TE TAI ŌHANGA
THE TREASURY

Half Year Economic and Fiscal Update 2019

Background paper: Labour productivity growth in the Treasury's fiscal projections

December 2019

New Zealand Government

Labour productivity growth in the Treasury's fiscal projections

Prepared by the Treasury[1]

About this paper

This background paper accompanies the *Half Year Economic and Fiscal Update*, which was released on 11 December 2019.

It reviews a range of factors influencing the labour productivity growth assumption in the Treasury's Fiscal Strategy Model (FSM) and the Long-Term Fiscal Model (LTFM). This assumption is relevant for both the regular FSM fiscal projections prepared alongside the *Economic and Fiscal Update* (EFU), and the *Long-Term Fiscal Statement* (LTFS), due in 2020, which uses the LTFM.

1 Overview

The economic variables in the Treasury's fiscal projection models serve as drivers of fiscal variables. The key economic variables in the models are real and nominal Gross Domestic Product (GDP), the Consumers Price Index (CPI), labour productivity growth and the annual rate of return on 10-year government bonds. Labour productivity is defined as real GDP per hour worked. Other economic variables such as the unemployment rate and average hours worked only affect GDP projections if they are changing. Since they stabilise at their long-run assumptions relatively early into projected years, their role is more limited.[2]

The high pass-through from labour productivity growth to real wage growth and then to government expenditure means that changes to the labour productivity assumption are largely 'washed out' in the tax and expenditure ratios to GDP. While this is model-dependent, labour productivity is likely to affect both tax and expenditure to some extent under any plausible modelling framework.[3]

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[2] Piscetek, M. and Bell, M. (2016). *Demographic, Economic and Fiscal Assumptions and Modelling Methods in the 2016 Long-Term Fiscal Model*. Background Paper for He Tirohanga Mokopuna: 2016 Statement on the Long-Term Fiscal Position. Wellington: The Treasury.

[3] Rodway, P. (2013). *Long-term Fiscal Projections: Reassessing Assumptions, Testing New Perspectives*. Background Paper for the 2013 Statement on the Long-term Fiscal Position. Wellington: The Treasury.

In other projection contexts, such as energy demand, climate change, and future material living standards, the levels of GDP (and GDP per capita) are more relevant. In these cases, labour productivity assumptions matter more.

The assumption for economy-wide annual labour productivity growth in the Treasury's FSM and LTFM is currently 1.5% per year. This value is reached *after* the forecast period. In Budget 2019 it was 2027/28. The assumption is relevant for two pieces of Treasury analysis:

- The regular FSM fiscal projections prepared alongside the EFU.

- The LTFS, due in 2020, which uses the LTFM.

This paper reviews a range of factors influencing the labour productivity growth assumption, including: Treasury's approach to the assumption over time (Section 2); the approach taken by other countries and agencies (Section 3); hours worked (Section 4); historical trends (Section 5); convergence (Section 6); and the economic effects of population ageing (Section 7).

The Treasury's approach has not been substantially reviewed since 1999…

The labour productivity growth assumption of 1.5% per year has been used in the LTFM since 1996 and has not been substantially reviewed since 1999.[4] It was based on a mix of historical trend analysis, convergence prospects, and the lagged effects of policy reform.

In the 1999 Fiscal Strategy Report, the 1.5% labour productivity assumption, combined with labour input projections, was used to generate real GDP for the 10-year fiscal projections. Previously, a top-down real GDP growth rate of 3% per year was assumed, with labour productivity growth a residual. This change placed the medium and long term fiscal projection models on the same basis. The 1999 change involved a review of the productivity assumption.

Although the post-forecast productivity assumption was not directly within the scope of the 2012 HYEFU review of potential output, the review signalled a slowdown in productivity growth.

Productivity trends and prospects were considered in background papers prepared for the 2013 LTFS. Overall, this work tended to support the 1.5% assumption. However, this work is now dated and the transition from the forecast period to the projection period is becoming more problematic given persistently low productivity outturns.[5]

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[4] GDP growth is calculated on the basis of labour-augmenting technological progress and growth in labour input. Capital is assumed to grow at a constant rate consistent with it remaining a constant fraction of output. For details see: Woods, J. (2000). *Manual for the Long Term Fiscal Model*. New Zealand Treasury Working Paper 00/2. Wellington: The Treasury.

[5] For more details on New Zealand's productivity performance see: Nolan, P., Fraser, H. and Conway, P. (2018). Moving on from New Zealand's productivity paradox. *Policy Quarterly*, 14(3), pp.3–9; Conway, P. (2018). Can the Kiwi fly? Achieving productivity lift-off in New Zealand. *International Productivity Monitor*, (34), pp.40–63.

…and other countries place more weight on historical averages

The Treasury's current approach to setting the productivity assumption is not in line with the Treasuries or public finance departments of countries like Australia, the USA, Canada, Switzerland or the UK, who largely base their assumption on an historical average. These historical averages encompass various periods (depending on the country) but generally include the most recent annual outturns. The UK makes a more explicit allowance for a recent slowing of labour productivity growth.

The OECD periodically publish long-term scenarios for member countries. Their approach uses a conditional convergence framework with explicit assumptions about global productivity growth and drivers of steady-state differences. However, the approach relies on cross-country econometric estimates and is better suited to scenarios around a baseline.

There is a weaker case for convergence and the effects of population ageing remain uncertain…

Factors supporting the 1.5% assumption, especially convergence towards high-income countries have been reviewed and there is now less evidence to show that convergence has occurred or is likely to occur in the future.

The fiscal models are primarily used to assess the medium-term fiscal outlook in relation to fiscal strategy (FSM) and the fiscal effects of population ageing (LTFM). We have assessed the productivity assumption methodologies used in other countries to help determine the appropriate methodology for New Zealand. As such, we are less interested in the specific values of the productivity assumptions used elsewhere. Nonetheless, those values convey information about the potential path of relative GDP per capita. Because the *current* 1.5% assumption is broadly in-line with assumptions used in other countries it is consistent with relatively stable income gaps. All else equal, adopting a lower productivity assumption implies non-convergence. Our reading of the methodologies and reports prepared elsewhere is that they do not put a lot of focus on the convergence aspects of their assumptions. Of course, if New Zealand's productivity growth rate were to change then this would gradually be reflected in the updating of a central tendency labour productivity growth measure, such as the average or median over a fixed length rolling interval.

Finally, in terms of other influences on the assumption, population ageing is likely to lower labour force participation, might reduce labour force productivity slightly, and may lead to lower savings and higher interest rates in the long term.

Other government agencies have lowered their productivity assumptions…

Other New Zealand government agencies are now using lower productivity assumptions in their modelling and publications. The Ministry for Business, Innovation and Employment (MBIE) recently published work on electricity demand and generation scenarios.[6] MBIE calculate that New Zealand's labour productivity growth averaged 1.4% per year from 1988 to 2007, then declined to an average of 0.5% per year. While they do not believe this low growth is the new norm, they also do not see productivity growth rates returning to those seen before the global financial crisis. As a result, they settle on a Reference scenario assumption of 1.1%, with 1.5% in a High scenario and 0.7% in a Low scenario.

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6   See https://www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-statistics-and-modelling/energy-modelling/electricity-demand-and-generation-scenarios/

The Ministry for the Environment (MfE) publishes a Biennial Report under the United Nations Framework Convention on Climate Change.[7] The fourth report will be published in December 2019. The Treasury, MBIE, Ministry for Primary Industries (MPI) and Statistics New Zealand (Stats NZ) were all asked to advise on the report's modelling assumptions for the preparation of emission projections out to 2050. It was agreed that the central projection will use labour productivity growth of 1.2% per year. Stats NZ indicated this was consistent with business cycles starting with the same year as the Greenhouse Gas Inventory (1990) and the long-term series.

Finally, the Productivity Commission's latest version of *Productivity by the numbers: 2019* includes scenarios for projections of key fiscal and economic indicators, such as GDP and tax revenue, using the Treasury's LTFM.[8] The Commission include a scenario with labour productivity growth of 1.0%, which is more consistent with New Zealand's productivity performance since the global financial crisis.

The options involve a key choice about the role of 'judgement'…

The two main options for setting the labour productivity growth assumption include:

- **Continue the current approach ("historical average + judgement")**. This could include adopting the UK approach of a slow transition from the current slowdown. This approach still requires a view on the long-run assumption.

- **Adopt a long-run historical central measure statistic,** such as the average or median, up to the most recent outturn.

The Treasury is now adopting the second approach and following a number of countries in using a long-run (30 year) rolling horizon that smooths cyclical influences on labour productivity growth. To be consistent with the Treasury's short-term forecasts and fiscal projection models, the assumption will be based on economy-wide measures of labour productivity. We recognise that for productivity analysis, sub-aggregate official measures may be more appropriate. Again, to be consistent with Treasury forecasts, the focus will be on official measures of GDP and labour input (in the absence of official measures of economy-wide labour productivity).

Nonetheless, there are challenges to adopting this new approach. For example, recent OECD work on the comparability of different methodologies suggests those using labour force surveys may overstate hours worked, and by a significant margin (see Section 4). In addition, the structural changes of the 1980s and 1990s suggest caution in the interpretation of New Zealand's historical labour productivity. This arguably makes a strict application of the long-run historical approach more difficult in New Zealand. To varying degrees and at different times, three of the countries considered in Section 3 also underwent structural reform (ie, Canada, Australia and the UK). However, these changes were generally smaller in terms of scale and impact than in New Zealand. An advantage of the long-run historical approach is that it abstracts from the interpretation of business cycles and structural change.

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[7] See https://www.mfe.govt.nz/publications/climate-change/new-zealands-third-biennial-report-under-united-nations-framework

[8] See https://www.productivity.govt.nz/research/productivity-by-the-numbers-2019/

Figure 1 plots a range of New Zealand historical averages for economy-wide labour productivity growth (see Section 5) against what is currently being assumed by agencies.

