Ageing is a drag: Projecting labour force participation in New Zealand

AN2018/10

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November 2018

Reserve Bank of New Zealand Analytical Note Series
ISSN 2230-5505

Reserve Bank of New Zealand
PO Box 2498
Wellington
NEW ZEALAND

www.rbnz.govt.nz

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NON-TECHNICAL SUMMARY¹

This Analytical Note explores the effect of the ageing New Zealand population and the business cycle on the outlook for the labour force participation rate.² These factors are important for understanding the level of maximum sustainable employment in the economy.

Labour force participation is influenced by a variety of structural factors. For example, an ageing population may result in a lower aggregate labour force participation rate, because older people tend to participate less. Labour force participation is also influenced by cyclical factors. For example, a strengthening economy encourages more workers to enter the labour force.

We find that labour force participation is mildly pro-cyclical in New Zealand. This suggests that monetary policy has a small influence on the participation rate, through an encouraged worker effect. The participation rates of young people and people near retirement age appear the most sensitive to business cycle fluctuations.

Our analysis suggests that the aggregate participation rate is likely to remain broadly flat out to 2035, as an ageing population offsets further increases in the participation of women and older people. We expect the aggregate participation rate to increase further if participation by women aged 24-54 and people aged 55 and above increases at a greater pace than over the past decade. Alternatively, if participation rates of women and older workers have peaked, an ageing population will reduce the aggregate participation rate over time.

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¹ The authors would like to thank Christie Smith, Ross Kendall, Thomas van Florenstein Mulder, Özer Karagedikli, Rebecca Williams, and staff in the Economics Department for their feedback.
² See Appendix A for definitions of the data used in this Analytical Note.
1. Introduction

Labour supply plays a key role in determining developments in the labour market and wider economy. In recent years, New Zealand has experienced rapid labour supply growth. This growth is due in part to an increase in labour force participation, which has tended to be higher than the Reserve Bank’s forecasts (figure 1). Assessing the outlook for the labour force participation rate (LFPR) is an important aspect of the Reserve Bank’s forecasting process.

The Reserve Bank of New Zealand (Monetary Policy) Amendment Bill 2018, currently under consideration in Parliament, embodies a dual mandate that emphasises both price stability and maximum sustainable employment. The 2018 Policy Targets Agreement likewise emphasises maximum sustainable employment as an important policy objective. Our research contributes to the Reserve Bank’s research agenda on the labour market by identifying the drivers of labour force participation in New Zealand.³

Figure 1: Labour force participation rate and Reserve Bank forecasts

![Labour force participation rate and Reserve Bank forecasts](image)

Source: Stats NZ, RBNZ estimates.⁴
Note: LFPR is seasonally adjusted and shown as a percentage of the working-age population.

In this Analytical Note, we breakdown changes in the labour force participation rate into its structural and cyclical components. Our results show that the increase in labour force participation since the 1990s has been largely structural, with a small contribution from the business cycle.

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⁴ In June 2016, Stats New Zealand’s Household Labour Force Survey (HLFS) was redeveloped. This caused a structural break in the LFPR, precluding longer-term comparisons. See Stats NZ (2016a).
On the structural side, the rise in New Zealand’s LFPR since the early 1990s has been driven predominantly by increasing participation by women, and higher participation by people aged 55 and above (Culling and Skilling, 2018). The aggregate participation rate has increased despite population ageing, which (all else equal) would have been expected to lower the LFPR. Looking forward, it is likely that continued population ageing will become an increasing drag on the LFPR.

In this Note we consider how the aggregate participation rate could evolve under alternative assumptions for participation at the cohort level. Our central projection in this paper uses demographic trends from Stats NZ population projections, and results in a participation rate that remains around 71 percent over the medium term.

The Note proceeds as follows. Section two explores a cyclical and structural breakdown of the labour force participation rate, both on aggregate and across cohorts. Section three outlines the structural drivers and results of our projection exercise. Section four discusses the implications of changing labour force participation for monetary policy generally. Section five concludes.

2. Business cycle analysis

2.1. Structural and cyclical decomposition methodology

Movements in the participation rate over decades are driven largely by long-term (structural) trends. However, in the short- and medium-term, the variation in the participation rate is also driven by cyclical factors such as economic booms and contractions. Economic contractions are usually associated with higher unemployment and lower LFPR, and vice versa for economic booms (Elsby et al., 2015).

