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# Golden Years – Understanding the New Zealand Superannuation Fund

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Golden Years – Understanding the New Zealand Superannuation Fund

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This paper is dedicated to the memory of David Bowie, in gratitude for a lifetime of inspiration.

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# Abstract

The New Zealand Superannuation Fund (NZSF) is one of New Zealand's largest publicly-owned financial assets. Its primary purpose is to act as an inter-generational tax smoothing vehicle, in order to assist future taxpayers cover the cost of providing the public pension, New Zealand Superannuation (NZS).

New Zealand's ageing population structure will, in the absence of any changes to pension settings, lead to a significant lift in NZS expenditure as a percentage of gross domestic product (GDP) over the next few decades. The paper includes an explanation of the reasons behind why this demographic change is occurring and will continue to unfold over the foreseeable future.

The paper contributes a comprehensive analysis of the NZSF's role in New Zealand's public finances.

This includes descriptions and modelling of NZS and the NZSF, explanations of the mathematical relationships behind the NZSF's legislated contribution rate formula, and a brief history of the NZSF.

Future outcomes for the NZSF's size and role in helping to fund NZS, depending on scenarios that vary the evolution of NZS relative to GDP, are illustrated and explained.

How and why projections related to the NZSF have changed over time is also analysed and explained, including what factors have had the most influence on these changes.

The paper does not comment on the merits of policy decisions that have been made in regard to either NZS or the NZSF. That is not the paper's purpose, outside of covering any aspects of these in regard to how the NZSF has evolved or may evolve in future, or how its logic operates.

**JEL CLASSIFICATION**

C20 Single Equation Models; Single Variables: General
G17 Financial Forecasting and Simulation
H55 Social Security and Public Pensions

**KEYWORDS**

Single Equation Model; Financial Forecast; Old Age Assistance; Public Pension; Pay as You Go.

# Executive Summary

The New Zealand Superannuation Fund (NZSF) was established by the government elected in 1999. The Minister of Finance, Dr (now Sir) Michael Cullen, realised that over the next few decades the ageing population structure of New Zealand would significantly increase the proportion of recipients of the public pension, New Zealand Superannuation (NZS), relative to the size of the taxpayer population. In an October 2000 Cabinet paper, related to establishing the NZSF, Dr Cullen stated "*By setting aside some Crown resources toward retirement income now, while we can afford it, we will be able to smooth out the cost over time*" (New Zealand Treasury, 2000a).

That sentence summarises why the NZSF was established and its prime purpose, which is to act as a tax-smoothing vehicle to reduce the cost of funding NZS for future generations of taxpayers. This is because New Zealand's ageing population structure is causing expenditure on the public pension to rise as a percentage of nominal gross domestic product (GDP). Unless changes are made to NZS, in regard to eligibility criteria, payment rate growth, or abatement conditions, this trend will continue to occur, over at least the next century and probably beyond this.

The New Zealand Superannuation and Retirement Income Act 2001 (New Zealand Legislation, 2018) established the NZSF and set in legislation the formula to define how capital contributions to, and in later years withdrawals from, the NZSF are to be calculated each year. It assigned the responsibility for making these calculations to the Treasury, and this formula is at the core of the logic of the Treasury's NZSF model.

The paper covers several topics either directly or indirectly connected to the NZSF. A brief history of the NZSF's nearly two decades of existence to date is provided. The main demographic and social causes of the ageing population structure are discussed. The legislated contribution rate formula that defines the NZSF's logic is explained, both in plain English and via mathematical proofs, and descriptions of its main parameters and how they are modelled are covered. A substantial section analyses how and why NZSF projections have changed over time, since its inception up until the 2020 Budget.

Key findings about the factors that influence the contribution rate formula that sets the timing and size of contributions to and withdrawals from the NZSF, and affects the size and profile of the NZSF's assets relative to GDP, are that, while the NZSF's level of assets, expected future return and tax rates, and especially the length of its funding horizon, are all important components, the future path of aggregate net NZS expenses relative to nominal GDP is the most significant. Various scenarios of future NZS to GDP paths and their effects on the evolution of the NZSF are examined.

A goal of the paper is to increase understanding of the NZSF, not just in regard to its mathematical logic, but also with respect to its role in helping to fund NZS in the future. Retirement income and public pensions are often topics of intense debate in many developed nations, and New Zealand is no exception. This has been the case in our history, and with an increasingly ageing population it is likely to continue to be so. It is neither the aim of this paper, nor the desire of its author, to influence those debates in any particular direction. However, when such debates occur, especially if they include the NZSF, this paper will hopefully have helped to inform them with information about why the NZSF was established, its history, and how and why the logic driving it works.

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## 1 Introduction

Leading up to the 1999 New Zealand general election and, once in government after it, then Minister of Finance Dr (and now Sir) Michael Cullen was concerned about how an ageing population structure would impact on the government's finances and impose large fiscal costs on future taxpayers. His solution, to at least some of these potential future problems, was to establish the New Zealand Superannuation Fund (NZSF). Such was his role and influence in driving forward the Fund[1], from initial idea to a functioning, large financial institution, that the NZSF was often referred to (and sometimes still is) as the "Cullen Fund" (NZ Super Fund, 2020a).

The NZSF was legally established by the New Zealand Superannuation and Retirement Income Act 2001 (New Zealand Legislation, 2018)[2]. Since that time, the NZSF has grown to be one of the largest publicly-owned financial assets, with a year ending 30 June 2020 (2019/20) closing balance of just under $44 billion (New Zealand Treasury, 2020a), or 13.9 percent of nominal gross domestic product[3] (GDP) in that year. By comparison the Reserve Bank of New Zealand reported that the total assets held in KiwiSaver funds, which are registered with the Financial Markets Authority, was just under $69 billion (21.8 percent of GDP) at the end of June 2020 (Reserve Bank of New Zealand, 2021).

The Fund is managed by an autonomous Crown entity, the Guardians of New Zealand Superannuation, has operational independence regarding investment decisions, and is overseen by an independent board (NZ Super Fund, 2020b).

However, the NZSF itself, along with the Reserve Bank, are the only two entities included in the core Crown segment of public entities that are not government departments nor offices of Parliament (New Zealand Treasury, 2020b). In the case of the Fund the rationale for its inclusion in the core Crown is covered by two sections of the 2001 Act. Section 38(2) states that "*The Fund is not an entity separate from the Crown*", while Section 40 is entirely composed of the phrase "*The Fund is the property of the Crown*".

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1 The terminology "the Fund" will often be used in this paper to refer to the New Zealand Superannuation Fund, as it is a commonly used shorthand term applied to the NZSF.

2 Various sections and schedules of this Act are referred to in a number of places in this paper. All of these can be easily accessed from the link to the Act given in the References section.

3 Unless clearly specified otherwise, all references to GDP in this paper should be taken to mean nominal gross domestic product, which is the current price, expenditure measure of GDP.

A deeper understanding of the context, policy framework and governance arrangements for the NZSF can be found in the paper *Governance of Public Pension Funds: New Zealand Superannuation Fund* (Frances and McCulloch, 2003). This was published as a chapter of the 2004 World Bank publication *Public Pension Fund Management* and is also available on the NZSF website.

The NZSF is a significant component of fiscal strategy and government finances. This is true due to the large amount of public funds that it manages and invests on a prudent, commercial basis. It should be emphasised that references in this paper to the NZSF's performance or behaviour are meant to be construed in relation to its logic and the parameters, both of the NZSF and external to it, that influence its past outcomes and potential future pathways. They are not intended, in any way, to relate to the management or investment decisions of the directors, managers, or any staff members of the New Zealand Superannuation Fund.

The NZSF is also important because of its role in helping future governments to meet the cost of publicly-funded superannuation in a manner that is fair to all generations.

Despite this, few people really have a good understanding of the logic behind the NZSF and what factors are important in determining the future pathways of its important variables, such as the contributions made to it, the future withdrawals from it, and the size of its assets. Information about both the past and potential future of the Fund is quite accessible, yet knowledge of how the Fund has developed over its history, and why this has occurred, does not appear to be widespread. There also does not seem to be a very high level of comprehension concerning the ways in which the NZSF may evolve in the future, and what kind of variables and outcomes will have the most influence on this.

The aim of this paper is to provide information about these very things. It is both understandable, and a sign of a healthy democracy, that people from varying backgrounds, socio-economic status and political leanings will have different views about prefunding of future public pension costs. However, it is important that when the media, politicians, government officials and members of the general public express their opinions or engage in debates on this issue, particularly with specific reference to the NZSF, they do so armed with the correct facts and figures and, possibly even more importantly, an understanding of the Fund and what things most affect it.

# 2 Some history of the NZSF

## 2.1 The beginning rationale

In an October 2000 Cabinet paper (New Zealand Treasury, 2000a) related to establishing the NZSF, points made by Dr Cullen included the following statements:

- *New Zealand's population is ageing. We need to start preparing now for the impending bulge in the cost of New Zealand Superannuation (NZS) that will accompany this trend. By setting aside some Crown resources toward retirement income now, while we can afford it, we will be able to smooth out the cost over time.*

- *The proposed Fund for NZS is not a conventional "fully funded" superannuation scheme that would meet all the future costs of pensions – to do so would require a massive reallocation of government expenditure and would be unrealistic. Rather, the approach is better described as "smoothed pay as you go". It builds up funds for around the next 25 years in order to meet part of the costs of NZS in the future. Eventually, the Fund will be run down.*

- *If we do nothing to prepare for this future, the sustainability of retirement income policy will be called into question. NZS will require an increasing proportion of government expenditure, when there are less people in the workforce to generate the income to pay for it. Although there are now about 6 workers per superannuitant, by 2050 there will be only about 2 workers per superannuitant. It is both unfair and unrealistic to expect the relatively small future proportion of workers-to-superannuitants to have to meet these costs through their taxes at the time, especially while we are much better placed now to save for those future costs.*

- *If the tax burden had to rise significantly in order to meet the expected increase in costs, New Zealand would become less attractive as a country in which to live and work.*

- *Our objective has to be to make our retirement income policies more financially sustainable. The objective is neatly summarised in the way we are defining sustainable development: "meeting the needs of the present generation without compromising the ability of future generations to meet their own needs". We want to put ourselves in a better position to honour the retirement income expectations of present generations without placing an undue burden on the incomes of future generations.*

These statements clearly spell out Dr Cullen's reasoning, backed by his Cabinet colleagues in the government of Prime Minister Helen Clark, for establishing the NZSF.

## 2.2 Significant dates and milestones

The following list highlights some of the key events, both leading up to the establishment of the NZSF and in its history to date. Much of the information given here, especially in regard to the history of retirement income, comes from *Retirement Income in New Zealand: the historical context* (Preston, 2008).

**1975** – The Labour government of Norman Kirk, by this time led by Prime Minister Bill Rowling following Kirk's death in 1974, introduced the New Zealand Superannuation Scheme. This was short-lived, as by 1976 it had been repealed by the newly-elected National government of Prime Minister Robert Muldoon.