Figure 1 – Labour productivity growth: Historical averages and agency assumption
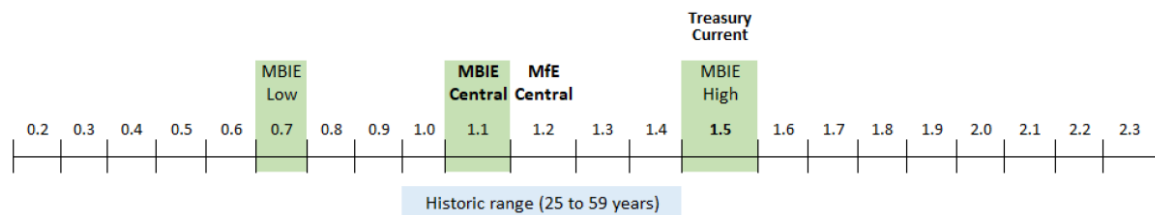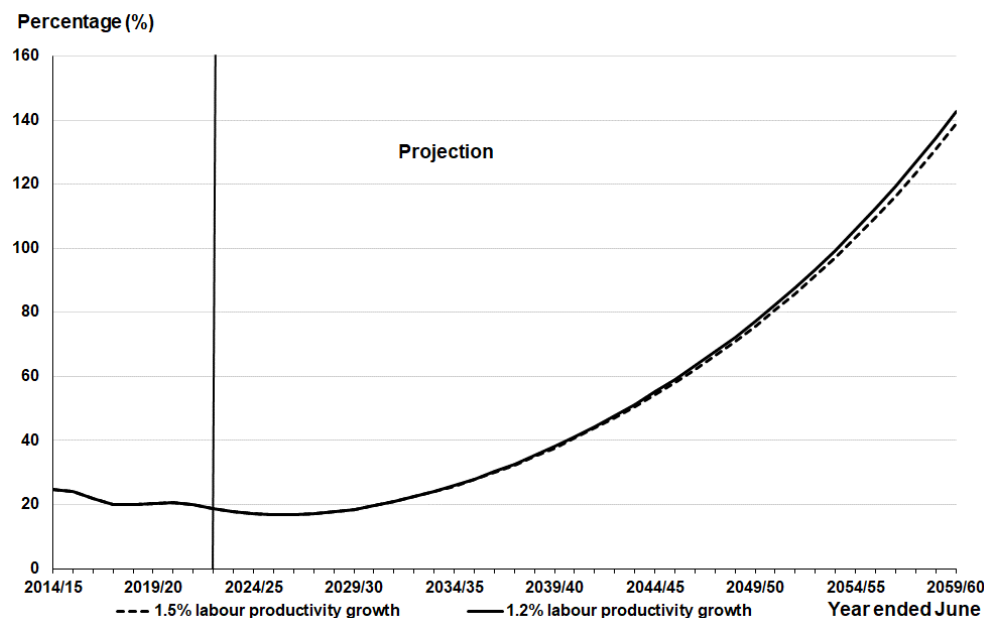

Source: The Treasury

Overall, the Treasury's current 1.5% assumption no longer reflects long-run historical averages. Depending on the time period averaged and the source of the data, the long-run historical average would be a maximum of 1.4%, and a minimum of 1.0%. If we place more weight on the historical average, put less weight on convergence, allow for hours worked issues, and recognise that the current cycle is incomplete, then an assumption of 1.2% per year is appropriate. This is within the range of long-run historical averages and estimates of *median* labour productivity growth (see Section 5). Since labour productivity growth is a volatile series, the median is a better statistic of central tendency than the mean.

The fiscal implications are largely symmetric for the LTFM…

Figure 2 indicates that for the LTFM, net debt to GDP is relatively insensitive to changes in the labour productivity growth assumption.

Figure 2 – Net core Crown debt under different labour productivity growth assumptions: Budget 2019 LTFM (% GDP)

Source: The Treasury

The use of operating and capital allowances in the FSM means there is less than a one-for-one linkage from changes in labour productivity growth to fiscal aggregates.

Figure 3 – Net core Crown net debt under different labour productivity assumptions: HYEFU 2019 FSM (% GDP)
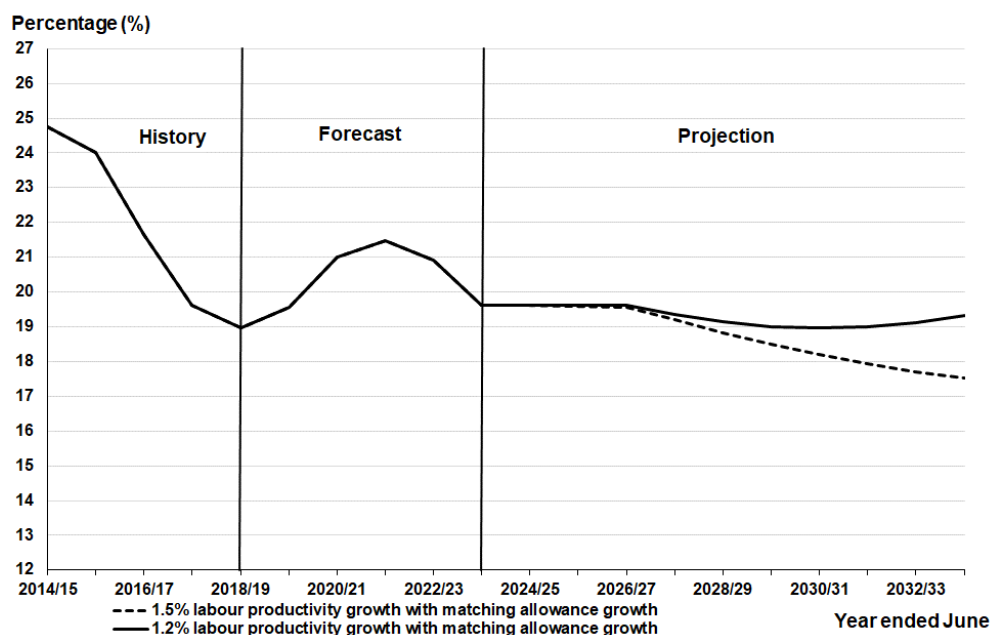
Note: "Matching allowance growth" indicates that operating and capital allowances in the projection period grow with the relevant labour productivity growth assumption, inflation, and growth in labour input.

Source: The Treasury

2   Chronology of the Treasury's approach

This section outlines the productivity assumptions made in various long-term fiscal projections, including those pre-dating the Treasury's fiscal projection models.

1992 Task Force on Private Provision for Retirement

The Task Force secretariat commissioned a model to support analysis of the long-term fiscal affordability of superannuation.[9] The Task Force model was reviewed and refined by the NZIER (*Review of Modelling the Long Term Affordability of National Superannuation* and *Long Term Fiscal Costings of Superannuation Options*). GDP growth was generated from growth in employment and output per worker. Sensitivity testing involved a 1 percentage point variation in labour productivity growth – "*from 1% p.a. to 2% p.a.*" – implying a baseline of 1%.

1994 Fiscal Strategy Report (FSR)

This FSR included the first set of 10-year fiscal projections and assumed an average GDP growth rate of 3% per year.

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[9]   Todd, J. (2008). *Superannuation Task Forces in the 1990s and the political accord*. Retirement Policy and Research Centre, Monograph, 2008-1, Economics Department, University of Auckland Business School.

1995

Diana Cook and John Savage (1995) *The fiscal implications of an ageing population.*
NZIER Working Paper 95/33.

This paper updated the NZIER analysis undertaken for the 1992 Task Force. Cook and
Savage referred to the baseline scenario in the 1995 FSR, where productivity growth was
assumed to be 2.15% per year from 2000/01 (consistent with 3% GDP growth). They
noted this productivity growth track was higher than average economy-wide productivity
growth in the previous 25 years (1977:2 to 1994:3) of 1.3%. They acknowledged that past
productivity growth may not be the best assumption because structural change may have
improved productivity growth. On balance, they considered it prudent to assume that
productivity growth tends towards the historical average. Their central scenario assumed
labour productivity growth of 1.3% after 1997/98.

1996

Hana Polackova (1997) *Population aging and financing of government liabilities in
New Zealand*. World Bank Policy Research Working Paper 1703.

This analysis assumed labour productivity growth of 1.5% per year, which was viewed as
comparable to OECD and IMF forecasts for industrial countries.

In March 1996, a Treasury paper on growth accounting looked at GDP growth to 2010. It
suggested a GDP growth rate of 3.3%, based on:

$$\text{GDP growth rate} = 0.6 \times 1.4\% + 0.4 \times 2.4\% + 1.5\% = \textbf{3.3}\%$$
$$\qquad\qquad\quad \text{(labour)} \qquad \text{(capital)} \qquad \text{(TFP)}$$

The implied *labour* productivity growth rate of 1.9% (ie, GDP growth less labour input
growth) was considered as optimistic by some commentators. Further analysis in August
1996 focused on the labour productivity assumption (see Table 1).[10]

Table 1 – Treasury growth accounting from late 1996

March Years	Capital Growth (%pa)	Employment Growth (%pa)	Capital Deepening (%pa)	Contribution of Capital Deepening (%pa)	TFP Growth (%pa)	LP Growth (%pa)
55/56-95/96	2.78	1.31	1.47	0.59	0.88	**1.47**

The output series is in 1991/92 prices and derived from SNBZ.SZ999 and SNBA.S2AZAT. Labour input is full-
time equivalent employment taken from Philpott (various) where 1 part-time worker = 0.35 full-time equivalent.
The net capital stock series is based on real investment in 1991/92 prices and is based on the total non-
residential net capital stock (public and private). The capital share is set at 0.4.

The August paper highlighted that Total Factor Productivity (TFP) growth over 1955/56 to
1995/96 averaged about 0.9%. Inserting a 1% TFP growth assumption into the March 1996
growth accounting scenario yields GDP growth of 2.8% and labour productivity growth of 1.4%.

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[10] See https://treasury.govt.nz/publications/staff-insight/measurement-new-zealands-productivity-capital

1999 Fiscal Strategy Report

The FSR (Annex 3) noted that:

- Fiscal projections in previous reports were generated by the Treasury's Medium-term Fiscal Model (MTFM). Central scenarios had assumed average real GDP growth of 3% per year. Labour force growth was projected to slow as the population aged. As these changes began to feature in the ten-year horizon, a 3% GDP growth assumption would imply an increasingly higher (residual) labour productivity growth rate.

- Instead of applying 3% GDP growth, the 1999 FSR assumed that GDP growth was the sum of labour force growth and labour productivity growth. This made the projections consistent with the Treasury's 50-year fiscal projections, generated using the LTFM.

- Projections of labour force growth and labour productivity growth are subject to uncertainty.