We undertake an empirical analysis to determine whether the cyclical variation in the LFPR is related to the business cycle, following the Council of Economic Advisers (2014) and Grigoli, Koczan, and Topalova (2018). These authors explain the variation in the cyclical component in the LFPR using different measures of the business cycle. The Council of Economic Advisers (2014) use the unemployment rate gap as an explanatory variable, whilst Grigoli, Koczan, and Topalova (2018) use an output gap and unemployment rate gap.

To estimate the effect of the business cycle on the LFPR, we follow the approach of the authors above and use the output gap to proxy for the business cycle (figure 2). The output gap is the difference between actual GDP and potential GDP, as a share of potential.\(^5\)

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\(^5\) The Reserve Bank’s method for calculating potential output is detailed in Lienert and Gillmore (2015). We use a range of indicators of capacity pressure to inform our output gap assumption at the end of history (see Armstrong, 2015).
Source: Stats NZ, RBNZ estimates.

Note: Grey bars represent recessions in New Zealand based on the Hall and McDermott (2016) dates.

We estimate the following equation from 1991 Q4 (the first data point for the RBNZ output gap estimate) to 2018 Q2:

\[ L\hat{FPR}_t = \beta_0 + \beta_1 \hat{Y}_{t-1} + \beta_2 \hat{Y}_{t-2} + \beta_3 \hat{Y}_{t-3} + \beta_4 \hat{Y}_{t-4} + \epsilon_t \]

where \( L\hat{FPR}_t \) is the detrended participation rate. We use the Hodrick-Prescott (HP) filter to detrend the participation rate. Before filtering, the participation rate forecast from the August MPS was appended to the participation rate data to mitigate the end-point problem associated with this filter.\(^6\) \( \hat{Y}_{t-1} \) is the output gap at time \( t - 1 \).

Two potential weaknesses with this approach are the reliance on the HP filter to detrend the participation rate, and only using the output gap as a proxy for the economic cycle. In Appendix D we demonstrate that using the linear projection method described in Hamilton (2017) to detrend the LFPR gives similar results to the HP-filtered LFPR. We also use unemployment and employment rate gaps as proxies for the business cycle, with all variables detrended using both the HP filter and linear projection methods, and find the results are all similar to the baseline results. Schuler (2018) shows that the linear projection is more suited to credit cycles than regular business cycles. As a result we use the HP filter for our main results.

\(^6\) For example see Kaiser and Maravall (1999) who show that augmenting a time series with an ARIMA forecast significantly improves the end-point issues the HP filter has.
We use a distributed lag specification, where the participation rate gap is regressed on the output gap and its lags (table 1). To determine the lag structure of the regression we use the Schwert (1989) criterion, where the maximum lag is given by:

$$\text{lag}_{\text{max}} = 12 \times \left( \frac{T}{100} \right)^{\frac{1}{4}}$$

where $T$ is the number of observations. This gives 4 lags with a sample size of 107. We then iteratively remove the highest remaining lag until we fail to reject the null that the final lag is insignificant.

The regression results are reported in Table 1. They show that around 40 percent of the cyclical variation in the LFPR can be explained by the output gap. This means that a significant proportion of the cycle in LFPR is related to the business cycle.

Table 1: LFPR and output gap regression

<table>
<thead>
<tr>
<th>Participation rate gap</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Output gap (1st lag)</td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td>(0.08)</td>
</tr>
<tr>
<td>Output gap (2nd lag)</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>(0.11)</td>
</tr>
<tr>
<td>Output gap (3rd lag)</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td>(0.11)</td>
</tr>
<tr>
<td>Output gap (4th lag)</td>
<td>0.12*</td>
</tr>
<tr>
<td></td>
<td>(0.08)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.08*</td>
</tr>
<tr>
<td></td>
<td>(0.05)</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.437</td>
</tr>
<tr>
<td>Adj. R-squared</td>
<td>0.414</td>
</tr>
<tr>
<td>No. obs.</td>
<td>103</td>
</tr>
</tbody>
</table>

Note: Standard errors in parentheses. Regressions are estimated using data from 1990:Q4 to 2018:Q2. *** p<0.01, ** p<0.05, * p<0.1.