**1977** – The National government introduces a taxable, universal pension called National Superannuation. This replaced the Age Benefit, which in 1938 had itself replaced the original New Zealand public pension, the Old Age Pension. The latter was introduced in 1898, with both an income and asset test and a test of good character. When first established, National Superannuation had a starting eligibility age of 60 years and a superannuitant couple received around 80 percent of the average wage.

**1991 and 1992** – The Task Force on Private Provision for Retirement is set up by the National government of Prime Minister Jim Bolger, under the chairmanship of Jeff Todd and comprising members from many different backgrounds. It consulted widely and published three reports, including detailing options and making recommendations about issues such as compulsory savings schemes, superannuation regulations, and the interface between state and private provision for retirement (Todd, 2008).

**1992 until 2001** – The age of eligibility for New Zealand Superannuation (this name for the public pension was adopted in 1993) was raised in steps from 60 years to 65 years. It first went to 61 in 1992, and then rose by six months every year, from 1993 until 2001, to eventually reach 65 years, which is still the eligibility age at the time of writing.

**September 1997** – The Coalition Agreement between the National and New Zealand First political parties, in forming a government after the first Mixed Member Proportional (MMP) election in 1996, requested the Treasury to design a compulsory retirement savings scheme. This was put to the public in the Compulsory Retirement Savings Scheme Referendum, but it was rejected by nearly 92 percent of those who voted.

**November 1999** – The Labour-led Coalition government of Prime Minister Helen Clark is elected with Minister of Finance Dr (now Sir) Michael Cullen advocating for a New Zealand Superannuation Fund. Work on developing and refining this proposal began in the New Zealand Treasury soon afterwards.

**October 2001** – The New Zealand Superannuation and Retirement Income Act 2001 legally establishes the NZSF and sets the formula by which annual capital contributions (and, in later years, withdrawals) are calculated (New Zealand Legislation, 2018).

**2001/02 and 2002/03** – In the first two years of the NZSF's existence capital contributions were less than the amount required by the legislated formula ($600 million and $1,200 million respectively). After that, up until 2009/10, the annual capital contribution required by the legislated formula was made each fiscal year, in fortnightly instalments, to the Guardians of New Zealand Superannuation.

**September 2003** – Capital contributions for the NZSF were first set aside in 2001/02, but the Board of the Guardians was not actually appointed until August 2002. Funds dedicated for the NZSF were managed by Treasury's Debt Management Office until the NZSF itself actually began investing in September 2003, initially with $2.4 billion.

**2008/09** – Due largely to the impact of the global financial crisis (GFC) on world stock markets, the NZSF recorded an annual return of -22.14 percent, its worst to date. The Fund bounced back in the next two years, with annual returns of 15.45 percent and 25.05 percent. Since its inception, up until the end of 2019/20, according to the NZSF's own reporting, their average annual return rate has been 9.63 percent. All of these returns cited are after costs but before New Zealand tax (NZ Super Fund, 2020c).

**May 2009** – The newly-elected National-led coalition government of Prime Minister (now Sir) John Key announced a suspension of contributions to the NZSF[4], although a partial contribution of $250 million would be made in 2009/10. Minister of Finance (now Sir) Bill English explained that, in the wake of the GFC, the government did not wish to further increase debt by borrowing in order to invest. He also stated, "*Once surpluses sufficient to cover automatic contributions return, the Government intends to contribute the amount required by the Fund formula*" (New Zealand Government, 2009).

**May 2013** – In the Fiscal Strategy Report accompanying Budget 2013 the National-led coalition government changed the rationale for re-starting contributions to the NZSF, from having cash surpluses large enough to cover contributions, to resuming them only once net core Crown debt fell below 20 percent of GDP. This extended the projected length of the contribution break. Between the 2010/11 and 2016/17 fiscal years inclusive, the NZSF received no capital contributions (New Zealand Treasury, 2013).

**July 2017** – The Labour Party promises to resume capital contributions to the NZSF if it wins the upcoming election. The commitment does not, in the first four years, match the amounts calculated under the NZSF contribution legislated formula (Small, 2017).

**December 2017** – The newly-elected Labour-led coalition government of Prime Minister Jacinda Ardern resumes capital contributions to the Fund, starting with $500 million in the 2017/18 fiscal year. Planned contributions for the next four fiscal years are $1 billion, $1.5 billion, $2.2 billion and $2.5 billion respectively (Mackenzie, 2017).

**May 2019** – A Budget 2019 announcement outlines that, between 2019/20 and 2022/23, small percentages of the capital contributions to the NZSF will be transferred to a new fund, administered by the Guardians of New Zealand Superannuation. This new fund will invest in New Zealand's early stage capital markets (New Zealand Government, 2019). It is now called the Elevate NZ Venture Fund and is managed on behalf of the Guardians by NZ Growth Capital Partners.

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[4] Section 44 of the New Zealand Superannuation and Retirement Income Act 2001 (New Zealand Legislation, 2018f) sets out the list of requirements that need to be met if less than the capital contribution calculated by the legislated formula, using the Treasury's NZSF model, is allocated in any year. These include publishing in the Fiscal Strategy Report the legislated amount, reasons why this amount is not being contributed, and the approach that the Government intends to take to ensure the NZSF will be sufficient to meet NZS payments over the next 40 years. Throughout the period of no contributions, and into the recent years when contributions have restarted, but are not at the legislated amounts, the Treasury has published the legislated contribution amounts, as well as projected tracks of the NZSF revenue, tax and assets had these amounts been contributed.

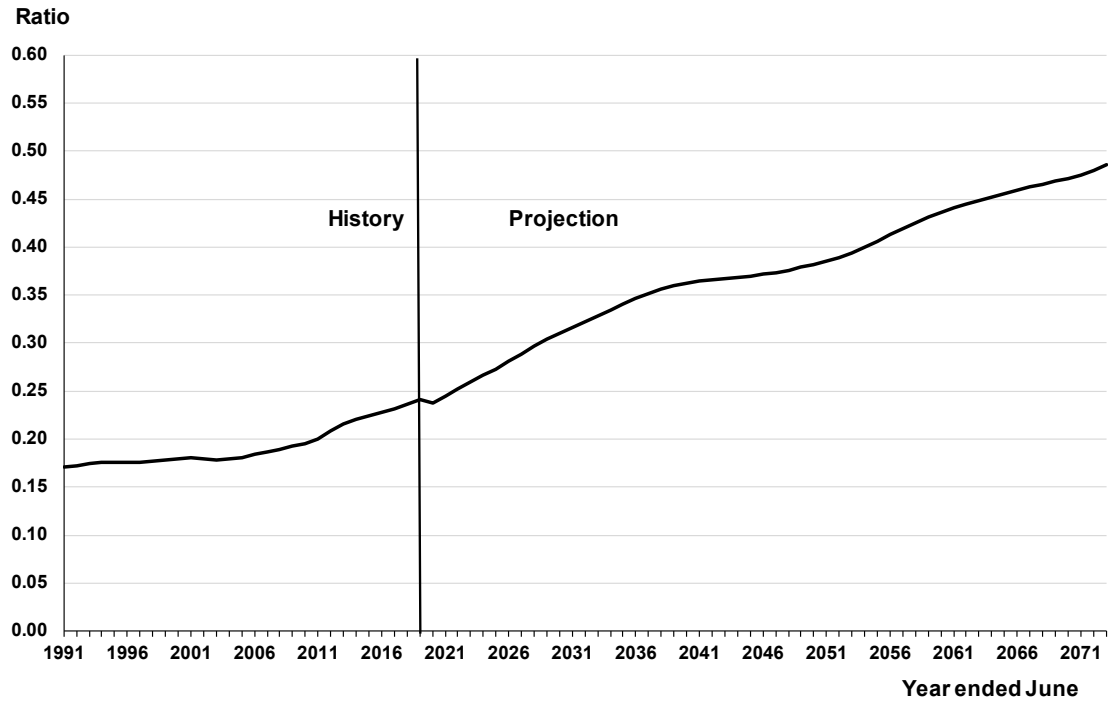
# 3 The impact of demographics

This section of the paper provides more detail about the ongoing demographic change that is producing New Zealand's ageing population structure.

Three main factors drive demography, and hence any changes in a population's age structure. These are the rates of fertility, mortality and net migration. Fertility rate refers to the average number of babies born per woman of child-bearing age. Mortality rate is the average number of deaths per 1,000 individuals in the population per year. Net migration is the number of people who arrive in the country in a year, with the intention of staying long term, less the number of residents who leave in that same year, with the intention of being away long term. In both cases "long term" is often taken to be at least a year.

As is the case for many advanced economy nations, and even for some developing countries, the population structure of New Zealand has been ageing in recent decades.

***Figure 1 – New Zealand's past and projected "65 & above" to "15 to 64" age ratio***




Source: Stats NZ

Figure 1 is comprised of actual data, which is also referred to as outturns, for the estimated resident population from the June-end years 1991 to 2019, and then from 2020 onwards projections made by Statistics New Zealand (or Stats NZ, as they are commonly referred to). The actual data begins in 1991 because this is the first year when data was recorded under Stats NZ's current estimation method (although earlier years that used a different measurement technique can be sourced). The projections are those of the median, or 50$^{th}$ percentile, from the National Population Projections, produced in 2020 (Statistics New Zealand, 2020a).

Many of the people who influence these projections are alive today. Consequently, unless the rates of at least one out of fertility (Section 3.1), longevity (Section 3.2) or net migration (Section 3.3) evolves in a manner that is quite different to its historical trends over the last half century, not to mention the expectations of the demographers, then the population projections are likely to be more reliable than long-run economic and fiscal projections, which are both subject to many more variable influences.

While the population projections that can be downloaded from the Stats NZ website do not go out to the end of the century, the Stats NZ demographers have provided 100 year projections to the Treasury, as these are necessary for the NZSF model. These show an expectation that the ageing of the population will continue for at least a century[5] and quite likely beyond this. If this were not the case, it is a fair assumption that the NZSF would never have been set up.

The ageing of the population does not always move at a uniform rate, due to variation over time in both the rates of fertility and longevity. This variance in the ageing progression will be illustrated later in Section 10, as an explanation of one of the seeming oddities that occurs when the contributions briefly turn to withdrawals for a few years in the late 2030s before returning to contributions again until the middle 2050s.

The number of people eligible for NZS, where eligibility for the vast majority of New Zealanders means reaching the age of 65 years[6], is growing relative to the size of the base paying for this public pension from taxes. This demographic shift is at the heart of the tax smoothing principle that is the fundamental role of the NZSF.

## 3.1 Reducing fertility

In modern history New Zealand's fertility rate rose quite quickly after the end of the Second World War, rising above three for the first time since the early 1920s. That previous higher point had come only a few years after the end of the First World War and the devastating Spanish flu pandemic which followed it. The fertility rate peaked in 1961 at 4.3, before dropping quickly over the remaining 1960s and the entire 1970s (Statistics New Zealand, 2018).