- Although a number of factors are likely to influence future labour productivity growth, including how quickly New Zealand adopts innovations, their size and timing is difficult to quantify. The 1.5% assumption is broadly consistent with recent historical estimates of New Zealand's labour productivity growth (Diewert and Lawrence, 1999).[11]

The background analysis noted that if the current GDP projections were taken as reasonable, then labour productivity could be set at an average of 2% between 2002/03 and 2008/09 and 1.5% beyond that. Support for the 1.5% assumption also came from the earlier 1996 analysis. The background analysis suggested the 1.5% long-term assumption was reasonable (although on the high side) based on history and OECD comparisons. The 1999 FSR 1999 adopted the 1.5% assumption over the entire projection period.

2012 review of potential output

Although the post-forecast productivity assumption was not directly within the scope of the 2012 HYEFU review of potential output, the review signalled a slowdown in productivity growth:[12] *"Productivity also appears to have weakened before the crisis began, something that is reflected in the official actual [measured sector] productivity data available from Statistics New Zealand. During the crisis, potential multi-factor productivity appears to have continued to fall and has only recently started to recover."*

The work on potential output examined trends in productivity, finding that historical labour productivity growth generally fell short of the 1.5% assumption. The typical range was around 1 to 1.3%, with a medium-term assumption of around 1¼% being suggested.

2013 LTFS

Productivity trends and prospects were considered in background papers prepared for the 2013 LTFS.

Nick Carroll (2013) *Structural change in the New Zealand economy 1974-2012.*

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[11] Diewert, E., and Lawrence, D. (1999). *Measuring New Zealand's productivity*. New Zealand Treasury Working Paper WP99/5. Wellington: The Treasury.

[12] See https://treasury.govt.nz/sites/default/files/2012-12/potential-output-hyefu12.pdf

This paper concluded that while other outcomes are possible (and probably likely), it is not unreasonable to use the past as a guide to the future, particularly where projections provide important insights into the strengths and weaknesses of existing settings and the trade-offs of less uncertain changes (such as demographic change). Looking at a period of major economic and social change between 1992 and 2007, New Zealand's real GDP per capita grew by around 1.8% per year and labour productivity grew at up to 1.5% per year (depending on the start and end points chosen).

Mario Di Maio (2013) *External influences on New Zealand's economic potential.*

This paper concluded that scenarios of long-run growth provide a 'thought experiment' about the broad direction of New Zealand's economic prospects. They suggest that per capita growth over the next 50 years might be somewhere between 1.5% and 2.0% per annum, implying that the gap in GDP per capita with the US will close over time. Most projections suggest that this gap closes only slowly. Relatively large gaps in income per capita with the frontier would remain in 50 years-time although this would still represent a significant improvement in economic performance compared with the past 50 years.

This analysis was incorporated into Rodway (2013), who concluded that:

"We intend to keep the 1.5% assumption of annual growth in output per hour worked (labour productivity growth) used in both the 2006 and 2009 statements (and in fiscal strategy modelling done for each annual budget). While we look at history as a guide to setting this assumption, it is perhaps better regarded as a view of where growth of the New Zealand economy could be converging with our major trading partners".

Rodway noted that measures of aggregate productivity vary widely with the historical period considered and cited the following factors as supporting the 1.5% assumption:

- It was broadly in line with (smoothed) productivity growth over the past three decades of 1.3%.

- Fiscal sustainability reporting by countries at similar stages of development used similar long-term productivity assumptions: Australia (2010) at 1.5%; UK (2010) at 2.2%; and Canada at 1.2%.

- The Di Maio and Carroll papers suggested that productivity growth of between 1.5% and 2% on average is possible.

Rodway acknowledged that the 1.5% assumption had been criticised as unrealistically high. Rodway also cites Gardiner *et al*. (2012), who decompose labour productivity by age and gender groups using wages and show that assumed labour productivity growth could fall over time to about 1.45% in 2060.[13] This relatively small reduction reflects the increase in the proportion of people 65 and older being offset by a decline in youth and a marginal increase in the proportion of prime age adults into the age groups with relatively higher productivity. See Section 7 below for an update on the economic effects of ageing.

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[13] Gardiner, P., Bell, M., and Rodway, P. (2012). New Zealand's long-term fiscal projections under alternative labour force scenarios, Presented at Population Ageing and the Labour Market, International Research Workshop, National Institute of Demographic and Economic Analysis/MOTU.

2016 LTFS

Finally, the productivity assumption was not reviewed for the 2016 LTFS. A background paper (Piscetek and Bell, 2016) noted that it was "always subject to much debate" and many factors were involved. New Zealand's 20-year median rate of labour productivity growth was calculated as 1.4 percent per year. Since labour productivity growth is a volatile series, the median was considered a better statistic to use as a measure of central tendency than the mean. Due to the uncertainty, the 2016 LTFS used history as a guide and left the assumption unchanged as it was broadly in line with the historical median.

3 What other countries and external agencies assume

The Australian Treasury

The main area where the Australian Treasury apply a post-forecast labour productivity growth assumption is in their Intergenerational Report (IGR). These reports are required to be produced every five years and are similar, in some respects, to the Treasury's LTFS. They project out 40 fiscal years beyond the last completed (June) fiscal year.

The most recent IGR was published in March 2015.[14] The Executive Summary states that: "*This report takes historical productivity growth as a guide, and assumes that average annual labour productivity growth over the next 40 years will be 1.5 per cent.*" Chapter 1 states that: "*Productivity growth over the next 40 years is assumed to be 1.5 per cent per annum in the projections in this report. This is the same growth rate as the 30–year average assumption used in the 2014–15 Budget and MYEFO. Labour productivity growth averaged 1.3 per cent in the 1980s, increased to 2.2 per cent in the 1990s, and was 1.5 per cent in the 2000s.*"

The 1.5% assumption is lower than the 1.6% assumption used in the 2010 IGR, which was based on a 30-year historical average. This was the same averaging technique and period used in the first two IGRs, in 2002 and 2007, when the labour productivity annual growth assumptions used were 1.75% in both reports. Overall, the Australian Treasury has lowered its long-run assumption for labour productivity annual growth over time as the historical average it is based on has reduced.[15]

The United States Congressional Budget Office (CBO)

The CBO publish their Long-Term Budget Outlook every year, most recently in June 2019.[16] These outlooks extend out 30 years beyond the most recently completed fiscal year. The US government's fiscal year is from 1 October to the following 30 September.

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[14] See https://treasury.gov.au/publication/2015-igr

[15] The Australian Bureau of Statistics publish a series of GDP per hour worked (annual percentage changes) under 5206.0 Australian National Accounts: National Income, Expenditure and Product. For the 40 years June 1980 to June 2019 the average annual growth rate is 1.5%.

[16] See https://www.cbo.gov/publication/55331

The 2019 projection applies an average value of 1.4% for annual labour productivity growth. The 30-year average from 1989 until 2018 was 1.5%, which is the value used in projections from 2030 onwards. However, for the first decade from 2019 to 2029 they apply a lower assumption of 1.3%. This pulls the average over the entire projection down to 1.4%. This lower assumption is based on the following rationale:

"*A number of developments support projections of slower growth in nonfarm business TFP (total factor productivity). One is the anticipated slowing of growth in labour quality, a measure of workers' skills that accounts for educational attainment and work experience that, in CBO's analysis, is implicitly a part of TFP. Following a relatively rapid rise during the 1980s and 1990s, growth in labour quality slowed after 2000. In CBO's assessment, that change results both from a gradual slowdown in the increase in average educational attainment and from the burgeoning retirement of a relatively large and skilled portion of the workforce – the baby-boom generation. In coming decades, however, the slowdown in the growth of labour quality is expected to be partly offset by the ageing of those remaining in the labour force, especially as better health and longer life expectancy lead people to stay in the workforce longer than did members of previous generations. (An older workforce generally has a larger proportion of more highly educated workers because they tend to remain in the labour force longer than do workers with less education).*" (p.59 in Appendix A)

The last four years of CBO annual labour productivity growth assumptions are set out in Table 2 below.

Table 2 – CBO labour productivity growth assumptions

Long-Term Budget Outlook	30-year historical average	First 10 years of projection	Second 10 years of projection	Third 10 years of projection	Average of 30 year projection
2019	1.5%	1.3%	1.5%	1.5%	1.4%
2018	1.5%	1.4%	1.6%	1.6%	1.5%
2017	1.5%	1.5%	1.6%	1.6%	1.6%
2016	Not shown	1.6%	1.7%	1.8%	1.7%

What is clear is that the CBO do not just apply an historical average for annual labour productivity growth in their projections. However, the assumption they apply does not move far away from the 30-year historical average.

Figure 4 – US labour productivity growth: CBO
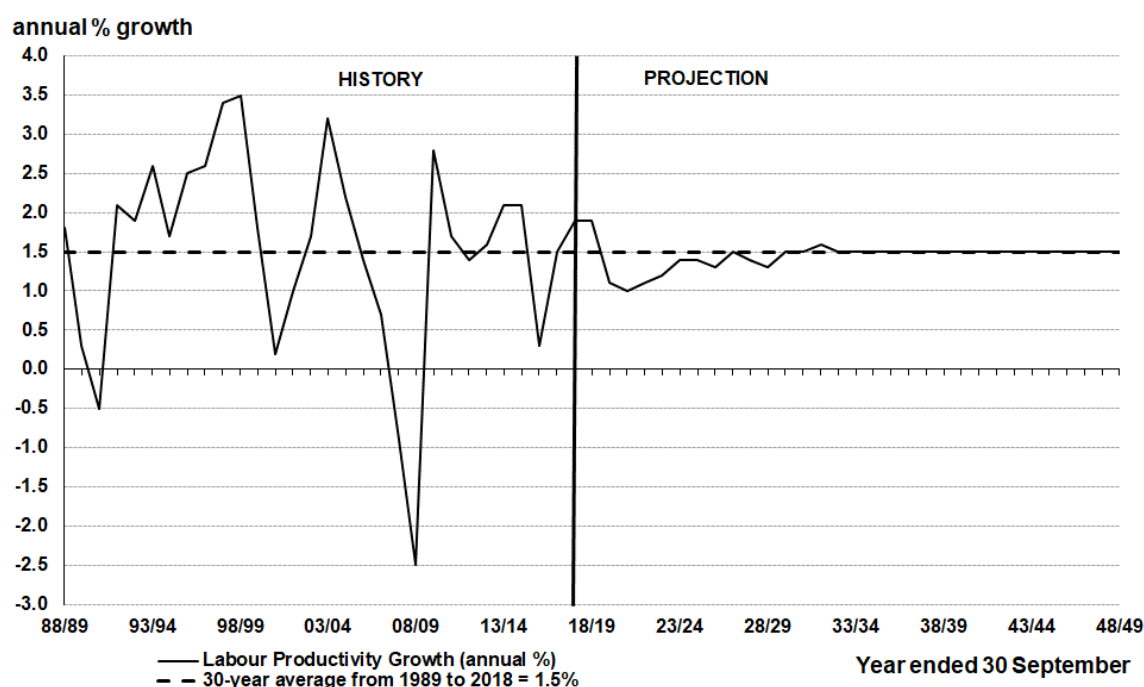
Source: The Treasury using CBO data