Using the empirical analysis above, we can decompose changes in the aggregate LFPR since 1994 into the contribution from the business cycle, and the contribution from structural factors. We subtract the business cycle component estimated in Table 1 from the total change in the LFPR. This leaves the implied structural contribution to the change in the LFPR. The results of this decomposition are displayed in figure 3.
The participation of some age-gender cohorts is more exposed to the business cycle than the aggregate LFPR.\textsuperscript{7} To further develop our understanding of participation in New Zealand, we therefore extend our analysis to examine the effect of the business cycle on the LFPR of individual age-gender cohorts. This is done using a similar method to above. We regress the detrended LFPR of each cohort on the output gap and its lags. This regression shows the cyclical change in participation for each cohort that is related to the business cycle.

Following the estimation, we aggregate the individual-cohort business-cycle effects to an aggregate cyclical effect. The cyclical component of each cohort is added together, weighted by their share of the total labour force.\textsuperscript{8} The results of the decomposition for each age-gender cohort are displayed in figure 4.

### 2.2. Results

Our results show that structural factors account for most of the change in the LFPR since 1993 (figure 3). Over the sample, business cycle effects explain some of the change in participation, particularly in the 1990s. Since the global financial crisis (GFC), spare capacity in the economy has been absorbed, which is reflected in the cyclical contribution to changes in the LFPR gradually becoming slightly positive. The structural impacts from population ageing and higher cohort participation rates since the GFC have far outweighed the drag from cyclical factors, such as discouraged worker effects.

\textsuperscript{7} Consistent with Grigoli, Koczan, and Topalova (2018), Chalom et al., (2018), Evans, Moore, and Rees (2018), and Aaronson et al., (2014)

\textsuperscript{8} These cyclical contributions do not add to the aggregate cyclical contribution in figure 3. This is likely because of rounding errors, as we are using 24 regressions (one for each cohort) to calculate the contributions.
Figure 3: Structural and cyclical contribution to the change in LFPR since 1986

Source: Stats NZ, RBNZ estimates.
Note: The chart does not begin until 1993 due to the lags included in the estimation.

Our results show that the LFPR is procyclical, but this effect is small relative to its structural drivers. When the economy is booming, the labour force participation rate rises and often exceeds its long-term trend. The opposite is true during downturns (Elsby, Hobijn, and Sahin, 2013; Evans, Moore and Rees, 2018).

As discussed above, the cyclical component of the aggregate LFPR can be further broken down into the contributions from various age and gender cohorts (figure 4). The participation rates of the younger cohorts (particularly aged 15-19) and those nearing retirement (aged 60-64) appear the most sensitive to changes in the business cycle. This is likely because both cohorts are less attached to the labour force, reducing the incentive to participate.
Figure 4: Decomposing the aggregate cyclical contribution in LFPR by age and gender

Source: Stats NZ, RBNZ estimates.
Note: the black line is the total cyclical contribution as calculated by aggregating the individual cyclical contributions for each age-gender cohort. Because these are all calculated using separate regressions, the black line will not be the same as in figure 4. However, the chart shows how sensitive each age-gender cohort is relative to the other cohorts.

The lower attachment to the labour force for younger people could be due to increased education and low real wages (Aaronson et al., 2006) or increases in household wealth (Aaronson, Park, and Sullivan, 2006). For older people, lower attachment could be due to individuals having a higher likelihood to retire (Aaronson et al., 2006). The participation rates of women and men appear to equally sensitive to the business cycle. Appendix C contains a more detailed breakdown of the cyclical contribution from each cohort.

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9 This is consistent with literature on the effect of marginal tax rates on the supply of labour. For example, see Laun (2017).
3. Analysis of structural drivers of participation

Our results show that most of the variation in New Zealand’s LFPR is driven by structural factors. Therefore, in this section we discuss some of the structural drivers of the LFPR, and our projection methodology.

3.1. Recent data developments and population projections

The upwards trend in New Zealand’s LFPR since the early 1990s has been driven largely by rising participation rates for women and people aged 55 and above (figure 5).

The increase in participation of older people is largely the result of several structural factors: raising the age of NZ superannuation eligibility from 60 to 65 between 1992 and 2001 (Hurnard, 2005); banning compulsory retirement in 1999 (Dixon, 2008; Ministry of Social Development, 2009); better health among older cohorts and improving longevity (Aísa, Pueyo, and Sanso, 2012); technological change; and increased concerns about sufficient retirement savings (OECD, 2013; OECD, 2015;).