This decline was not due to chance. In its entry on contraception and sterilisation in New Zealand, the on-line encyclopaedia Te Ara states: "*The year the pill arrived in New Zealand, 1961, was the peak of the post-war baby boom, when New Zealand women had an overall average of 4.3 children. Though the baby boom continued into the early 1970s, the use of the pill had a significant effect on the birth rate. The boom was followed by what has been called a 'baby bust', the birth rate dropping to about two children per woman for both Māori and Pakeha in the 1980s and beyond"* (Tolerton, 2018).

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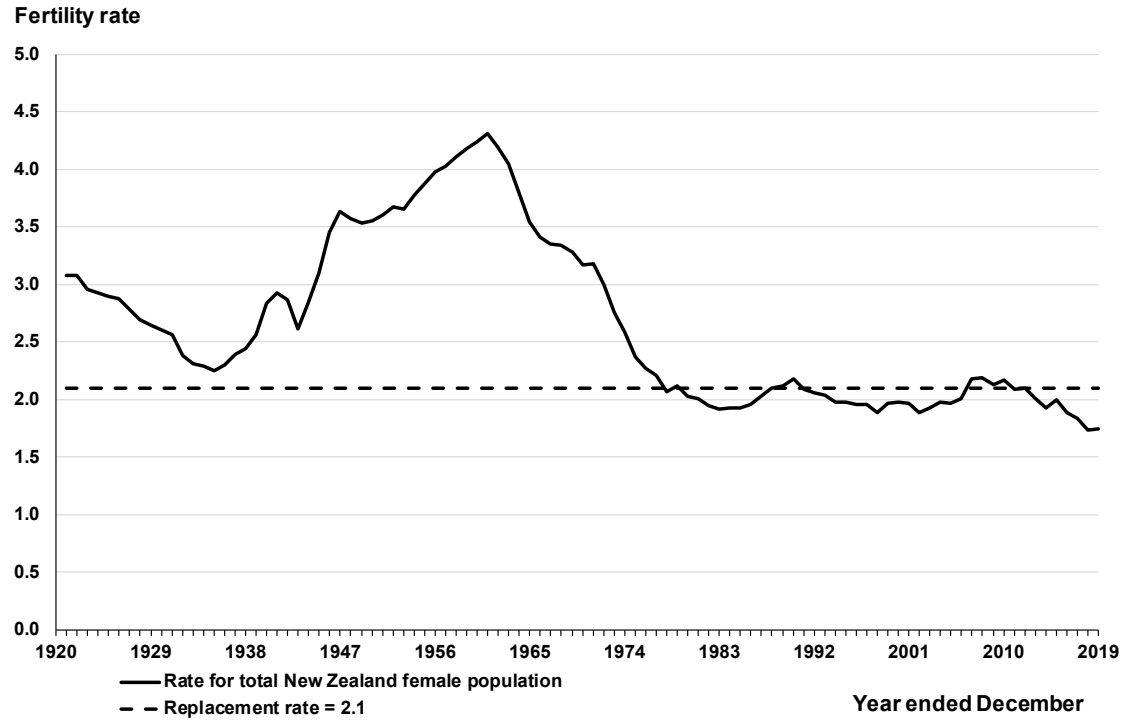
5 This is not to say that Stats NZ believes that the ageing of the population structure will end after a century. It is simply that 100 years is as far as they go out in their population projections.

6 Other criteria are that you need to be a New Zealand citizen or permanent resident; normally live in New Zealand at the time of application; and must have lived in New Zealand for at least ten years since turning 20 years old, with at least five of those years occurring since turning 50 years old.

The replacement rate is the demographic term for the average number of children each woman in a population is required to have in order for the population to replace itself in the long term, without migration. Stats NZ says that the replacement rate for New Zealand is 2.1 and this level was reached in 1978. Since then it has fluctuated around this level, being as high as 2.2 in 1990 and 2007 through to 2010, and as low as 1.7 in 2018 and only just above this at 1.75 for the year ended December 2019 (Statistics New Zealand, 2020b).

***Figure 2 – New Zealand's fertility rate over the last century***




Source: Stats NZ

In Stats NZ's 2020 population projections they stabilised their long-run fertility rate assumption, for their median projection, at 1.65 for the entire projection. They are certainly not predicting a return to rates anywhere near like those of the late 1940s through to the middle 1960s, or even managing to rise above the replacement rate (Statistics New Zealand, 2020a).

This reflects one major component of the ageing population story. For the last half a century New Zealand has had a much lower fertility rate than before the 1970s, and this is expected to continue.

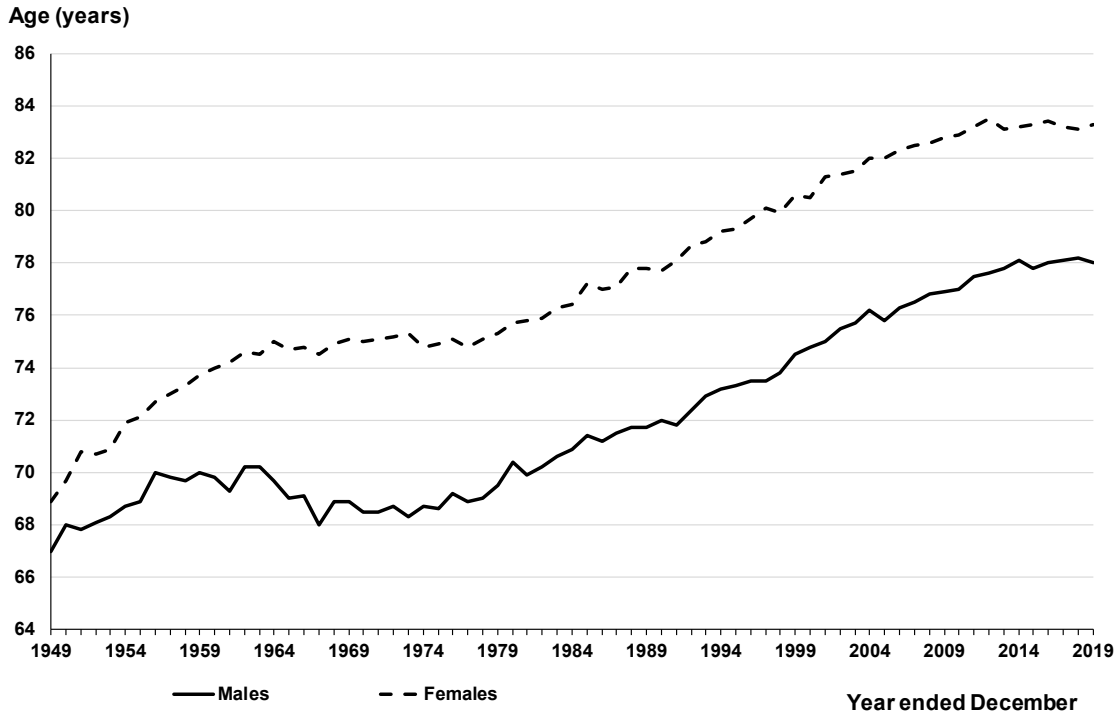
## 3.2 Increasing longevity

It is not decreases in the mortality rate which boosts the ageing population structure, but rather increases in the median[7] life span, or longevity, of people in the population. Just as fertility rates are declining in many advanced economies, so is longevity increasing and again New Zealand is also following this trend.

In the early 1950s the median age of death for a New Zealand male was around 68 years, and not much higher for females at around 70 years. As Figure 3 clearly shows, significant improvements have occurred for both sexes, particularly since the 1980s. In 2019 the median age of death for males was 78 years and for females it was 83 years (Statistics New Zealand, 2017).

Stats NZ demographers, in their 2020 population projections, expected average life expectancy at birth to keep rising. In the final year of the median projection, 2072/73, the life expectancy for males had risen to 87.5 years and for females to 90.2 years (Statistics New Zealand, 2020a).

***Figure 3 – New Zealand's median age at death for both sexes since the 1950s***




Source: Stats NZ

The average life span increasing is the other major part of the demographic change producing an ageing population structure. It is a situation of change at both ends of the age scale, which is lower fertility leading to proportionally fewer younger people than in the past and longer life spans resulting in proportionally more older people.

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[7] The median age of death is used as a measure of longevity for modelling purposes, and it also reflects changes in the mortality rate. Median, or average, age of death is not the same concept as life expectancy, which takes account of different sized age groups and potentially birth cohorts, and so reflects the average length of life remaining at a given age. However, any of these measures, shown over time, can adequately illustrate a trend of increasing life spans.

The word proportionally is important here, particularly in regard to younger age groups, as the population of New Zealand is still growing. Actual numbers of, for example, those aged between 15 and 64 years and those aged 65 years and above are both expected to be significantly higher in the future than they are now. However, largely because of reduced fertility and increased longevity, the “65 years and above” age group is expected to grow much more than the “15 to 64 years” age group, which results in the average age of the New Zealand population increasing markedly.

Older age groups, such as those aged 75 years and above, are projected to grow at an even faster rate than the “65 years and above” age group, especially over the next 50 years. This means that a one-off rise in the age of eligibility for NZS, say to 66 or 67, will not flatten the aggregate net NZS to GDP projection. That is certainly not stated in order to discourage debate around such a policy option, but rather to simply point out that such a single change will not be sufficient to stop the rise of NZS to GDP.

The median age of the New Zealand population at the end of June 2020 was 37.4 years. In their 2020 National Population Projections Stats NZ expected this to increase to 47.1 years by 2072/73. Furthermore, the median age was continuing to gradually rise even this far out, for only a decade earlier in their projection it had been an entire year lower at 46.1 years (Statistics New Zealand, 2020a).

## 3.3 Net migration

The third determinant of population growth, other than the fertility and mortality rates, is net migration. This has certainly had an effect on the age structure of the New Zealand population, especially as both immigrants and emigrants are, on average, younger than the resident population average.

Since 2014 New Zealand has experienced high net migration by historical standards, averaging over 57,000 annually between the calendar years 2014 and 2019. However, as recently as 2012 the figure was negative.

Stats NZ brought in a different method of measuring net migration after departure cards were no longer required to be filled out by people leaving the country. Estimates of net migration, under this new method, are available from the Stats NZ *Infoshare* database in quarterly outturns from the first quarter of 2001. At the time of writing estimates were available up to the fourth quarter of 2020. Net migration for the calendar year 2020 was still quite high, by historical standards, at 44,100, but 87 percent of this figure was attained in the first quarter of the year. The rapid reduction over the next three quarters of 2020 was a result of the Covid-19 pandemic (Statistics New Zealand, 2021).