The United Kingdom Office of Budget Responsibility (OBR)

The OBR Fiscal Sustainability Report (FSR) includes projections that extend 50 years out beyond the last completed fiscal year. In the United Kingdom (UK) the government's fiscal year is from 1 April to the ensuing 31 March. The latest FSR was produced in July 2018 and states that:[17]
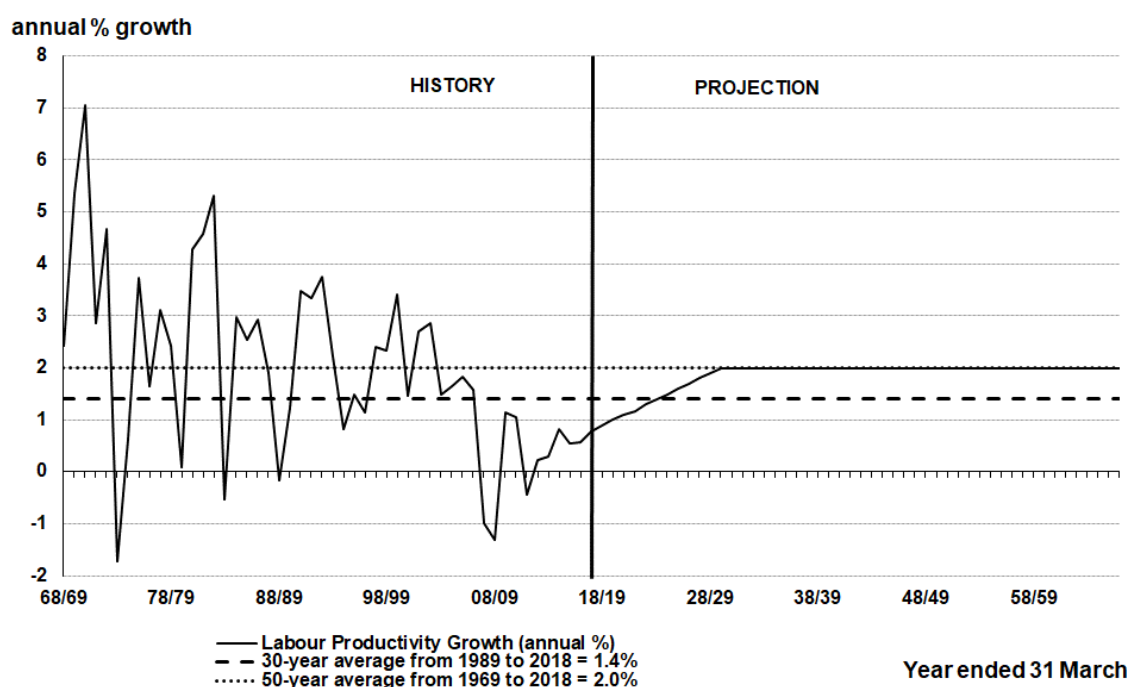
"*In our November 2017 EFO (Economic and Fiscal Outlook) we reassessed the hypotheses put forward to explain the weakness in productivity since around the time of the financial crisis. This led us to revise down our forecasts for trend productivity growth. We now assume that trend hourly productivity growth will rise slowly to 1.2 per cent in 2022, significantly lower than the 1972 to 2007 average of 2.1 per cent.*

We assume in our long-term projections that this post-crisis weakness in trend productivity growth will ultimately fade, returning to 2.0 per cent a year after an extended period. Specifically, we assume that productivity growth will rise by 0.1 percentage points a year from 2023-24 until it reaches 2.0 per cent in 2030-31. Given our uncertainty about the causes of the slowdown in the rate of productivity growth, there is necessarily also considerable uncertainty about whether, and how quickly, productivity growth will recover. Many other paths are equally plausible."

The OBR's approach, while related to an historical average, is not one of simply using the average over the last 30 years (which would be 1.4%). Rather they exclude the years of the global financial crisis, 2008 and 2009, where labour productivity growth was -1.0% and -1.3% respectively, and the mainly positive but generally "under 1%" outturns in the years that followed.

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[17] See https://obr.uk/fsr/fiscal-sustainability-report-july-2018/

Figure 5 – UK labour productivity growth: OBR

annual % growth

Labour Productivity Growth (annual %)
– – 30-year average from 1989 to 2018 = 1.4%
⋯⋯ 50-year average from 1969 to 2018 = 2.0%

Year ended 31 March

Source: The Treasury using OBR data

The OBR expect growth in output per hour to rise steadily towards 2 per cent over the long term, rather than assuming that the recent weakness of productivity growth, which has been driven by a small number of sectors, will persist indefinitely. The OBR *Fiscal Risks Report* (July 2019) maintains this approach.

The Canadian Department of Finance

The Canadian Department of Finance published its first long-term fiscal sustainability analysis in October 2012. Since then it has published an Update of Economic and Fiscal Projections every year. In the latest publication of 2018, they note that: *"Labour productivity is assumed to grow at about its historical average over the 2024–2055 period."*[18] Average annual labour productivity growth was 1.2% for the 48 year historical period from 1970 to 2017, and this is assumed over the entire projection, from 2018 to 2050. This appears to be a fairly stable assumption as it was being applied as early as their 2013 Update, when it was based on the average from 1970 to 2012.

The Swiss Federal Department of Finance

The Federal Department of Finance produces a report on the long-term sustainability of public finances in Switzerland, at least every four years. The latest is the 2016 version.[19] This has a 30 year projection, from 2015 to 2045, and applies a value for labour productivity annual growth of 1.2%. The 2016 report states: "*For the baseline scenario, it is assumed that labour productivity up to 2045 will develop much as it has in the past. Between 1992 and 2014, average annual productivity growth in Switzerland amounted to 1.2%.*" The Swiss report also runs sensitivity analyses involving pessimistic (0.9%) and optimistic (1.5%) assumptions of future productivity growth.

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[18] See https://www.fin.gc.ca/pub/ltefp-peblt/2018/report-rapport-eng.asp

[19] See https://www.efd.admin.ch/efd/en/home/themen/finanzpolitik/report-on-the-long-term-sustainability-of-public-finances-in-swi.html

OECD long term projections

The OECD have recently made the first update to their long-term scenario analysis since 2014.[20] Projections of potential output (Y) are based on a production function that includes physical capital (K), trend employment (N) and labour-augmenting trend technological progress (E, referred to as trend labour efficiency).

In terms of capital, the public sector capital stock-to-output ratio is assumed to be constant while the path of the business sector capital stock depends on the economy's cyclical position, a degree of inertia, and in some cases, the current account deficit. In steady state, the capital-to-output ratio is stable so the growth contribution from changing capital intensity is modest.

The projection of trend employment is the result of: the changing size of the working-age population; its age composition; and trends in the employment rates of different age/sex groups. Population ageing tends to lower the aggregate employment rate because older cohorts (aged 55-74) tend to have lower employment rates than prime-age cohorts (aged 25-54). In most countries, this effect is offset to an extent by rising aggregate female employment rates as younger female cohorts with higher employment rates replace older ones.

Trend labour efficiency growth for each country is determined in a conditional convergence framework (see Section 6 below). In the long-run it converges to an assumed exogenous rate of global technological progress of 1½ per cent per annum. This is a mid-point between the weak performance recorded in advanced countries since the global financial and economic crisis and the stronger rates measured in earlier decades. The OECD emphasise this assumption is highly uncertain.

The equilibrium *level* of labour efficiency for each country depends on its institutional and policy environment, as represented by indicators for: governance; human capital; product market regulation; macroeconomic stability; trade openness; R&D stocks; and income inequality. If a country reaches its equilibrium labour efficiency level, and there is no further change to fundamentals, then labour efficiency growth is equal to the assumed exogenous global rate.

At the start of the projection period, most countries, including New Zealand, are within plus or minus 50% of their predicted equilibriums.[21] However, the preferred estimation equation has a low goodness-of-fit (about 0.3). Therefore, the transition path for some countries is adjusted manually. The equation's less-than-perfect fit also means that it – and more generally the simulation model that it anchors – should primarily be used to illustrate the impact of changes to productivity determinants on outcomes *relative* to a baseline path.

The following equation is used to divide changes in GDP *per capita* into four components:

$$\Delta(y - p) = [\alpha\Delta e] + [(1 - \alpha)\Delta(k - n)] + \Delta(n - pwa) + \Delta(pwa - p)$$

where *P* is total population, *PWA* is population of working age (aged 15 to 74), and lower-case letters denote logarithms. The wage share, α is assumed to be 0.67 for all countries. The first term on the right-hand side measures the *contribution* of labour efficiency growth to GDP per capita growth. The second term measures the contribution of changes in capital intensity, the third picks up the contribution of the employment rate and the fourth term indicates the contribution of the share of the working-age population.

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[20] OECD (2018). *The long view: Scenarios for the world economy to 2060*. OECD Economic Policy Paper No.22. This section is an abridged summary of the relevant OECD working papers.

[21] Guillemette, Y, Kopoin, A., Turner, D. and De Mauro, A. (2017). *A revised approach to productivity convergence in long-term scenarios*. OECD Economic Department Working Papers No.1285.

Table 3 summarises the baseline results for New Zealand, the OECD, and the countries discussed previously. The largest contributor to projected increases in GDP per capita comes from growth in trend labour efficiency.

Table 3 – Sources of real GDP per capita growth in baseline scenario (% per year)

	GDP per capita		Trend labour efficiency		Capital per worker		Employment rate		Share of active population	
	2018-2030	2030-2060	2018-2030	2030-2060	2018-2030	2030-2060	2018-2030	2030-2060	2018-2030	2030-2060
NZ	**1.6**	**1.9**	0.9	1.3	0.6	0.6	0.3	0.1	-0.2	-0.1
Australia	**1.4**	**2.0**	1.0	1.5	0.5	0.7	0.1	0.0	-0.2	-0.1
Canada	**0.9**	**1.5**	0.9	1.1	0.4	0.5	-0.1	0.0	-0.3	-0.2
UK	**1.1**	**1.8**	0.8	1.4	0.5	0.6	0.0	0.1	-0.2	-0.2
US	**1.1**	**1.5**	1.0	1.1	0.4	0.5	-0.1	0.0	-0.3	-0.1
Switzerland	**0.9**	**1.6**	0.8	1.3	0.4	0.6	0.0	0.0	-0.3	-0.3
OECD	**1.5**	**1.7**	1.1	1.3	0.4	0.6	0.1	0.0	-0.2	-0.2

Source: Adapted from OECD (2018) Table 1.