Figure 5: Participation rates by age and gender

![Participation rates by age and gender](image)

Source: Stats NZ, RBNZ estimates.
Note: 2035 cohort LFPRs are based on our central projections detailed in Figure 8.

The increase in female participation likely reflects several factors, including ongoing changes in social norms and attitudes towards women working, and policy changes such as the introduction of Working for Families in 2005 (Johnson, 2005), part-time work entitlements, and increased education (Blau and Kahn, 2013).

The increase in the aggregate LFPR has come despite an ageing workforce (figure 6). Since the early 1990s, the share of the population aged under 40 has been declining,
with the decline mostly accounted for by an increase in the share of the 40-64 year old age group.

Figure 6: Size of age-group cohort by gender

Source: Stats NZ, RBNZ estimates.
Note: Age cohort size is shown as a percentage of the total female and male population respectively. 2035 population shares are based on Stats NZ median population projections.

Statistics NZ’s national population projections indicate the expected population ageing and cohort distribution within New Zealand. For our projection, we use Stats NZ’s median projections (50th percentile). We also use their ‘high migration’ scenario, which is more similar to the Reserve Bank’s projections for net immigration than the median baseline.\(^\text{10}\)

The key assumptions behind the population projections used in this Analytical Note are:\(^\text{11}\)

- a total fertility rate of 1.85 births per woman in the long term;
- life expectancy at birth reaching 89.1 years for males and 91.3 years for females in 2068 from 80.04 and 83.44, respectively, in 2016; and,
- annual net immigration of 30,000 people in each year from 2021.

Using these population projections as a baseline, we examine changes in the LFPR and project it forward under different assumptions for age-gender cohort participation rates.

\(^\text{10}\) We also performed our analysis with Stats NZ’s baseline assumption, which assumes annual net immigration falls to 15,000. Our results were not overly sensitive to this assumption.

\(^\text{11}\) See Stats NZ (2016b) for further information of population projection assumptions.
3.2. Shift-share methodology

The evidence discussed above shows that population ageing has put downward pressure on the LFPR in New Zealand, but this has been more than offset by structural factors such as the change in participation rates within certain age and gender cohorts. Looking forward, a key question is: how long can these trends continue?

To examine this question, we use a shift-share analysis. This analysis replicates the work of Culling and Skilling (2018), and extends it into the forecast horizon to illustrate the potential evolution of the LFPR, alongside the effects of population ageing and changing cohort participation rates.

Our backwards-looking analysis covers 1991Q4 to 2018Q1. From 2018Q2 to 2035Q1, we illustrate the potential changes in the LFPR using a central projection and construct scenarios based on different assumptions about how participation rates for different cohorts might evolve.

The shift-share analysis by Culling and Skilling (2018) separates out the total change in the LFPR (ΔLFPR) into two components: the change due to population ageing (ΔLFPR\textsubscript{Aging}) and the change due to cohort participation rates (ΔLFPR\textsubscript{Cohort}), where \(w\) is the working-age population share for specific age-gender cohorts, \(i\) is a specific age-gender cohort, the number 1 indicates period 1, and \(N\) is the total number of age-gender cohorts. The decomposition follows:

\[
LFPR_1 = \sum_{i=1}^{N} LFPR_{i1} w_{i1} \tag{1}
\]

\[
LFPR_2 = \sum_{i=1}^{N} LFPR_{i2} w_{i2} \tag{2}
\]

\[
\Delta LFPR = LFPR_2 - LFPR_1 = \sum_{i=1}^{N} LFPR_{i2} w_{i2} - \sum_{i=1}^{N} LFPR_{i1} w_{i1} \tag{3}
\]

\[
\Delta LFPR = \sum_{i=1}^{N} LFPR_{i2} w_{i2} - \sum_{i=1}^{N} LFPR_{i1} w_{i1} + \sum_{i=1}^{N} LFPR_{i1} w_{i2} - \sum_{i=1}^{N} LFPR_{i2} w_{i1} \tag{4}
\]

\[
\Delta LFPR = \sum_{i=1}^{N} LFPR_{i1} (w_{i2} - w_{i1}) + \sum_{i=1}^{N} w_{i2} (LFPR_{i2} - LFPR_{i1}) \tag{5}
\]

\[
\Delta LFPR = \Delta LFPR_{Aging} + \Delta LFPR_{Cohort} \tag{6}
\]
For simplicity, we separate the change due to cohort participation rates \(\Delta LFPR_{\text{Cohort}}\) into four age-gender cohorts:

1) 15-24 year old individuals of both genders
2) 25-54 year old men
3) 25-54 year old women
4) 55+ year old individuals of both genders

The mathematical breakdown can be defined as follows:

\[
\Delta LFPR_{\text{Cohort}} = \Delta LFPR_{a,15-24y} + \Delta LFPR_{m,25-54y} + \Delta LFPR_{f,25-54y} + \Delta LFPR_{a,55+y}
\]  

(7)

To project the LFPR, we draw on the results of the shift-share analysis and combine them with Statistics NZ’s population projections.\(^{12}\) Our central forecast includes a number of assumptions for age-gender cohort participation rates (figure 7, 8), based on New Zealand’s relative position in the OECD (figure 9). We assume:

- A continued trend of increasing participation by women aged 25-54. The end-point is 86.5 percent in 2035, compared to 81.6 percent in 2018Q1. This is above the 90\(^{th}\) percentile of OECD economies today, and about 93 percent of the current participation rate of men in this age group.

- A continued trend of increasing participation by people aged 55 and above. The end-point is 57 percent in 2035 compared to 49.4 percent in 2018Q1. Participation by older workers is already high in New Zealand, at around the 90\(^{th}\) percentile relative to other OECD economies.

- A flat trend over the projection for participation by 15-24 year olds. There has generally been a declining trend in youth participation in New Zealand since the 1980s, which may reflect youth having a greater likelihood of participation in education (Stats NZ, 2013). However, this trend has flattened off recently and has not been a significant driver of the aggregate LFPR.

\(^{12}\) This follows a similar methodology to Grigoli, Koczan, and Topalova (2018).
A flat trend over the projection for participation by men aged 25-54 years. Male participation (aged 25-54 years) has been flat, or slightly declining in New Zealand and across OECD economies since the 1980s.

Figure 7: Summary of central cohort LFPR assumptions

Source: Stats NZ, RBNZ estimates.
Figure 8: Age-gender cohort LFPR assumptions

Source: Stats NZ, RBNZ estimates.
3.3. Central forecast

The largest contributor to the increase in the LFPR in New Zealand over recent decades is increased participation rates among people aged 55 and above (figure 10). Participation by older people has contributed around 9 percentage points to the increase in the LFPR since 1991. Increasing participation by women aged 25-54 has supported the LFPR by around 3 percentage points since 1991. However, the effects of population ageing have been a drag on the LFPR by around 4 percentage points.\textsuperscript{13}

\textsuperscript{13} As discussed in Aaronson \textit{et al.} (2014), ‘population ageing’ technically reflects the effects of both the ageing population and shifts in gender composition. However, the effects of ageing dominate those of changing gender composition.
Our central projection for the LFPR extends the decomposition above, using the assumptions outlined in Section 3.2. These assumptions result in a LFPR that remains around its current level of 71 percent until the end of this projection period. Our central projection implies that the negative impacts from population ageing are offset by the positive impacts of changing within-cohort participation rates. This appears to be the most likely scenario given current population projections and trends in participation.

This central forecast is quite similar to that in the August 2018 Monetary Policy Statement. This analysis increases our understanding of the recent trends in the LFPR, and indicates that the RBNZ’s LFPR projection is consistent with a reasonable baseline set of assumptions about the effects of demographics and ongoing trends in cohort participation rates.

### 3.4. Forecast scenarios

Forecasts and projections are subject to significant uncertainty. A range of plausible changes to labour supply over the next two decades can be illustrated with two scenarios based on different assumptions about how participation rates for different cohorts might change, along with population projections from Statistics NZ (figure 11).

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15 See McDermott (2017).
These scenarios highlight the potential impacts of assumptions regarding cohort participation rates in the future. Our ‘high’ scenario assumes participation by women and older individuals increases rapidly, while our ‘low’ scenario assumes cohort participation rates remain at their 2018 levels.\textsuperscript{16}

Both scenarios show that population ageing will continue to be a drag on participation (as we use the same population projections from Stats NZ). A high scenario shows that participation could increase up to 5 percentage points more than our central projection. Our low scenario shows the opposite.