The average over the 20 years of outturns from calendar years 2001 to 2020 is over 29,800. That is a little higher than the 25,000 figure that Stats NZ build into their 2020 median population projections from 2022/23 onwards. In terms of adding to New Zealand’s population, this figure represents about half of the population growth in 2022/23 in that projection, with the rest coming from the addition of births over deaths. However, by 2072/73 the median projection has deaths outnumbering births, so that net migration provides over 120% of the annual population growth. Stats NZ also produce a “No Migration” scenario and by 2072/73 this produces a population of under 5 million, which is below the current level and less than three quarters of the figure attained by the median projection in this year (Statistics New Zealand, 2020a).

Clearly net migration is expected to play an important role in New Zealand's future. If it continues at the levels seen over recent years, it will help to slow the ageing of the population. However, it would require much greater levels of migration of people in younger age groups to actually halt or reverse the ageing of the population structure, and that is not a likely outcome. Migrants age too, and even though they may come from countries with higher fertility rates, their children and grandchildren often adopt family sizes more like those of the society that they have grown up in.

It remains to be seen what will happen once the Covid-19 pandemic is over or at least under control via vaccines and New Zealand's borders can open again. Net migration may return to the high levels seen in recent years before the pandemic, potentially go even higher, or may only match the more moderate numbers that occurred in the decade between 2004 and 2013. Given that New Zealand has a small, open economy, much will depend not only on conditions here, but also on how they compare to those in other countries, particularly in Australia and especially in regard to the labour market.

# 4 The main parameters of the NZSF

A description of the contribution rate formula that defines the logic of the NZSF, and so affects its outcomes, is easier to understand if the formula's main parameters, and how they are derived, are first explained. There is also information on the following topics, especially in regard to how they are used and projected in the NZSF model, in the New Zealand Superannuation Fund (NZSF) Model Guide (New Zealand Treasury, 2020d).

The five main parameters in the legislated formula that sets the capital contributions to, and withdrawals from, the NZSF are the forecast and projected tracks of:

- the closing NZSF balance in each year
- nominal GDP
- aggregate net (of tax) New Zealand Superannuation (NZS) expenditure
- the after-tax annual rate of return on the Fund's assets, and
- the length of the funding horizon.

Actual outturns refer to values recorded for time periods that have been completed.

Forecasts are made for the Treasury's Economic and Fiscal Updates (EFUs), which normally comprise the partially complete fiscal year[8] in which the forecast is made, plus the next four fiscal (June-end) years. Outturns and forecasts of variables that relate to the NZSF are made by either the Treasury, the Ministry of Social Development (MSD) or the NZSF itself.

Projections refer to the fiscal years beyond the forecast base, and in many cases are strongly influenced by the forecasts from which they arise. The demographic projections are either made by Stats NZ or by Treasury based on the Stats NZ projections. The economic projections, such as of the long-range GDP track, and the fiscal projections, such as the long-range aggregate net NZS expenditure track, are produced by Treasury models. Any projected NZSF variables are all produced by the Treasury's New Zealand Superannuation Fund model.

In section 9.3 there is a description of how the NZSF's tax payments and the contributions to the Fund, and in later years withdrawals from it, are treated in different areas of the government accounts. In particular this section explains how the cash flows between the NZSF and the government do affect an important cash measure, namely core Crown residual cash, but are eliminated to avoid double counting in the reporting of the government's financial performance and financial position.

[8] A New Zealand fiscal year is from 1 July to the ensuing 30 June eg, 2019/20 is the period from 1 July 2019 to 30 June 2020. The New Zealand government's financial statements are prepared in fiscal years.

## 4.1 The NZSF closing balance

This is simply the closing asset position of the NZSF in each fiscal year. It is an important component of the formula, as it sets the starting amount of funds that the formula seeks to build up and then run down over the 40 year funding horizon.

Starting from the previous year's closing balance, returns on assets, both in terms of revenue and valuation gains, are added to any capital contributions from the government to the Fund. Tax and non-tax expenses, or valuation losses if they occur instead of gains, and, in later years, capital withdrawals from the NZSF, are subtracted. There are also small amounts of "Other movements in reserves" added, which relate to things like the revaluation of physical assets, such as land, owned by the NZSF.

## 4.2 Nominal gross domestic product (GDP)

The relationship between aggregate net (of tax) NZS expenses and nominal GDP is at the heart of the tax smoothing role of the NZSF. This operates across such long time frames that comparison of pension expenses, in nominal dollars, would be virtually meaningless. Expressing these costs relative to the size of the economy makes them comparable between generations.

The Treasury produces its own forecasts of real and nominal GDP, based on outturns recorded by Stats NZ. Real GDP is a volume based measure of an economy's output that corrects for inflation by using dollars of a base year, such as 2009/10. Nominal GDP uses current prices and so incorporates both volume and price changes.

Real GDP is projected from the forecast base via a formula involving the annual growth of the employed labour force's total hours of work multiplied by annual growth in labour productivity, which is a proxy for real wage growth. The average hours worked and the unemployment rate components of the total hours of work normally reach their long-run assumptions quite early in the projected years. Once this occurs the projected annual growth of the employed labour force corresponds to that of Stats NZ's aggregate labour force projections. The assumption for annual labour productivity growth is usually constant throughout the projection. It was 1.2 percent[9] at Budget 2020.

Nominal GDP is projected as the product of the growth rate of real GDP and annual Consumers Price Index (CPI) inflation, which is set to the midpoint of the band set in the remit for the Monetary Policy Committee and is currently 2 percent. This means that the "non-demographic" component of projected annual growth in nominal GDP, which is the product of the annual labour productivity growth and inflation, is actually the projection of nominal wage growth. This is because annual labour productivity growth is a proxy for real wage growth, so when it is multiplied by inflation it becomes a proxy for nominal wage growth. Furthermore, this means that annual nominal

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[9] This was the value in the projections of GDP used for the Budget 2020 NZSF model (New Zealand Treasury, 2020c). However, for the NZSF models predating that produced for the *2019 Half Year Economic and Fiscal Update* (*HYEFU*) the annual labour productivity growth assumption was higher at 1.5 percent. See New Zealand Treasury (2019) for more detail. At the recent 2020 HYEFU version of the NZSF model, the assumption was further lowered to 1.0 percent. In terms of the relationship between aggregate net NZS expenses and GDP this is not of great consequence, as it is a component of both of their projected annual growth rates.

wage growth settles, again usually quite early into the projected years, to a stable value derived via 1.012 x 1.02 -1 = 3.22 percent.

Hence, generally just a few years into the projections, annual growth in nominal GDP is determined by two factors. One is the non-demographic component of stable, nominal wage growth of 3.22 percent. The other is the demographic component of projected annual labour force growth, which declines over the years due to an ageing population.

## 4.3 Aggregate net of tax NZS expenses

Unless otherwise stated, in this paper references to net NZS should be taken to mean the total cost to the government of providing the public pension in any given fiscal year. Every fortnight each superannuitant receives their own particular net of tax NZS payment. However, in regard to the NZSF and its legislated formula, it is the aggregate of all of those payments in a fiscal year that matters.

MSD provides outturns and forecasts of both gross and aggregate net NZS expenses, as well as recipient numbers. Aggregate net NZS expenses are projected forward from the forecast base using annual growth of recipient numbers multiplied by annual growth of payment rates. Recipient numbers are modelled using Stats NZ's population projections, specifically the growth of the "65 years and above" age group. Annual payment rates of NZS are pegged to the after-tax average ordinary time weekly earnings (AOTWE). Stats NZ provides outputs of the AOTWE and Treasury forecasts them, and both outturns and forecasts are gross (before tax). A specialised Treasury model converts outturns and forecasts to after-tax annual AOTWE figures, and these are normally projected using the Treasury's projections of nominal wage growth.

The word normally is used here because the modelling does have the capability to allow for fiscal drag, which effectively means that with no changes to tax rates or thresholds the tax on income grows faster than the income itself. When this applies after-tax figures grow more slowly than the gross values from which they are derived. As personal income tax rates or thresholds are usually adjusted to compensate for fiscal drag at some point, this modelling facility, if used at all, is not usually continued beyond the first decade of projections.

Therefore, the non-demographic growth component for both aggregate net NZS and GDP settles to nominal wage growth relatively early into the projections. This means that what drives aggregate net NZS expenditure up, relative to GDP, is the difference in the demographic components of their growth.

Section 3 explained why the ageing population structure is occurring. An outcome of this demographic change is that the "65 years and above" age group is growing, and will continue to do so for many years, at a faster rate than that of the aggregate labour force. As these are the demographic drivers of growth of aggregate net NZS and GDP respectively, this difference is what keeps aggregate net (of tax) NZS expenditure, as a percentage of GDP[10], rising into the foreseeable future.

[10] The shorter notation "net NZS to GDP" or "net NZS as a percentage of GDP" will often be used rather than the full expression "the aggregate net (of tax) NZS expenditure as a percentage of GDP".

## 4.4 Annual return rate for the NZSF

Both the gross and after-tax return rates for the NZSF in actual outturns and forecast years can be determined from the data and forecasts provided by the NZSF.

The NZSF publishes a *Statement of Performance Expectations* every year and this includes a section called the *Statement of Estimated Fund Performance*. This begins with the comment "*Predicting short-term financial market returns with any useful accuracy over such a near-term horizon is impossible. We therefore show our long-term, or equilibrium, expectations for the Reference Portfolio return. To that we add our expectations of returns from value-added activities to arrive at the mid-point for the actual Fund*" (NZ Super Fund, 2020d).

The parameters used in the *Statement of Estimated Fund Performance* are:

- a risk-free rate, which is the estimate of the equilibrium return on 90-day Treasury bills
- an excess return after costs, which is the reward for taking market risk above the risk-free rate, and
- a reward for value-adding activities.

These parameters, under normal circumstances, are reviewed every five years and the most recent update, at the time of writing, appears in the *Statement of Performance Expectations 2020-21*. They set the risk-free rate at 4.0 percent, the excess return after costs at 2.8 percent and the reward for value-adding activities at 1.0 percent. Overall this adds to a mid-point, long-term estimate for the annual gross rate of return of 7.8 percent (NZ Super Fund, 2020d).

In producing forecasts to supply to the Treasury for Economic and Fiscal Updates, the NZSF analysts base their gross return rate estimates on this equilibrium return rate. The first, partially complete forecast year will incorporate known outturns for the year, so may end up with a markedly different return rate to the long-run estimate. However, for all future periods, and so in particular the final four forecast years, the equilibrium return rate derived in the *Statement of Estimated Fund Performance* is applied.

The majority of the annual return for the NZSF in any year is comprised of valuation gains and losses on their assets. These can vary widely from month to month, let alone over years. Consequently, basing the forecasts on an average, long-run expectation helps to smooth out the rises and falls that will, in reality, unfold across these years.

In the projected years of the NZSF model this long-term, or equilibrium, gross return rate assumption is also applied, with one difference from its use in the forecasts. The modelling gradually reduces, at an equal annual rate, the reward for value-adding activities component to zero. The standard assumptions used in the NZSF model are to begin this reduction 20 years after the last year with known outturns for the NZSF, and to lower the value-adding reward component in equal increments over 40 years. This reduction is done because it is less certain that this additional return above market expectations could be maintained over the truly long-term horizon, as the Fund gets significantly larger. This means that the projected gross return rate for the NZSF settles, after 60 years under the standard assumptions and the parameters applied at the time of writing, to an annual value of 6.8 percent.