As noted above, trend labour efficiency growth and capital deepening are reported as weighted contributions. For the period 2030-2060 this implies that trend labour efficiency growth is: 1.9 for New Zealand (ie, 1.3/0.67); 2.2 for Australia; 1.6 for Canada; 1.9 for Switzerland; 2.1 for the United Kingdom, and 1.6 for the United States.

The projected GDP per capita increase for New Zealand is 76%, with 51 percentage points coming from labour productivity and 25 percentage points from capital deepening. This is slightly ahead of the OECD per capita GDP increase of 70%. Australia's GDP per capita is projected to increase by 77%.

In an earlier version of the paper (February 2018), the OECD assumed an exogenous rate of global technological progress of 1 per cent per annum. For New Zealand, GDP per capita growth and labour augmenting productivity growth over the period 2030-2060 were 1.4% and 1.5% respectively. These match the current LTFM projections. However, the higher productivity assumption affects all countries and so does not change the extent of convergence.

In summary, all the countries reviewed above, to some degree, use an historical average to set their projection assumption. In the case of the Australian Treasury, the Canadian Department of Finance and the Swiss Federal Department of Finance this is literally what they do. The United States CBO uses slightly different values over different decades of their 30 year projection, but these remain within 0.2 percentage points of their 30 year historical average. The United Kingdom OBR is the only one of the five that lifts their long-run projection to well above their most recent 30 year historical average. However they don't reach this higher value until a decade into their projection, and they can justify their higher assumption as a 50 year average.

The OECD long-term scenario approach is transparent in using a conditional convergence framework in which there are explicit drivers of steady-state differences and so an ability to simulate policy change. However, the approach relies on cross-country estimates and is better suited to scenarios around a baseline. A review of the literature (see Section 6 below) also raises some questions about convergence.

4   Hours worked

Section 2 indicates that historical trend analysis has played a role in the Treasury's approach to setting the long-term productivity growth assumption. Section 3 highlights that it plays a *dominant* role in several other countries. Reviewing the productivity growth assumption and adopting a methodology that places a greater weight on historical trends requires analysis of those trends. While uncertainty around estimates of capital and multifactor productivity (MFP) is generally well-known, in the New Zealand case there is also uncertainty around labour input. Indeed, sensitivity to alternative labour input measures was a key finding of Diewert and Lawrence (1999). More broadly, productivity measurement issues have been a feature of the global productivity slowdown debate, including the challenges of measuring growth in the digital economy.[22]

The 2008 SNA and the *Measuring Productivity OECD Manual* state that neither the number of persons employed, nor employees, job-counts or full-time equivalent employment are ideal for productivity indicators. The recommended measure is the *total number of hours actually worked* by all persons engaged in production (ie, employees and self-employed). This measure captures variations in the incidence of part-time work, absences from work, and changes in normal working hours. Productivity analysis is concerned with measuring the volume of inputs engaged in the production of a given volume of output. So the underlying concept for working time should include all hours effectively used in production, whether paid or not.[23]

Total annual hours worked is made up of two parts, the number of people employed and the average hours worked per employee. The number of people employed is relatively easy to count, but the average hours worked is not. This is particularly so when comparing across countries. A background note to the Conference Board's Total Economy Database (TED) notes that: *"Estimates of working hours involve serious measurement problems and international comparability is difficult. … Some countries use mainly labour force survey based estimates, others rely more heavily on establishment type surveys, while all are making adjustments which are generally not very transparently reported."*[24]

The variation in hours worked across different series is considerable, and makes it difficult to determine the overall *levels* and *trends*.

- The variation in *trend* means there is considerable uncertainty about the split of the contribution to economic growth between labour input and labour productivity.

- The variation in *levels* means there is uncertainty about whether New Zealand has a high labour input compared to other countries.

The Conference Board have indicated there is cross referencing of source data across the international productivity datasets. For example, TED relies on the OECD for more recent years, while the OECD uses TED data for some historical series.

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[22]   Pells, S. (2018). Productivity measurement in the digital age. *Policy Quarterly*, 14(3), pp.52–57.

[23]   Ward, A., M. Zinni and P. Marianna (2018). *International productivity gaps: Are labour input measures comparable?* OECD Statistics Working Papers, 2018/12.

[24]   Vries, K. and Erumban, A. (2017). Total Economy Database: A detailed guide to its sources and methods.

For New Zealand, the Conference Board relies on data sourced directly from Stats NZ for 1986-2018, with the total number of employed and total hours worked sourced from the Household Labour Force Survey (HLFS). For the period 1970-1986, the series are back cast using the trend from the variable *'Hours worked per worker, total economy'* sourced from the OECD's *Economic Outlook*. The resulting series follows a linear trend from 1970 to the mid-1970s and is *below* the average of the (then) OECD countries. For New Zealand, the OECD also use the HLFS from 1986. From 1970 to 1986 the OECD use annual hours worked per worker person employed from TED.

In line with other countries, New Zealand could be expected to see a long term decline in the average hours worked driven by:

- ***The rise in part-time employment.*** Part-time work (defined as less than 30 hours a week) rose from 17% of the labour force in 1986 to 23% in 2013 through trends such as the increased proportion of women and semi-retired workers and the increased proportion of young people in tertiary education (associated with part-time employment into their early 20s).

- ***An increase in holiday and other non-working entitlements***, notably the rise in minimum annual holidays from 2 to 3 weeks in 1974, and 3 to 4 weeks in 2007; the addition of Waitangi day as a public holiday in 1974, and the subsequent Monday-isation of Waitangi and Anzac days (when they fall on a weekend) from 2013; and the increase in other leave such as parental leave, sick leave and funeral leave (to a wider range of relatives).

However, while part-time work and increases in holidays have led to significant decline in hours worked in other countries, in New Zealand the official HLFS figures suggest that they have had less impact, with both a slower downward trend, and periods when the trend ceased or reversed.[25] The result is that measures of hours worked, which are provided to the OECD, Conference Board and others for cross-country comparisons, show we now have relatively high working hours, compared to the OECD 1973 group of largely high income countries, and to the wider group of European countries included in the OECD 2018 group.

Recent OECD work on the comparability of different methodologies suggests those like the HLFS overstate hours worked, and by a significant margin. Unfortunately the OECD work does not include New Zealand. In particular, the OECD found:

"…countries making no adjustments to average hours worked measures extracted from the original source, such as self-reported hours actually worked, appear to systematically over-estimate labour input and, so, under-estimate labour productivity levels. [The proposed new methodology] point to a reduction in the relative productivity gaps of around 10 percentage points in many countries compared to current estimates."[26]

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[25] For example, the HLFS series grows strongly in the period from 1992 to 1995. While it is not possible to be definitive, there is some limited evidence that the redesign of the HLFS in 1993-94 overstated growth in actual hours worked over this period. See: Statistics New Zealand and New Zealand Treasury (2010). *Taking on the West Island: How does New Zealand's labour productivity stack up?* Wellington: Statistics New Zealand and New Zealand Treasury/Treasury Productivity Paper series TPRP 10/01.

[26] Ward, A., M. Zinni and P. Marianna (2018), *International productivity gaps: Are labour input measures comparable?* OECD Statistics Working Papers 2018/12.

It would appear that the HLFS-type surveys did not actually cover the whole year (often missing general holiday times). In addition, the background notes for New Zealand in the OECD database recognise that we may be missing the increasing amount of other leave. It notes that there are currently no specific rules around respondents on paid parental leave, maternity leave, and other long absences, and these people 'most likely considered to 'be not in the labour force' but that this is defined by the person themselves'.

The OECD has proposed that *usual hours worked* is the more robust metric from survey data, and that the actual annual hours worked should be calculated from it by adjusting for holidays, sick, parental and any other leave entitlements. In some cases, such as the UK and Sweden, the labour productivity gap is significantly reduced with the revised hours worked.

Figure 6 plots a wide range of New Zealand metrics that are available on a consistent basis, and includes a replication of the new OECD method (from 1986). The key message is that there are significant variations between the various datasets both in level and in trend. The figure highlights:

- The discrepancy in the HLFS track in the early 1990s, when average hours first fell then rose sharply, before a significant decline.

- A strong indication that the HLFS actual hours worked is systematically under-reporting holidays, as shown by the widening gap between the HLFS actual hours worked and the new OECD methodology based on modifying the HLFS usual hours worked series.

- Shows that the revised OECD methodology and the Census data show very similar trends.

Focusing on the upward lift in the HLFS track, the plausibility of this track seems doubtful. A comparison with the track for people working "40 hours less holidays" with the growth in the proportion of part-time (less than 30 hours per week) workers suggests the HLFS is not picking up the rise in part-time hours that occurred between 1986 and 1999. On the other hand, the decline in the 2005-07 period is beyond what would be expected from the lift to four weeks annual leave, when there was only a comparatively minor decline in the number of part-time workers that would explain the sharper decline.

