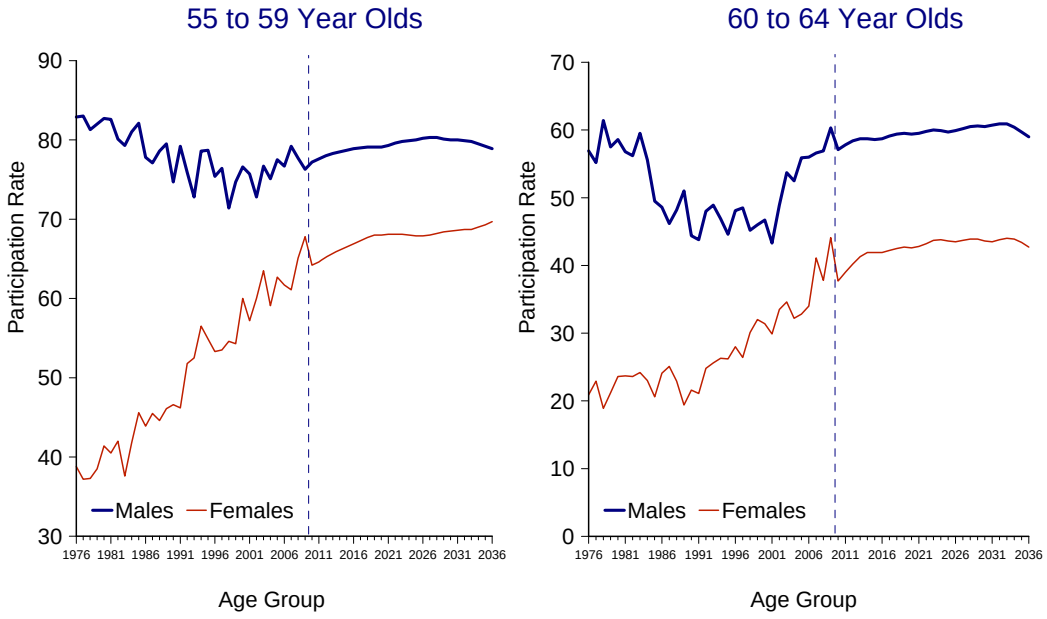


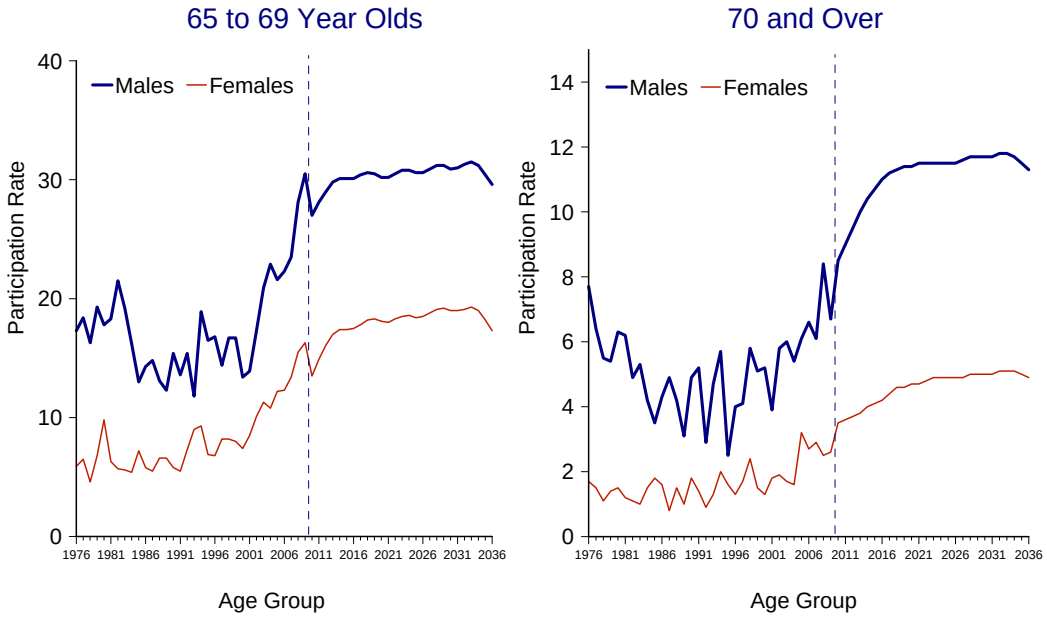
Figure 10: BC Labour Force Participation Rate Projection - 55 to 64 Year Olds



Participation rates for men and women aged 55 and over are expected to trend up through most of the projection period, at least until the last few years. Labour imbalances resulting from an ageing population will create opportunities for older people who wish to continue to work past

traditional retirement ages. In the last several years, there have been significant increases in participation rates of people aged 60 and older. While female rates are likely influenced, at least in part, by cohort effects, male participation has also increased and to an even greater extent than that of females.

Figure 11: BC Labour Force Participation Rate Projection - 65 and Over



The projection is for participation rates of men and women aged 65 and over to continue to rise in the next several years. Older British Columbians are healthier than they have ever been in the past and are more able to continue to work and this, combined with greater opportunity due to labour imbalances, will result in greater labour force participation.

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