Analysis in regard to interest rates and other returns on financial assets, especially over an extended period, often uses geometric, rather than arithmetic, rates of return.

Over a period of N years, where the annual rate of return in year *i* is denoted $r_i$, the geometric return is given by:

$$\sqrt[N]{(1 + r_1)(1 + r_2) \ldots . (1 + r_i) \ldots . (1 + r_N)} - 1$$

The arithmetic return for the same series is the average of the N returns, given by:

$$\frac{\sum_{i=1}^{N} r_i}{N}.$$

In analysis of historical performance of asset classes and investment portfolios the geometric return is often applied. This is because it provides a useful descriptive measure of the annualised proportional change in wealth that actually occurred, as if there had been no volatility in return over the period reviewed.

However, for forward looking projections, such as those produced by the Treasury's NZSF model, the expected annual arithmetic return is a more relevant statistic, as no true volatility in either economic conditions or financial returns is built into the projection. Consequently, the NZSF contribution rate formula applies arithmetic means.

More information can be found about the differences between the two average return rate measures and why arithmetic return rates are assumed in the NZSF modelling in the 2003 Treasury Working Paper *Geometric Return and Portfolio Analysis* (McCulloch, 2003).

## 4.5 Tax rates and the after-tax return rate

The contribution rate calculation for the NZSF applies the after-tax annual rate of return on the Fund's assets. This is applied as the discount rate over the 40 year horizon used in the calculation, because it relates to the rate at which the funds added or subtracted from the NZSF could accumulate over this horizon.

The after-tax rate is used, rather than the gross rate of return, because the one component of the Fund's earnings that it does not get to retain is the tax paid on these earnings, which are transferred to the government. The after-tax rate of return is applied to the components in the contribution rate formula that add to or subtract from the size of the Fund. These components have an earnings-generating potential, whether that increases Fund assets via the returns on the added amounts over time or decreases them via lost earnings on the amounts withdrawn over time. Whichever the case, it is only the after-tax return that the Fund has gained or lost, so it is the after-tax rate of return used in the contribution rate formula, not the gross rate.

The tax rate applied in projections is very close to that assumed by the analysts at the NZSF in their forecasts, at least in the purely forecast years. In the first, partially completed forecast year the tax rate could be almost any percentage, including a negative value. In this year the Fund analysts will have some idea of the likely final tax payment, which will be affected by timing factors, carried over losses, valuation changes etc. However, in the last four years of the forecast horizon, at the time of writing the tax rate used tends to be very close to 24 percent. Consequently the NZSF model applies a 24 percent annual tax rate on the Fund's earnings in projected years.

This is the long-run stable tax rate used in the NZSF model and reflects a New Zealand company tax rate of 28 percent, but allows for lower tax rates on some of the Fund's overseas investments. The NZSF analysts have far more information about their asset base and which returns are taxed at what rates than the Treasury modellers have. Hence it is sensible to adopt, in projections, the stable tax rate assumed in forecasts.

The annual after-tax rate of return is calculated by multiplying the annual gross rate by (1 – tax rate). This results, at the time of writing, in an initial projected assumption for the NZSF's after-tax annual return rate of 7.8 x (1- 0.24) = 7.8 x 0.76 = 5.93 percent. Once the reward for value-adding activities has been reduced to zero after 60 years, it stabilises at 6.8 x 0.76 = 5.17 percent.

## 4.6 The NZSF funding horizon

From the Budget 2000 NZSF planning model up until the latest versions, including the Budget 2020 NZSF model referred to frequently throughout this paper, a funding horizon of 40 years has always been applied in the contribution rate formula.

In Chapter 12 of the *Pre-funding New Zealand Superannuation Working Document* (New Zealand Treasury, 2000b) several different lengths of years for the rolling horizon are modelled and discussed. The second sentence of that chapter indicates that 60 years was actually the original choice. "*The base case analysis in this chapter was undertaken before the decision was made to proceed with a forty-year rolling horizon, rather than sixty years."*

Unfortunately none of the planning documents from 2000, which are available on the Treasury website (use the link for New Zealand Treasury, 2000a or 2000b) appear to detail why forty years was eventually chosen for the rolling funding horizon.

The length of the funding horizon effectively determines the amount of tax smoothing that the NZSF does, under the existing conditions at the time of the other Fund parameters discussed in this section. This is covered in more detail, including illustrations of Budget 2020 projections of key NZSF variables under different funding horizons, in Section 7.2, after the contribution rate formula and the tax smoothing role of the NZSF have been described.

It suffices at this point to note that, while a rolling funding horizon of 40 years has been applied in all of the NZSF models available on the Treasury website (New Zealand Treasury, 2020c), this is still a key variable in projecting out future NZSF outcomes. It is vital in determining the total amount of NZS expenses that need to be funded from the year in which the contribution rate is calculated, and hence the amount of funds that will need to be built up and run down in the NZSF over this period, and through that the pattern of contributions and withdrawals over the funding horizon. Because of its importance to all of these areas, it has always been a variable in the NZSF models that can be altered if people wish to experiment with the model.

# 5 The legislated contribution rate formula of the NZSF

The New Zealand Superannuation and Retirement Income Act 2001 legally established the NZSF. Section 43 of this Act defines how the amount of the capital contribution to (or, in later years, withdrawals from) the Fund in each fiscal year is to be determined. This formula establishes a parameter of the NZSF called the contribution rate. It is the contribution rate that is at the core of the NZSF model's calculations and which is the focus of much of the material in the remaining sections of this paper.

## 5.1 The wording and formula of Section 43

Section 43 of the Act states:

*The required annual capital contribution for each financial year is*

a ÷ 100 × that year's GDP − b

*where:*

*a is the percentage of that year's GDP that, if the same percentage of the GDP that is projected for each of the next 40 years were contributed (by way of either or both of annual required capital contributions and annual expense payments under section 45) each year for the next 40 years, would be just sufficient, taking into account the Fund balance at the start of that year and projected Fund investment income over the next 40 years, to enable the Fund to meet the expected net cost of the New Zealand superannuation entitlements payable out of the Fund over the next 40 years*

GDP *is the projected annual gross domestic product of New Zealand*

*b is the expected net cost of the New Zealand superannuation entitlements payable out of the Fund in the year*

*net cost is the cost of New Zealand superannuation entitlements net of any amount of tax deducted or withheld, or required to be deducted or withheld under the PAYE rules in the Income Tax Act 2007*

*next 40 years means the financial year for which the required annual capital contribution is being calculated plus each of the following 39 financial years*

The variable '*a*' in the formula is the combination, as a percentage of GDP, of the capital contribution (or, in later years, withdrawal) and aggregate net NZS expenditure for that fiscal year. This may be made clearer from a numerical example.

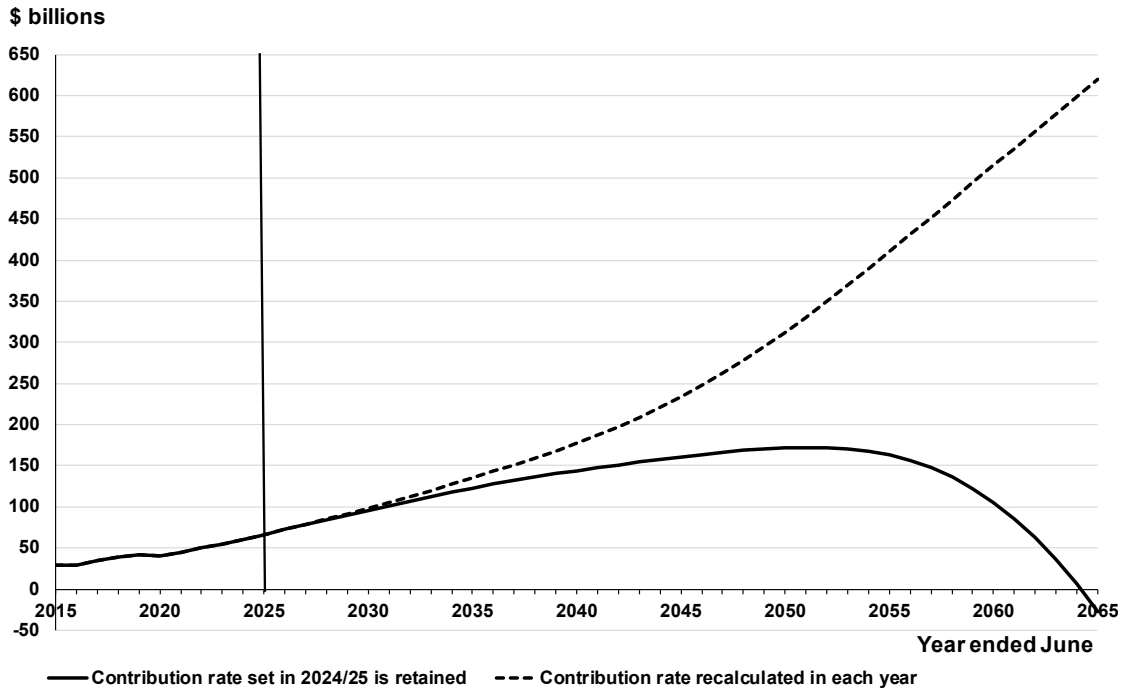
In the Budget Economic and Fiscal Update (BEFU) 2020 NZSF model[11] (New Zealand Treasury, 2020c) the contribution rate for the projected 2024/25 year was calculated as 4.92 percent of GDP. For this same year the projected GDP and aggregate net NZS expense, both in billions of New Zealand dollars, were 392.768 and 17.049 respectively. Hence the prescribed capital contribution = 0.0492 x 392.768 – 17.049 = 19.324 – 17.049 = 2.275[12].

## 5.2 Clarifying what the formula calculates

The previous section explains how a single year's capital contribution figure is derived, but it does not really make clear what the legislated formula really achieves.

That concept is better illustrated in Figure 4, which contrasts the Budget 2020 projection of the closing balance of the NZSF with one using the same inputs, but holding the contribution rate constant at the 2024/25 value of 4.92 percent.

***Figure 4 – NZSF closing balance under constant and varying contribution rates***




Source: The Treasury

When the contribution rate is held at 4.92 percent, which is the value calculated for 2024/25, then the last year in which the Fund's closing balance is positive is 2063/64. This is precisely the 40 year interval described in the legislated formula, inclusive of the year, 2024/25, for which the constant contribution rate was calculated. Beyond this 40 year period the assets of the NZSF are used up, shown by the fact that paying for aggregate net NZS in 2064/65 would leave the Fund in deficit ie, it does not have the funds to cover the aggregate net NZS expense in that year.