Figure 6 – Alternative sources of average weekly hours
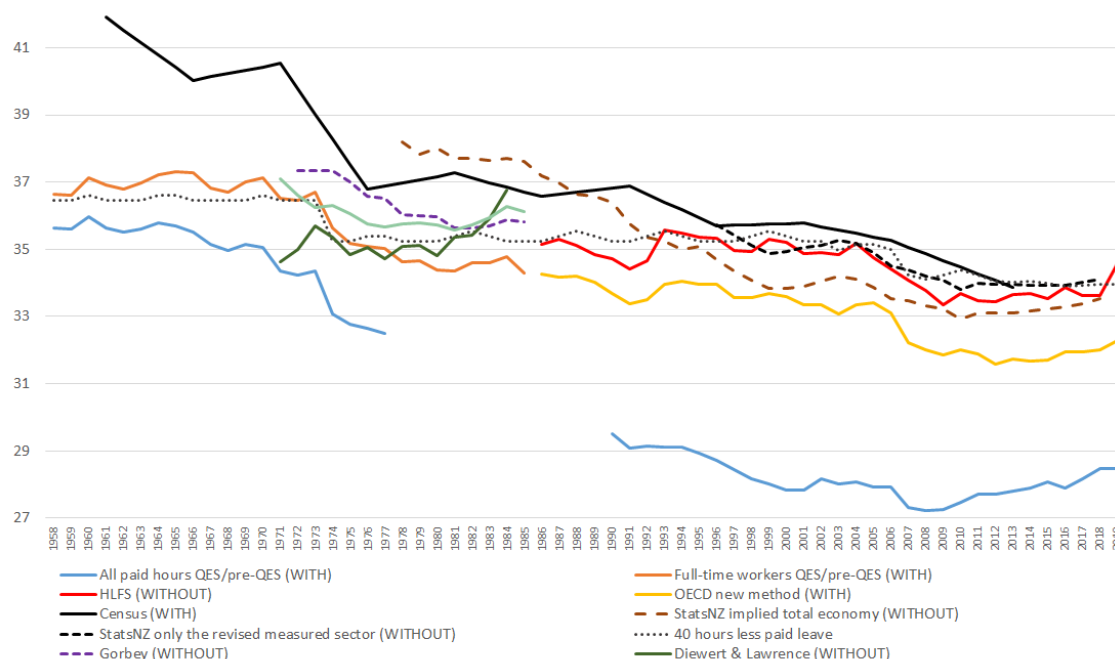
Note: (WITH) indicates an adjustment for holiday hours, (WITHOUT) indicates no adjustment.
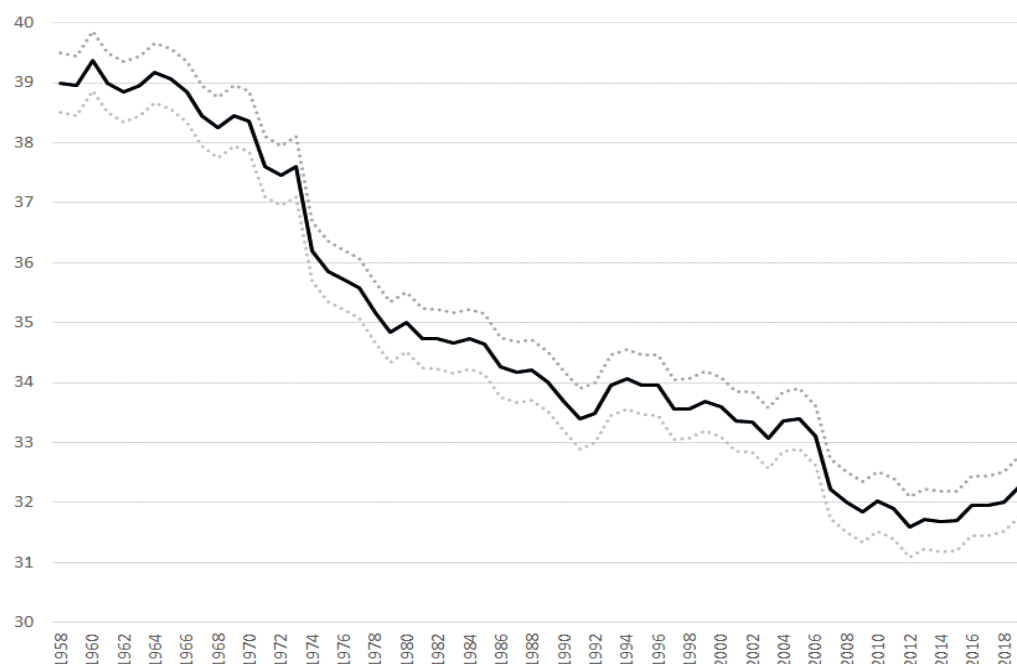
Source: The Treasury

The most notable outlier is the series from the Quarterly Employment Survey (QES), which falls below all the others. While it may be different in terms of *level,* it cannot be ignored when it comes to the issue of *trend.* In fact the two different metrics with the most similar trends are the QES and the Census, one of which is based on asking everyone, and the other based on paid hours reported by employers (though without agricultural and the self-employed). This may be the reason that the QES trend seems to have been more influential than the HLFS hours worked in the construction of the paid hours worked in the Stats NZ official productivity series (see Annex). This is significant because the Census track suggests that the QES:

- Over-estimates the decline in hours in the 1990s.

- Under-estimates the decline in the 2000s.

- Over-estimates the decline over all (though not by much).

Our preliminary estimate of a *composite* series is an attempt to replicate the new OECD method for the post-1986 (HLFS) period, as well as including various judgments for the pre-1986 period. The composite series shows New Zealand following the pattern of the "1973 OECD" group of countries rather than being an exception. While the analysis suggests the difference from adopting the new OECD approach is relatively small, the discrepancy is increasing over time, rising from about 3% in 1990 to peaking at about 6%.

Figure 7 – Composite average hours worked per week

Note: Dashed lines indicate upper and lower bounds

Source: The Treasury

A key point to note is the stabilisation and mild uptick in the decade prior to 2018, which all else equal would be affecting the path of labour productivity. Should average hours revert back to the downward trend, then this might influence the productivity assumption.

Using the new OECD methodology reduces New Zealand's working hours from 1745 to 1678 per year. This moves New Zealand from having one of the longest working years to having one that is in the middle of the OECD. There are two important caveats:

- New Zealand still has a relatively high labour input in total because of a high labour market participation rate.

- While about 18 countries in the OECD database have had their hours worked adjusted for the new methodology, there are still about a dozen countries that have not. As a result, New Zealand's relative position may yet change.

Finally, while there is arguably a case for Stats NZ and/or the OECD to adjust the hours worked numbers reported for New Zealand, at a minimum these issues should be acknowledged in productivity analysis and reporting (as they were in the OECD 2019 Economic Survey of New Zealand – see Figure 2, p.17).

5   New Zealand historical trends

Table 4 sets out various estimates of New Zealand's labour productivity growth. Historical trend analysis for the LTFM assumption has typically been on an economy-wide basis and utilised a variety of data sources. For example, the "Spliced long history" series in Table 4 uses the Stats NZ long-term series for 29 years (1961 to 1989) and the Treasury derived hours worked measure for 30 years (1990 to 2019). The first part of this series uses full-time equivalent employment as the measure of labour input (defined as the number of full-time workers plus half the number of part-time workers). As noted in the previous section, full-time equivalent employment is considered less than ideal for productivity indicators. In addition, because of gaps in the employment data for agriculture, the sectors real output is excluded prior to 1977/78.[27]

Three considerations are relevant to the historical averages presented Table 4:

- The Treasury's fiscal projection models are based on June fiscal years. This requires the underlying GDP and labour input series to be on a quarterly basis. This places some limits on the length of the available time series. Data for annual March years allows some labour productivity series to be calculated over longer time periods.

- Stats NZ updated the design of the HLFS in June 2016 to improve the relevance of the survey.[28] The change in the survey created level shifts in some of the HLFS series, including the number of people employed and the total actual number of hours worked each week. Stats NZ have estimated the impact of the change, with their central estimates suggesting that growth in labour input is lower and growth in labour productivity is less negative once the change in the HLFS survey is adjusted for. However, these adjustments will not be incorporated into the headline HLFS results given the wide range of uncertainty around the estimates. We have used the published HLFS series in our labour productivity calculations. The HLFS changes are less of an issue given we are focusing on long-run historical growth rates although it does affect productivity levels.

- Stats NZ have assessed the effects of revisions to national population estimates on the HLFS for the September 2013 to June 2019 quarters.[29] These revisions have been incorporated in Table 4.

Depending on the time period averaged and the source of the data, an historical average that included recent years' data would appear to be a maximum of 1.4%, and a minimum of 1.0%. Figure 8 plots the mean and median annual growth rates for the hours worked series.

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[27] See http://archive.stats.govt.nz/browse_for_stats/economic_indicators/NationalAccounts/long-term-data-series/productivity.aspx. Dalziel, P. and Lattimore, R. (1991). *A Briefing on the New Zealand Macroeconomy. 1960-1990,* 1st edition.

[28] See https://treasury.govt.nz/publications/mei/monthly-economic-indicators-july-2017

[29] See https://www.stats.govt.nz/reports/household-labour-force-survey-population-reweight-from-revised-national-population-estimates-june-2019-quarter

Table 4 – Economy-wide labour productivity growth

Source of series	Time period averaged	Average annual % growth
Treasury: using hours worked (June years) - Figure 8	**1990 to 2019 (30 years)**	**1.0%**
Treasury: using hours worked (June years)	1995 to 2019 (25 years)	1.1%
OECD: GDP per hour worked (December years)	1971 to 2018 (48 years)	1.2%
Stats NZ and Treasury: Spliced long history	1961 to 2019 (59 years)	1.2%
Treasury: using hours worked (March years)	1988 to 2019 (32 years)	1.2%
Treasury: using composite hours worked (March years)	1988 to 2019 (32 years)	1.2%
Treasury: using unofficial hours paid (March years)	1979 to 2018 (40 years)	1.4%

*Figure 8* – New Zealand Labour productivity growth: The Treasury
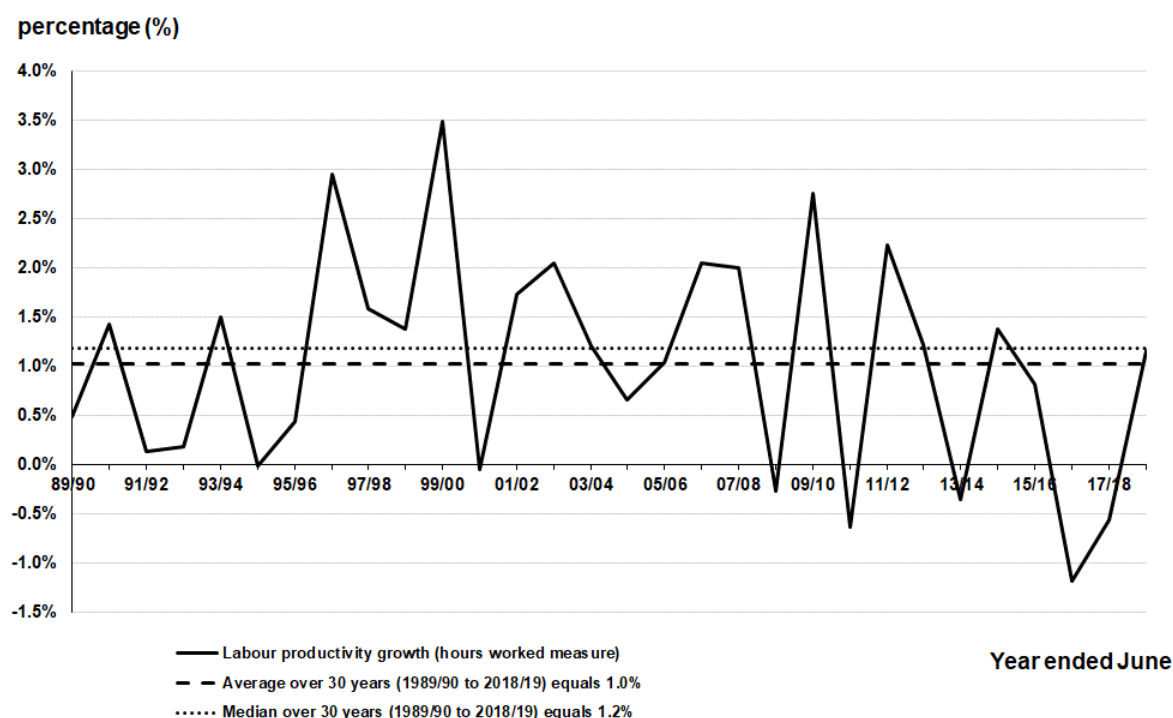
Source: The Treasury