Overall, the central projection in this \textit{Analytical Note} is a balance between these two scenarios, showing that increases in cohort-specific participation rates are likely to offset the drag from population ageing.

\textsuperscript{16}See Appendix B for details.
4. Policy implications

Our central projection in this *Analytical Note* is equivalent to assuming that negative impacts from population ageing are almost exactly offset by the positive impacts of changing within-cohort participation rates (figure 12, 13). This appears to be the most likely scenario given current population projections and trends in participation.

Figure 12: Structural and cyclical contribution to the change in the LFPR since 1986

![Graph showing structural and cyclical contribution to the change in the LFPR since 1986](source: Stats NZ, RBNZ estimates. Note: The projection here is only shown to 2021. This is the most relevant horizon for current monetary policy settings, because monetary policy transmissions operate with an approximate two-year lag (Drew and Sethi, 2008).)

Many of the underlying demographic trends affecting the labour force are slow moving, and do not tend to affect monetary policy decisions from quarter to quarter. However, demographic trends do have a bearing on the conduct of policy, as they affect long-run supply capacity, potential growth, and neutral interest rates.

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17 See Appendix B for detail.
18 Furthermore, we use the unemployment rate gap from the Reserve Bank’s forecasts, which are projected up to three-years ahead.
19 However, it is often difficult in real-time to determine cyclical movements from structural.
Figure 13: LFPR projection scenarios

Source: Stats NZ, RBNZ estimates.
Note: The projection here is only shown to 2021. This is the most relevant horizon for current monetary policy settings, because monetary policy transmissions operate with an approximate two-year lag (Drew and Sethi, 2008).

Some cyclicity in the participation rate can help buffer the inflationary impact of stronger aggregate demand (Evans, Moore, and Rees, 2018). Strong economic growth, if accompanied by increased labour force participation, results in less inflationary pressure than would otherwise be the case. Alternatively, if weak economic growth is accompanied by a decrease in labour force participation, this would result in relatively less slack and hence less deflationary pressure. Cyclicity in the LFPR can therefore act as a stabiliser, by dampening inflation dynamics over the business cycle.

In New Zealand, unexpectedly strong growth in labour supply in recent years has helped to explain why wage and non-tradables inflation pressures have been weaker than expected (Bascand, 2016).

Changes in the LFPR are also relevant when assessing the level of maximum sustainable employment. An increase in employment that is associated with an increase in labour force participation would be less likely to be accompanied by wage and inflationary pressure, and imply that a higher employment rate could be sustained over time. This scenario would imply smaller monetary policy responses.\(^\text{20}\)

\(^{20}\) However, in the event of a labour supply shock which is not accompanied by an increase in employment, monetary policy could be more stimulatory to assist labour demand to meet labour supply (Erceg and Levin, 2013).
5. Conclusion

The analysis in this Note explored the effect of the ageing New Zealand population on the outlook for labour market participation. Going forward, we expect the participation rate to remain broadly flat, which is consistent with the Bank’s projections in the August 2018 Monetary Policy Statement. We expect an ageing population to broadly offset further increases in the female and older worker participation rates.

The business cycle appears to influence aggregate labour market participation to a small extent. This suggests that monetary policy can only have a very small influence on the participation rate through a discouraged/encouraged worker effect. Participation rates of young people and those nearing retirement age appear the most sensitive to business cycle fluctuations.

The aggregate participation rate may increase further if female and older people participation rates continue to increase. Alternatively, if female and older people participation rates have peaked, an ageing population will reduce the aggregate participation rate over time.
References


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*Journal of Economic Dynamics and Control*, 17(1-2), 207-231.


*Reserve Bank of New Zealand Analytical Note*, AN2015/01, March.