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[11] The Budget 2020 NZSF model is often referred to in this paper and was used to run many of the scenarios featured. It can be accessed from the link to the archive of NZSF models on the New Zealand Treasury website in the References section (New Zealand Treasury, 2020c), as can all the NZSF models referred to in this paper.

[12] The actual figure is $2.272 billion, with the difference being due to the NZSF model not rounding the inputs to three or four decimal places, as the calculation presented here has done.

To clarify further, if 4.92 percent of GDP were contributed to the NZSF in every year from 2024/25 onwards, then the Fund would be able to cover the cost of aggregate net NZS for the next 40 years, but after that time it would be used up.

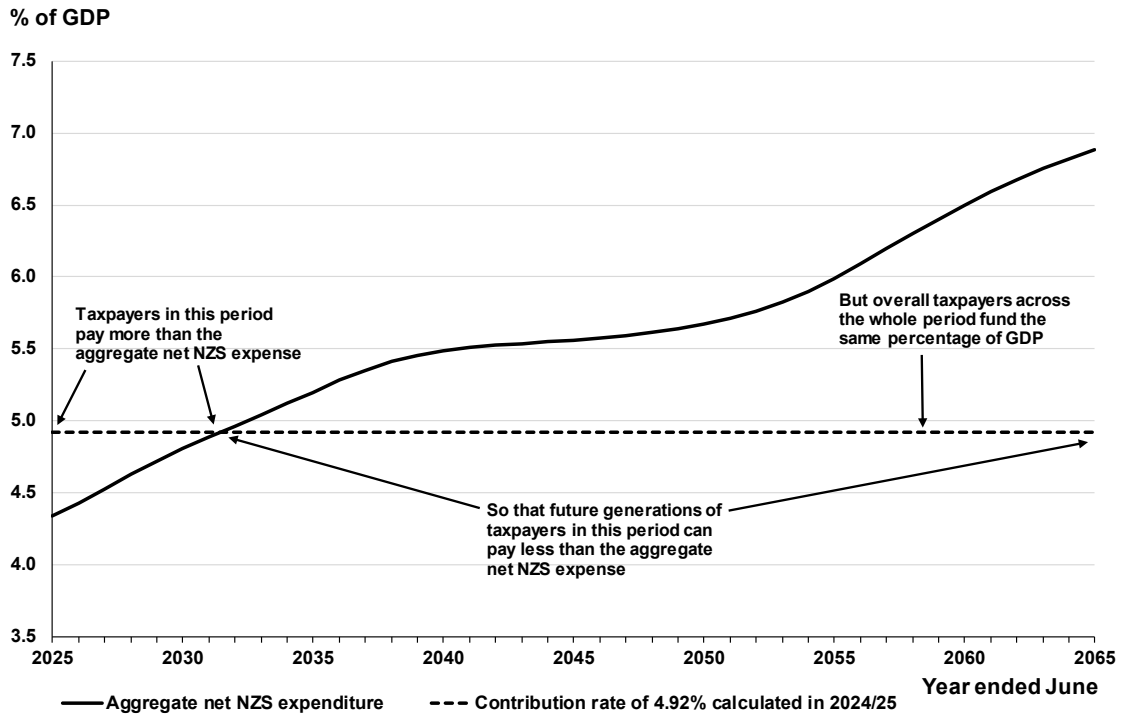
The main things that affect the contribution rate calculation are, for the year in which it is made, the size of the Fund and future expectations over the next 40 years of the aggregate net NZS cost and GDP.

Using these, the formula works out what constant percentage of GDP taxpayers need to provide in each of the next 40 years so that, with the help of the Fund, the total aggregate net NZS expenditure over this period can be covered. In the early years of this 40 year interval, depending on the size of the NZSF assets in the year that the contribution rate is calculated for, taxpayers may need to provide more than the aggregate net NZS to GDP in that year, so that there is a capital contribution left over to grow the Fund's assets. In later years, and possibly for the whole 40 years depending on how far into the Fund's future this calculation is made, taxpayers can provide less than the net NZS to GDP amounts in those years, with withdrawals from the NZSF making up the differences. The Fund also adds to its asset base over this period from its investment earnings. However, the contribution rate is calculated so that the combination of contributions, withdrawals and investment earnings results in the assets of the NZSF being exhausted at the end of the 40 year period.

## 5.3 The tax smoothing role of the NZSF

The Fund facilitates tax smoothing between current and future taxpayers. This is the principle upon which the contribution rate formula is based.

***Figure 5 – Taxpayers funding of NZS under a constant NZSF contribution rate***




Source: The Treasury

In 2024/25 net NZS to GDP is projected, in the Budget 2020 NZSF model, to be 4.34 percent. However, by the time the Fund covers its final aggregate net NZS payment in 2063/64 in the scenario where the contribution rate is held constant, net NZS to GDP is projected to have risen to 6.82 percent. Without the NZSF, New Zealand taxpayers would cover the entire cost of aggregate net NZS in every year. While taxpayers in 2024/25 need to meet a cost of 4.34 percent of GDP, by 2063/64 this grows by more than half this value, so that taxpayers of that year face a cost of 6.82 percent of GDP.

When withdrawals from the Fund do actually begin, there does not appear to be anything in the legislation that specifically outlines exactly how those funds will be used to help pay for NZS. Section 47 of the New Zealand Superannuation and Retirement Income Act 2001 simply directs that they will be "*paid into a Crown bank account*". However, section 41, which addresses payments out of the Fund, clearly states "*The Fund must be held for the purpose of paying New Zealand superannuation.*"

With the NZSF, as Figure 5 illustrates, taxpayers over this whole 40 year period contribute the same percentage of GDP, namely 4.92 percent. The assets and after-tax investment earnings of the Fund make up the difference, until the assets are depleted.

The contribution rate should not be confused with the capital contribution itself (or withdrawal in later years). The contribution rate is the percentage of GDP contributed by taxpayers that, were it held constant over the 40 years used in the NZSF legislation, would cover the cost of aggregate net NZS over this period, as well as any capital contributions to the NZSF or withdrawals from it. In other words, in any given year it is the aggregate net NZS expense plus the capital contribution to the Fund, or minus the withdrawal from it, expressed as a percentage of GDP.

In Figure 5 the contribution rate is the dotted line. In any year the capital contribution or withdrawal, as a percentage of GDP, is simply the difference between the contribution rate and the aggregate net NZS expense. In Figure 5 this is the difference between the dotted line and the solid line, which represents net NZS to GDP. In the early years this difference is positive, leading to a capital contribution, and in later years it is negative, producing a capital withdrawal. The capital contributions and withdrawals are converted to dollar amounts by multiplying by GDP.

Unlike the depiction in Figure 5, which was done for an explanatory purpose, the NZSF is not designed to run out of funds in the next 40 years. It is intended to act as a tax smoothing vehicle for considerably longer than that. Consequently the contribution rate is recalculated each year and how that process works will be explained in Section 7.1.

However, in order to facilitate that explanation, it is first necessary to present and explain the mathematical version of the legislated contribution rate formula.

# 6 The NZSF contribution rate formula in a mathematical form

The legislated formula needs to be converted to a mathematical one that can produce the desired outcomes for the NZSF in a model. In this section the formula is simply presented and the terms in it are defined.

The first appendix to this paper derives this mathematical formula, and the second appendix explains how the annualised returns for sub-annual frequencies, used in the formula, are calculated.

A third appendix explains how the formula shown in this section can be expressed in a simpler form. The necessary condition for this is that the annual after-tax rate of return for the NZSF is stable at a constant value, which generally is assumed from some point onwards in projections.

The mathematical formula that produces the results required by the legislated contribution rate formula is:

$$k_j = \frac{\sum_{t=1}^{H} P_{j+t-1}\left(1+f_{j+t-1}\right)\prod_{i=t+1}^{H}\left(1+r_{j+i-1}\right) - B_{j-1}\prod_{t=1}^{H}\left(1+r_{j+t-1}\right)}{\sum_{t=1}^{H} G_{j+t-1}\left(1+m_{j+t-1}\right)\prod_{i=t+1}^{H}\left(1+r_{j+i-1}\right)}$$

$k_j$ = contribution rate as a proportion of nominal gross domestic product (GDP) in year j

H = time horizon of calculation (legislated as 40 years, but can be varied in the model)

t = time variable, in years

$P_t$ = aggregate net (of tax) New Zealand Superannuation (NZS) expenses in year t

$f_t$ = annualised after-tax return on the NZSF in year t to reflect the fact that aggregate net NZS payments are made in fortnightly instalments

$m_t$ = annualised after-tax return on the NZSF in year t to reflect the fact that capital contributions to or withdrawals from the NZSF are made in monthly instalments

$r_t$ = annual after-tax rate of return on the NZSF in year t

$B_{j-1}$ = NZSF closing balance in year j-1, which equals the opening balance in year j

$G_t$ = nominal GDP in year t

It should be clarified that, if this formula is applied literally, there is a logical difficulty in the last year. In this year t = H in the summation terms and so the starting i term in the product operator becomes H+1 in this year, when the finishing term is H. In this final year of the interval, no more years remain in which to earn returns on the NZSF assets or to generate interest costs on the aggregate NZS expenses. Consequently, what is actually applied in the product operator, in this final year in the model, is a value of one.

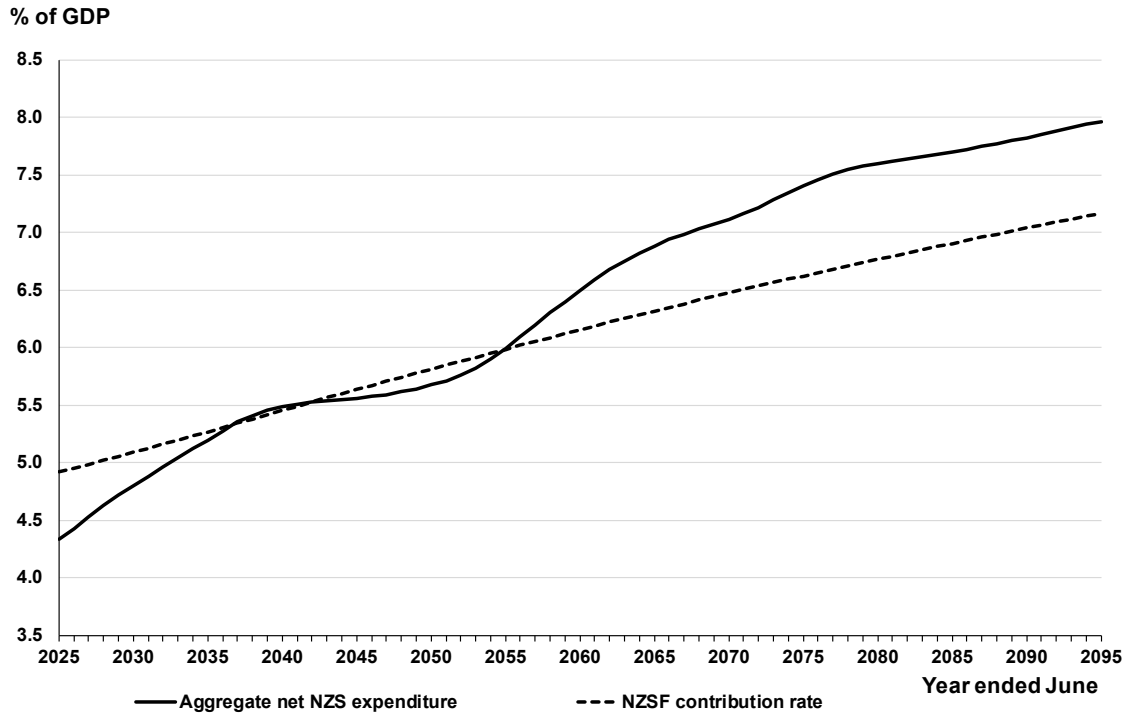
# 7 Further examination of the NZSF contribution rate formula

Section 5 explained what the contribution rate calculated for a given year means. This section examines the profile of the contribution rate over time, and the key factors that can affect this, as well as what implications these have for the NZSF's closing balance.