While the fiscal projection models are essentially growth models, it is useful to also consider the *levels* of labour productivity. Figure 9 below plots the levels for three of the series in Table 4. For official measured sector productivity series (MS-11 and MS-16), Stats NZ derive a composite labour input series based on *hours paid* (see Annex). Stats NZ have provided us with the unofficial/unpublished labour data for the implied total economy on an hours paid basis. This allows us to construct an economy-wide labour productivity measure more akin to the official productivity series.[30]

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[30] Strictly, the data is for 'job counts and hours for employees and working proprietors' and differs slightly from the Labour Volume Series (LVS) used in the official productivity statistics. This is because the LVS weights each industry by its income share (See Annex).

The key points to be taken from Figure 9 are that:

- Because real GDP is the same for each series, the differences are due to labour input.

- Labour productivity using composite hours is higher than when calculated using Stats NZ hours worked, as per the analysis in the previous section. By 2018 the gap is around 5 percent.

- Labour productivity using the unofficial *hours paid* series is relatively close to the composite series, with the exception of the last few years. Stats NZ (2014) have argued that the annual change in hours paid at the aggregate level is not significantly different from the annual change in actual hours worked (see Annex). This is less the case in recent years. Furthermore, the LTFM projects hours worked rather than hours paid.

Figure 9 – Labour productivity: Real GDP per hour (March years)
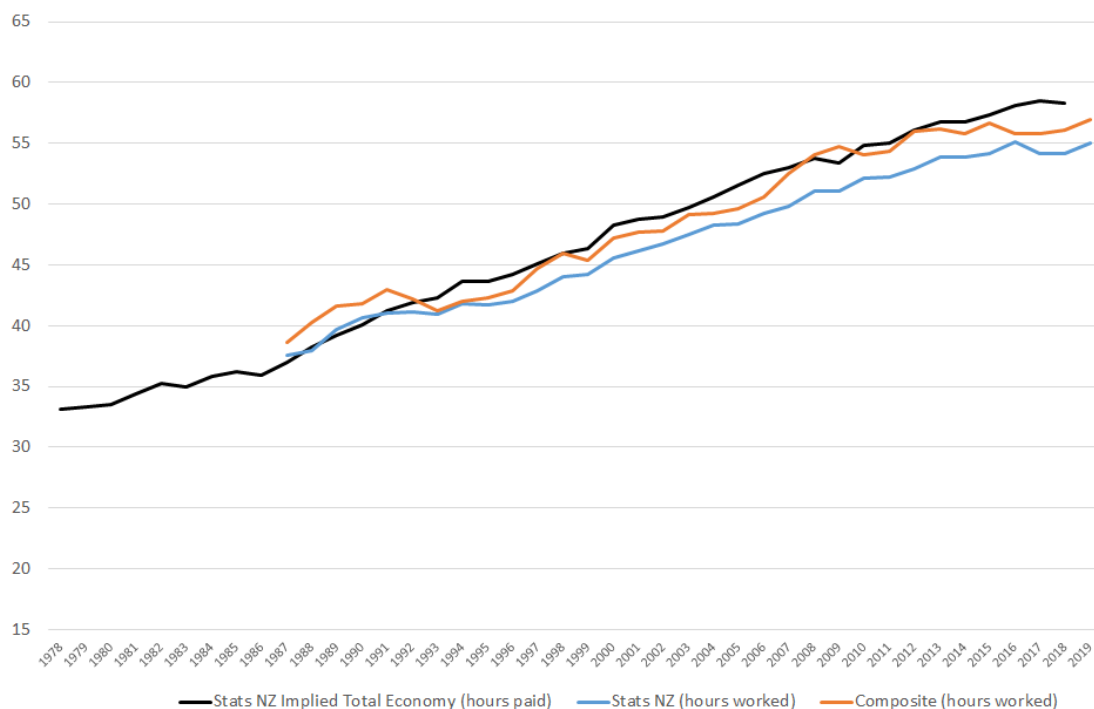
Note: Real GDP is 2009/10 base (SG01RAC00B01). For the composite series, HLFS employment is used to calculate total hours.

Sources: Stats NZ, the Treasury

Both of the labour productivity series based on hours worked begin to plateau from around 2012. The post 2008 period, with its modest capital deepening, affects the long-run labour productivity averages. In their reporting of measured-sector productivity, Stats NZ consider the role of productivity cycles.[31] The most recent cycle starts in 2008 and remains incomplete. Relatively slow productivity growth over the recent cycle could support the adoption of an OBR approach whereby we assume a phased transition back to pre-2008 trends. However, the OBR have the benefit of more data to establish their 2% historical trend.

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[31] See: Statistics New Zealand (2007) *Extracting Growth Cycles from Productivity Indexes,* October.

6 Convergence

As noted in Section 2 above, the Treasury last reviewed convergence as part of the 2013 LTFS (Di Maio, 2013). At that stage the key question was to understand why, given New Zealand's policy settings and levels of human capital, the country had not experienced the convergence that might be expected from the literature. The review considered the evidence available for convergence and suggested *that "the process of convergence is an exception rather than the rule"* and that it was more likely to be conditional and into 'clubs' than absolute. It came to no conclusion on whether New Zealand in particular was likely to converge with the OECD average, and if so under what conditions.

In an earlier 2004 review, the Treasury raised the issue of whether there were structural issues (eg, size, distance or industrial structure) that meant New Zealand did not belong to the "OECD convergence club". However the review suggested there were signs that the reforms of the 1980s had increased the possibility of convergence with the other OECD countries (Treasury, 2004, paragraph 137).[32]

Most studies of convergence have looked at GDP per capita, whereas most of the theoretical work has focussed on productivity.[33] Although the research on GDP per capita can be taken as likely to be predictive of productivity, it is not totally aligned because of labour quantity. This is arguably important in the case of New Zealand given high population growth and labour market participation.

In the 1990's three different but related ideas on convergence emerged:

- *Beta-convergence* occurs when poor regions or countries grow faster than rich ones and therefore catch up on them. This theory is based on the Solow growth model, where one key assumption is that factors of production, particularly capital are subject to diminishing returns.

- *Sigma-convergence* does not assume that low income countries grow faster, it merely suggests that the variation between countries will diminish over time, which may be because of beta-convergence or it could be because while there is no overall pattern, the differential growth rates of countries means that the variance between them declines. It is often assumed that beta-convergence will automatically lead to sigma-convergence, but this is not always the case, and certainly many studies have found one type of convergence without finding the other.

- *Stochastic-convergence* assumes that the current income differentials are largely the result of random shocks which are temporary. As the gains from these shocks are transmissible across countries, and because future shocks are likely to be random, in the long run, income will converge.

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[32] See: https://treasury.govt.nz/sites/default/files/2007-11/economicgrowth.pdf

[33] This section draws on: Abreu, M., De Groot, H. L. F., and Florax, R. J. G. M. (2005). A meta-analysis of β-convergence: The legendary 2%. *Journal of Economic Surveys,* 19(3), pp.389-420*;* Islam, N. (2003). What have we learnt from the convergence debate? *Journal of Economic Surveys,* 17(3), pp. 309-362.

For all three types of convergence, the literature gives two options: *absolute convergence* (where income/productivity converges to the same level for every country) or *conditional or "club" convergence.* The main arguments for absolute convergence include:

- ***The law of diminishing returns*** predicts that as more capital, labour and technology is added to an economy the income gain from each additional unit will be less (though this is less clearly the case for major technological changes). This suggests that low income countries will gain more from adding resources than high income countries.

- ***Technological transfer*** suggests that low income countries will be able to grow more rapidly because they are adopting known technology while high income countries have to create new technological breakthroughs to actually grow.

The main arguments suggesting that convergence won't occur or will only occur within conditional "clubs" are:

- ***Different economic environments:*** While low income countries do have access to known technology their ability to use it may be constrained by their labour skills, access to capital, social norms, and by their policy settings. Some of these settings, particularly property rights and the rule of law, have been shown to be particularly important.

- ***Natural resource distribution***: The uneven distribution of natural resources may prevent convergence.

The key structural factors affecting conditional convergence include: the levels of human and physical capital; technology; openness to trade (although research suggests this is likely to lead to club convergence with trading partners rather than to absolute convergence); strong property rights; the rule of law and good government; and demographic features such as the rate of growth and the age structure of the population.

Early research, particularly by Robert Barro, led to the idea of "the iron law of convergence" which suggested that income or productivity levels converged at the rate of 2% per annum.[34] The "iron law" of convergence has been undermined by the reality of persistent disparities both between regions within countries and between countries. Internationally, the pattern over the last 50 years has been less about convergence than about persistence. With a small number of notable exceptions: countries that were poor (rich) in 1960 remained poor (rich) in 2008, and of those that did change, at least as many became poorer (richer) as those that converged. In fact, the poorest countries have shown no signs of convergence (even though they are richer, they are not relatively richer) and many countries that lifted from low-income to middle-income seem to fail to progress further (the so-called "middle-income trap").