## Appendix A: Data definitions

<table>
<thead>
<tr>
<th>Definition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working-age population</td>
<td>The usually resident non-institutionalised population of New Zealand aged 15 years and over.</td>
</tr>
<tr>
<td>Labour force</td>
<td>Members of the working-age population, who were classified as 'employed' or 'unemployed' during the survey reference week.</td>
</tr>
<tr>
<td>Labour force participation rate</td>
<td>The total labour force (i.e. the number of employed and unemployed) expressed as a percentage of the working-age population.</td>
</tr>
<tr>
<td>People unemployed</td>
<td>All people in the working-age population who, during the reference week, were without a paid job, available for work, and had either actively sought work in the past four weeks ending with the reference week, or had a new job to start within the next four weeks.</td>
</tr>
<tr>
<td>Unemployment rate</td>
<td>The number of unemployed people expressed as a percentage of the labour force.</td>
</tr>
</tbody>
</table>

Source: Stats NZ.
Appendix B: Cohort LFPR assumptions

**High LFPR Scenario**

In this scenario, participation rates among those aged 55 years and older and women aged 25-54 years increase by more than the central projection (figure B.1). Female participation reaches 90.5 percent by 2035, which is 97 percent of the male participation rate and beyond the current maximum of OECD economies. Participation by people aged 55 years and older increases more rapidly to 65 percent, instead of 57 percent in the central projection.

**Figure B.1: High participation scenario assumptions**

Source: Stats NZ, RBNZ estimates.
Low LFPR Scenario

In this scenario, cohort participation rates remain constant at 2018 levels (figure B.2). This means that the only effect influencing the aggregate LFPR is population ageing.

Figure B.2: Low participation scenario assumptions

Source: Stats NZ, RBNZ estimates.
Appendix C: Cohort sensitivities to the business cycle

Figure C.1: Cyclical component of the LFPR for each age and gender cohort

Source: Stats NZ, RBNZ estimates

Figure C.2: R² for cyclicality by age and gender

Source: RBNZ estimates.
Appendix D: Robustness checks

Detrending methods

The baseline regression used to calculate the cyclical component of the LFPR uses a LFPR gap that is calculated using the Hodrick-Prescott (HP) filter. The shortcomings of this filtering method are well documented in literature. For example, see Harvey and Jeager (1993), Canova (1994), Cogley and Nason (1995) and King and Rebelo (1993), Hamilton (2017) and Schuler (2018).

These problems with the HP filter mean that it is important to check the robustness of results obtained using the filter. We do this by re-estimating the regression with a LFPR gap that is calculated using the linear projection method developed in Hamilton (2017).

The HP filter is used for the baseline results reported in section 3. However, we re-estimate the regression using Hamilton’s linear projection method to detrend the variables, and find that the results are comparable (figure D.1).

The main difference is that the linear projection method suggests a more positive cyclical contribution since the GFC than the HP filter. This is likely because the linear projection method does not use future observations to detrend a variable at time $t$. Therefore the large increases in the LFPR since around 2015 will be large upside surprises to the filter, and appear as large positive cyclical contributions. The HP filter uses future past and future observations to detrend the LFPR at time $t$. This means that it observes the large increases in participation since around 2015 when calculating the trend, and so is not surprised by them, and does not find as large of a cyclical component.

Figure D.1: LFPR gap with different detrending methods

![LFPR gap with different detrending methods](source: Stats NZ, RBNZ estimates.)
Note: Grey bars represent recessions in New Zealand based on the Hall and McDermott (2014) dates.

**Business cycle measurement**

As noted in the main text, we use the output gap as a proxy for the business cycle. This relies on estimates of potential output, which are unobservable and subject to revision. We therefore re-estimate the cyclical component of the LFPR using the unemployment rate gap and employment gap. We also show the results from using the HP and linear projection methods for detrending these variables. Figure D.2 shows that the results are all broadly consistent with each other, both in sign and magnitude.

Figure D.2: Cyclical LFPR contribution calculated from different variables and detrending methods

![Graph showing cyclical LFPR contribution](image)

Source: Stats NZ, RBNZ estimates.
Note: Grey bars represent recessions in New Zealand based on the Hall and McDermott (2014) dates. LP = linear projection, HP = Hodrick-Prescott.

Figure D.2 shows that the cyclical contribution to the LFPR calculated with the HP filtered output gap is currently close to most of the other estimates. Each method of calculating the cyclical contribution of the LFPR suggests that the cyclical movements in the LFPR have been much smaller than the structural movements.

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21 The employment rate we use is HLFS total employment divided by working-age population. We use the Reserve Bank’s estimate of potential output to construct the output gap (see Lienert and Gillmore, 2015).