## 7.1 Why the contribution rate keeps rising

Figure 6, using Budget 2020 NZSF model projections, shows that the calculated contribution rate actually changes each year. Furthermore, the direction of change is not randomly up in some years and down in others, but rather constantly increasing.

***Figure 6 – NZSF contribution rate compared with net NZS to GDP***




Source: The Treasury

This seems at odds with the explanation of the contribution rate formula in Section 5.3. However, that discussion involved what the calculated contribution rate for a given year represented, and Figure 5 illustrated a scenario where that contribution rate was held constant. Two key features of the contribution rate calculation and two assumptions about the projection mean that, under current NZS policy and prevailing demographic and economic expectations, the contribution rate is projected to rise from year to year.

The key features of the contribution rate calculation are that:

- it is calculated anew in each successive fiscal year in the model, and
- the calculated contribution rate in each year would deplete the NZSF of funds after 40 years, if it were held constant over that period.

The important assumptions about the projections are that:

- GDP is always increasing, and
- Net NZS to GDP continues to rise or, at best, stabilises, but does not decline for any sustained period of time.

In a severe economic downturn, such as the one induced by the 2020 Covid-19 pandemic, there could be one or more years when GDP does not increase, or even falls. However, that is not the normal path for GDP in a well-functioning, advanced economy like that of New Zealand. Consequently, relatively early into the Treasury's post-forecast projections of GDP, the assumption is one of an economy growing on trend. Even if labour force growth dropped to the point of being negligible, the annual labour productivity growth assumption would still increase projected GDP each year.

Under current policy in relation to NZS and demographic projections, increasing net NZS to GDP is the outcome over the time period shown in Figure 6 and probably will carry on well into the next century too.

In Sections 5.2 and 5.3 it was explained that the contribution rate calculated for a given year is the amount that taxpayers have to provide each year, as a percentage of GDP, over a 40-year horizon to cover the cost of aggregate net NZS throughout that period. It was also shown that adhering to this contribution rate results in the NZSF no longer having any funds left beyond the final year of that interval.

The arguments that follow, to prove various results for the contribution rate calculation under specific conditions, use the mathematical technique of proof by contradiction.

The first question to answer is where NZS to GDP is, on average[13], not falling over the 40-year interval beginning from the year for which the contribution rate is calculated, can the calculated rate remain the same in moving from one year to the next?

If, in a given year T, a contribution rate $k_T$ was calculated, then, if this was retained, the NZSF would no longer have any assets left after the year T+39. Then, in moving to year T+1, the contribution rate is recalculated so that the NZSF would now not run out of funds until after the year T+40. However, if the new contribution rate calculated stayed at $k_T$ then, from the first statement, the Fund would be exhausted after year T+39, and not until only after year T+40, as the contribution rate formula dictates. Hence, assuming the contribution rate calculated in the year T+1 has remained the same as that calculated in the previous year has led to a contradiction. Consequently the contribution rate calculated in year T+1 must be different to that calculated in year T. In other words, the contribution rate calculation must change from year to year.

Given the contribution rate calculated must change, the next question is, under the same conditions of NZS to GDP generally not reducing over the 40-year interval, can the calculated rate decline in moving from year T to T+1?

[13] It is possible to have small dips in the NZS to GDP percentage over the 40-year interval, usually due to short-lived demographic changes, without changing the logic of the following argument. However. it does not hold in a situation of a sustained reduction in the percentage of NZS to GDP over the period.

In Section 5.1 it was explained that the capital contribution to, or withdrawal from, the NZSF in any year is given by that year's GDP multiplied by the difference between the contribution rate, calculated as a percentage of GDP, and net NZS to GDP in that year.

Consider the scenario where the contribution rate calculated for year T+1 was lower than that calculated for year T, and NZS to GDP is generally not reducing over the 40 year interval. Then, for years T+1 to T+39, the contributions remaining would be lower, and the withdrawals taken out would be greater, than if the contribution rate stayed at the higher value calculated in year T. Both of these outcomes drain the resources of the NZSF more quickly. However, this means that, as the contribution rate calculated in year T results in the NZSF having no funds remaining after year T+39, it would run out of funds before this if the contribution rate used in years T+1 to T+39 was lower. Hence, this assumption has led to a contradiction, as the logic of the contribution rate calculation means that the rate calculated in year T+1 should not result in the NZSF being exhausted until after year T+40. As a consequence, in a situation where NZS to GDP is generally not reducing[14] over the 40-year interval for which the contribution rate is calculated, each successive calculation must not only see it change from the previous year's value, but, in fact, must result in it increasing.

## 7.2 Alternative funding horizons in the NZSF

Section 4.6 explained that the funding horizon was an important NZSF parameter. If the funding horizon is changed, a reasoned line of logic suggests how that will affect the tax smoothing role and the profile of the NZSF's assets over this altered horizon.

Suppose the funding horizon was doubled to 80 years. This means the contribution rate is now calculated on the premise of the amount needed, as a percentage of GDP, for each of the next 80 years to fully fund the total of aggregate net NZS expenses, as a percentage of GDP, over this period. With NZS to GDP not projected to decline, this means at least double the total that has to be covered over 40 years and probably considerably more. Also, in each year the contribution rate is based on the Fund depleting all of its assets at the end of the funding horizon, so the NZSF has to now meet a larger NZS cost and retain assets for longer. Hence, it seems logical to assume that it needs to build up a bigger asset base than when working with a 40 year funding horizon. In order to do this it will need bigger capital contributions in its build up phase.

As nothing has changed regarding the net NZS to GDP profile, larger contributions in the build-up phase require a higher contribution rate. This will again rise from year to year, but the higher returns on a larger asset base allow withdrawals to be larger too once they begin. Figure 6 suggests that both of these outcomes can be achieved by flattening the contribution rate line. Figure 7 confirms that this is exactly what occurs.

A greater need to build up Fund assets and each ongoing contribution rate calculation being based on assets not being exhausted for twice as long, suggests the NZSF's closing balance to GDP will need to lift to higher levels and take longer to begin bending down. Figure 8 illustrates that this is what happens.

Unsurprisingly, the exact opposite outcomes occur when the funding horizon is halved from 40 years to 20 years. The contribution rate profile lifts on a steeper slope, and the assets of the Fund do not rise to the same levels and start to decline earlier. Both outcomes are also illustrated in Figures 7 and 8 respectively.

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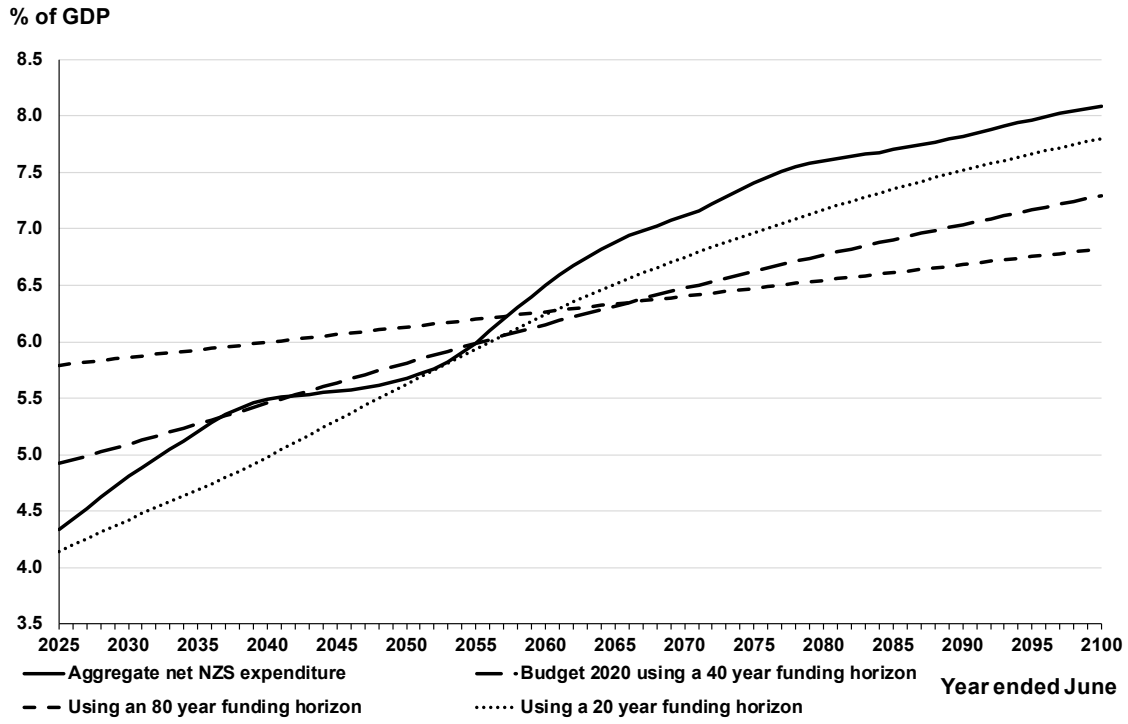
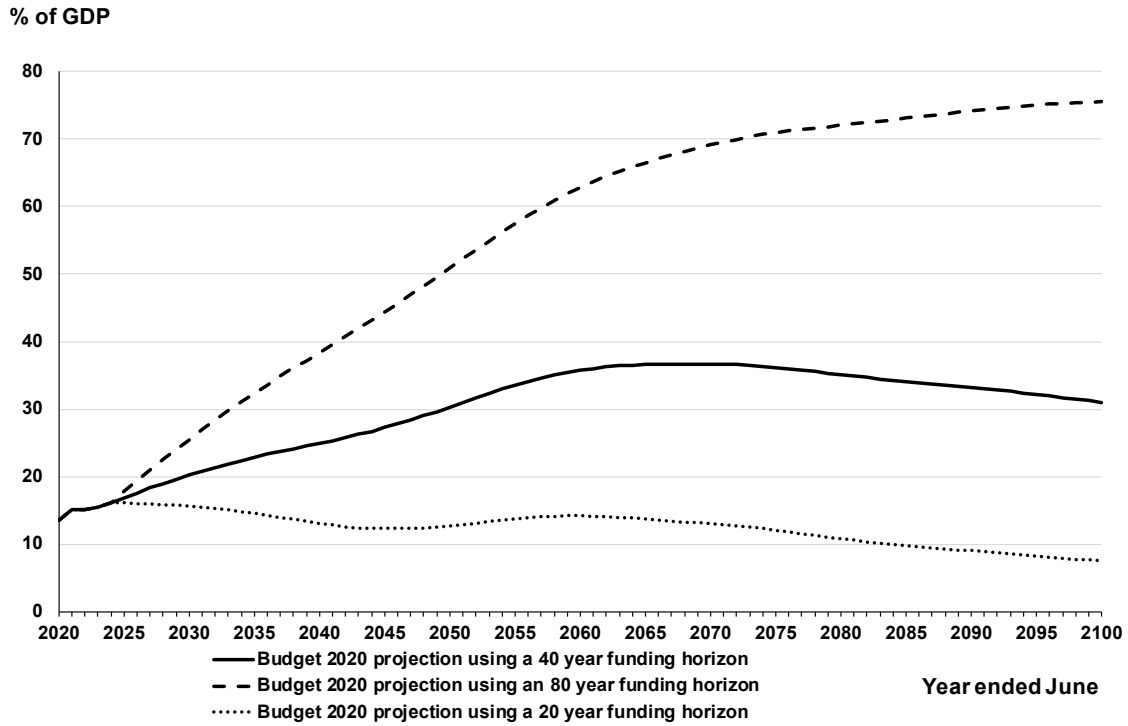
[14] The condition set for these proofs to hold does not require aggregate net NZS expenditure to GDP to necessarily keep rising, as the logic is still valid if it remains stable at any given percent of GDP.