Further, long-term growth patterns show highly variable annual growth rates with little consistency in the growth of individual countries. A country that grows rapidly in one period, may or may not grow rapidly in the next. Where convergence is observed it is caused at least as much by the slowdown in growth of developed countries (eg, Japan) as by the faster growth of low income countries.

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34 Barro, R. J. (2015). Convergence and modernisation. *Economic Journal,* 125(585), pp.911-942.

Both the methodology and the data used influence the findings. In particular, studies that used cross-section data had higher convergence rates than those that used time series data. The early studies all used cross section data but the growth of longer term data sets has led to a move to time series analysis. Time series data revealed that convergence was concentrated in particular decades, and that divergence was more common in other decades. For high income countries, the 1960's and 1970's experienced a higher rate of convergence than other time periods, and many, though not all, studies have found divergence, particularly since 1995, and even more strongly since 2008.

More recent reviews have also shown a distinctive pattern of results being related to the methodology used. In particular:

- **Country effects:** Studies that did not include fixed country variables (which are intended to capture systemic differences like political and legal settings) tended to show higher convergence rates, suggesting that at least some of the convergence is caused by the nature of different economies.

- **Country choice:** China and the ex-Soviet Union countries were associated with convergence, Latin America and Africa with divergence and so the inclusion or exclusion of these groups affected the results. It also made a difference when the results were weighted by population (which increases the impact of China in particular). The impact of the selection effect was particularly an issue for the earliest studies which tended to be countries that developed early (and so had long term statistics).

- **Industry structure:** Convergence through the transmission of technology, and learning new transferable skills through doing, appears to be easier in manufacturing than in most service sectors and parts of agriculture (which dominate the New Zealand economy). This means that low income countries are more likely to grow rapidly if they have manufacturing as a significant proportion of their GDP.

Of the many factors that may influence convergence, only two, the quality of governance and trade openness, seemed to effect the speed of convergence, but the impact was mild.

Most of the early studies included both low and high income countries. It has become clear that when convergence occurred it was because low/medium income countries grew at a faster rate than developed countries. In fact, as the average growth rate in developed countries has declined, the level of variation between them has shrunk. This means that the countries that have converged are not like New Zealand, and it is important therefore to look at the results for high income countries.

The main studies on whether high income countries converge with each other are those looking across the EU and USA studies looking at sub-regions. These have come to very different conclusions. In summary, these are:

- **Long-term convergence**: Some studies say that convergence is a long term pattern, but that it may not happen smoothly.

- **Time-period (or economic condition) specific:** Some studies say that it is a feature of certain time periods driven by the economic settings in those time periods, and that there is no long-term pattern either way.

- *No convergence amongst the rich:* Some studies say there is no evidence of convergence at all or that convergence only happens between poor and rich countries and not between rich countries.

- *Club convergence only:* Some studies say that convergence happens only within clubs – often driven by specific industries.

- *Convergence – but no club convergence.*

The "club convergence" findings suggest that New Zealand is unlikely to be converging with other high income countries, as in many cases we are on the "wrong" side of the analysis. For example, we have a high technology agriculture sector and very limited manufacturing and financial sectors.[35]

It may be that a key reason why New Zealand has not demonstrated strong convergence to the OECD average is that our policy settings changed to encourage convergence just at the very time when the world economic system no longer promoted convergence. Had those policy settings been in place in the 1960's and 1970's when the international tendency was towards convergence, it may well be that New Zealand would have shown strong economic growth.

Overall, developments in the literature suggest that the certainty that may have prevailed at one stage that New Zealand would converge with the OECD average is no longer realistic. The rate of growth of both the OECD and New Zealand is more likely to be determined by the fundamentals of the economy.

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[35] For New Zealand evidence, see: Matheson, T.D. and Oxley, L. (2007). Convergence in productivity across industries: Some results for New Zealand and Australia. *International Review of Applied Economics,* 21(1), pp.55-73; Giles, D.E.A. (2005). Output convergence and International trade: time-series and fuzzy clustering evidence for New Zealand and her trading partners, 1950-1992. The *Journal of International Trade and Economic Development,* 14(1), pp.93-114; Vu, X-B. (2015). Disparities and growth within APEC countries, 1990-2011. *Journal of Economic Integration,* 30(3), pp.399-428.

7   The economic impacts of population ageing

Population ageing is occurring in all developed countries, although at varying speeds. As it is an unprecedented phenomenon, there is significant uncertainty about the ways in which it will affect society. Demographic change affects the fiscal projections via labour supply and government expenditure. On the other hand, the economic implications of population ageing are much harder to pin down. We have to rely on models that use historic data to project a future that will look entirely different. For example, it is problematic to try to predict what effect an increase in the old-age dependency ratio will have if the extent of the increase has never in the past been experienced. The global average old-age dependency ratio has never before been above 15; over the next 40 years the United Nations Population Division projects it will more than double. There are other challenges such as behavioural responses, policy changes, measurement issues, and the validity of assumptions. The key findings of the review are as follows:

- Labour force growth will decline. As people get older, they are less likely to participate in the labour force, and if they do participate, they generally work fewer hours. Therefore, as people age, the aggregate labour force participation rate (LFPR) will decline. The extent of the overall decline in labour supply is softened by an increase in the LFPR and hours worked by both women and elderly people. In New Zealand, the elderly's labour force participation has already increased significantly, and the scope and potential effect of further increases are therefore limited. There is arguably still some scope for female labour supply to increase, but it will not change the overall picture of a slowdown in labour force growth.

- Labour force productivity might decline slightly, but it is not a given. There is considerable evidence that at least some types of cognitive abilities decline with age.[36] Older workers make up for this at least partially by their experience, as well as their breadth of industry knowledge and networks. Moreover, there is also macro-level evidence that suggests that having a relatively older workforce might even have positive effects on labour productivity and company performance. A relatively smaller labour force will also increase the amount of capital per worker, which should boost productivity levels. Therefore, on the whole it is difficult to make an overall assessment on the impact of ageing on labour productivity.

- Ageing will tend to increase the average propensity to consume, and this will have knock-on effects on both goods and capital markets.

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[36] For a literature review, see Skirbekk, V. (2004). *Age and individual productivity: a literature survey*. Vienna Yearbook of Population Research 2004, Vol. 2, pp. 133-153.

- Assessing the net impact of population ageing on interest rates is challenging, as there are both downward and upward pressures. A slowdown in labour force growth will increase the capital/labour ratio, which in turn will put downward pressure on interest rates. Furthermore, if productivity growth slows down, this will also tend to lower interest rates. Of crucial importance is how adequately people are financially prepared for retirement. Theoretically, there should be a positive relationship between life expectancy and savings. Therefore, population ageing should, initially at least, result in an increase in savings, which will exert downward pressure on interest rates. On the other hand, as more people move into retirement and start drawing down on their funds, aggregate savings will fall, putting upward pressure on interest rates.

- Moreover, international capital flows should also be considered. It is reasonable to assume that capital will increasingly flow to relatively younger developing countries with growing labour forces, provided there is an adequate amount of profitable investment opportunities. In turn, this will raise the return on capital in developed economies. On balance, the net effect of ageing on interest rates is difficult to pin down, and it might conceivably first decline for a number of years before it starts increasing. The empirical evidence is mixed; ultimately the net impact will be determined by country-specific conditions as well as international capital markets.

- The composition of consumption will look different in an older society, shifting for example away from education and towards health.[37] Since retired people will tend to have a higher propensity to consume, consumption per capita should increase (assuming net worth levels are high enough).

Overall, the net effect on economic output is uncertain. By lowering labour supply growth and possibly also labour productivity growth, population ageing might lead to a reduction in potential output. However, while some endogenous growth models show a negative relationship between population ageing and GDP growth, others reveal a positive relationship.[38] Ultimately, estimates of how ageing will affect GDP growth depend heavily on the model specification, assumptions, countries assessed, and the time period. It is therefore difficult to come to a definite conclusion. There are also potential mitigating effects that must be considered, such as behavioural and public policy responses, technological progress, changes in relative prices and wages, and lifestyle changes.

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[37] See: Ballingall, J., Lees, K. and Stephenson, J. (2013). *Hi ho silver lining? What firms need to think about as New Zealand ages*. New Zealand Institute of Economic Research (NZIER) Working Paper No. 2013/2.

[38] See: Fougère, M., Harvey, S., Mercenier, J. and Mérette, M. (2009). Population ageing, time allocation and human capital: A general equilibrium analysis for Canada. *Economic Modelling*, 26(1), pp.30-39; Maestas, N., Mullen, K.J. and Powell, D. (2016).The effect of population aging on economic growth, the labor force and productivity. *National Bureau of Economic Research Working Paper 22452.*

ANNEX: Stats NZ labour input (Sources and Methods, 2014)

Hours paid is the number of ordinary and overtime hours for which an employee is paid. It excludes unpaid overtime but may include some hours that are not actually worked, such as paid leave and statutory holidays.

Actual hours worked, derived from household survey data would have been selected as the measure of labour input if the sole objective was a measured-sector (or economy-wide) series without any industry splits. At the measured-sector level, the annual change in actual hours worked is as statistically robust as hours paid. However, at the industry level, the 'hours paid' measure is more robust than the 'hours worked' measure. Stats NZ have more confidence in aligning industry labour inputs with corresponding industry outputs using hours paid data. Given that the methodology used to calculate the labour input series is based on aggregated industry-level data, it is desirable to have good alignment of industry input and outputs.

Different sources and methodologies are used to calculate the four components in the Labour Volume Series (LVS). For data on counts and hours for employees and working proprietors across industries, the LVS uses the:

- Quarterly Employment Survey (QES)
- Business Demography Database (BDD)
- Household Labour Force Survey (HLFS)
- Census of Population and Dwellings (census)
- Linked Employer-Employee Data (LEED)
- Department of Labour Quarterly Employment Survey and Half Yearly Employment Information Survey

The four components are summed to derive industry totals. The LVS can be aggregated to the published industry, measured-sector, or total economy-wide level.

The LVS for the measured sector is formed using a Tornqvist index formula that weights the annual industry averages of paid hours by their relative labour income share in current prices. This share is derived using compensation of employees and the net mixed income received by working proprietors and those who are self-employed.

Assuming a positive correlation between industry labour incomes and skill levels, the industry weighting regime goes some way towards 'quality adjusting' the labour volume index. This implies that an increase in the aggregate level of output due to an increase in the skill level of the labour force will only partially show up as an increase in labour productivity. If the labour measure did not have this degree of implicit quality adjustment, the increase in output would be fully reflected as an increase in labour productivity.