### *Figure 7 – NZSF contribution rate under different funding horizons*




Source: The Treasury

### *Figure 8 – NZSF closing balance to GDP under different funding horizons*




Source: The Treasury

## 7.3 Behaviour of the contribution rate if net NZS to GDP stabilises

If net NZS to GDP just continues to rise it is fairly clear from the logic of the previous proof that so will each successive contribution rate calculation. But what happens if it stabilises? The two big drivers of an ageing population, a decreasing fertility rate and a lengthening average life span, may stabilise at some point in the future. Depending on the rates at which they do so, the timing of each stabilisation, and the effects of the other key demographic component, net migration, it is possible that net NZS to GDP could stabilise, or even possibly decline, at some future point. However, it is worth reiterating that demographers do not expect such outcomes over the next century.

The situation of a sustained reduction in net NZS to GDP is examined in Section 8. The following argument is restricted to where net NZS to GDP eventually stabilises.

Consider calculating the contribution rate in some year T* such that net NZS to GDP has either actually stabilised by this year or at least does so within the 40 year horizon of the contribution rate calculation. Could the contribution rate calculated be equal to, or even higher, than the stable net NZS to GDP percentage?

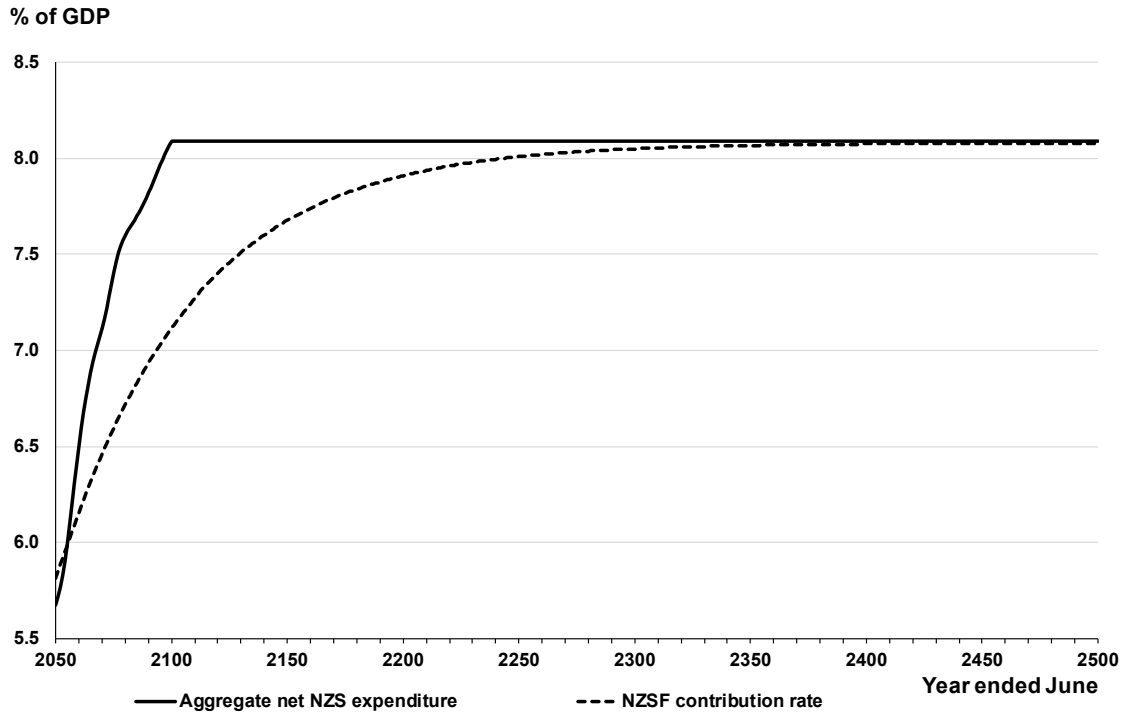
If it were, then if this rate were held constant, in year T*+39 the calculation is designed to ensure that the capital withdrawal taken in this year finally depletes the NZSF of its remaining funds. But if the contribution rate were at or above the stable net NZS to GDP rate established by this year, there would either be no withdrawal from the Fund in this year or even a contribution to it. Consequently the Fund would not be exhausted in this year and, as the following year T*+40 would have net NZS to GDP at the same percentage, it could be funded too. However, that outcome contradicts the contribution rate logic, which is designed to exhaust the NZSF after the 40 year period from its calculation date, which in this case ends in year T*+39. Consequently, the contribution rate calculated in year T* cannot be equal to or greater than the stable net NZS to GDP rate, which means that it must be below it.

The last result has an even more powerful implication. If net NZS to GDP generally does not decline before stabilising, it has been shown that the calculated contribution rate must increase from year to year. Furthermore, if the contribution rate is calculated in a year in which net NZS to GDP has stabilised or at least does so within the ensuing 40-year interval, it has also been shown that the contribution rate must be less than the stable percentage of net NZS to GDP.

Combining these results means that the contribution rate has to increase from year to year but cannot reach the plateau of the stable net NZS to GDP value. There is only one way that this can occur, and that is for the calculated contribution rate to approach the stable net NZS to GDP level in an asymptotic manner ie, getting closer and closer but never actually attaining it.

Figure 9 extends the Budget 2020 NZSF model out to the year 2500, and assumes that, from 2100 onwards, the aggregate net NZS expense to GDP stabilises at 8.09 percent. The asymptotic nature of the contribution rate calculation is clearly illustrated. By 2499 the contribution rate calculation has reached 8.07981 percent. A year later, in 2500, it has moved a tiny bit closer to the stable net NZS to GDP value and is 8.07982 percent. However, the contribution rate, in this scenario, will never get to 8.09 percent.

*Figure 9 – Contribution rate when net NZS to GDP stabilises in the long run*




Source: The Treasury

## 7.4 Implications for the NZSF closing balance

If net NZS to GDP either just continues to rise, or at best stabilises relative to GDP, it was shown in Sections 7.1 and 7.3 that this will lead to the contribution rate continually rising from year to year and, if net NZS to GDP eventually stabilises, approaching this stable percent of GDP in an asymptotic manner.

In either situation this means that, in any year where the contribution rate calculated is below net NZS to GDP in that year, the NZSF will still need to be holding assets. This is true because the Fund has to have enough capital to generate the withdrawals occurring over the 40-year interval before, if that contribution rate were held constant, its assets were all used up. However, as this calculation is repeated in every year, this effectively means the NZSF will need to have a positive closing balance in every year.

Hence, under a situation of net NZS to GDP not declining, in general, while the Fund's closing balance might reduce as a percentage of GDP, it cannot actually be depleted. This result can be extended to an even stronger statement about the Fund's closing balance, which is that, under given conditions, it will increase in nominal dollar terms.

One of the conditions is the familiar assumption that there is not a sustained decline in net NZS to GDP at some point in the future. For this stronger statement to definitely be true it is also necessary to assume that the after-tax rate of return on the NZSF assets eventually reaches a stable, positive value. This is exactly what is assumed in the NZSF model. In reality the Fund's return on assets and the tax rate paid on these will differ from year to year, but no long-run projection can realistically predict these

fluctuations[15]. Also, in any actual year the Fund could make a negative return ie, a loss. This happened, following the GFC, in both 2007/08 and 2008/09, but a positive return is assumed in projections, as in most years that is the norm.[16] The NZSF model reaches a stable, positive return rate once the reward for the value-adding activities component has been reduced to zero. While the starting year for this reduction, and the number of years that it takes, can be varied in the NZSF model (including the option of having no reduction), it is normally completed inside the first 60 years of projections. The final assumption needed is that there is not a sustained decline in nominal GDP in the projection. To be fair, it would be very unusual, for an advanced economy like that of New Zealand, to assume that GDP did consistently decline for any extended period.

Consider a situation where, in a given projected year T^, the nominal balance of the NZSF begins to decline. Given the projection assumptions outlined in the last paragraph, the only way that this can happen is if the capital withdrawal from the NZSF in that year is greater than the Fund's after-tax return. This, in turn, means that T^ has to be a year in which the calculated contribution rate is below the value of NZS to GDP, otherwise no capital withdrawal would occur.

As was explained in Section 5.2, the contribution rate for this year, if held constant, would result in the Fund being exhausted by year T^+39. And, as was shown in Section 7.1, this contribution rate must be below the future profile of net NZS to GDP, even if that is stable or stabilises at some point over the 40-year interval from year T^ to year T^+39. As a consequence of this, and relative to the constant contribution rate calculated in year T^, the capital withdrawals required in each year beyond T^, as percentages of GDP, must be greater, or at the least the same, as that in year T^. As GDP is increasing, the capital withdrawals in these years must be bigger, in nominal terms, than the capital withdrawal amount in the year T^. However that, in turn, means that if the Fund is now earning the same after-tax return rate in each year, and its balance declined in year T^, then it must earn less in year T^+1 than it did in year T^.

It is a situation of, if the contribution rate calculated in year T^ were held constant, that the withdrawal in year T^+1 would be bigger, in nominal terms, than it was in year T^, while the after-tax return would be smaller. As the withdrawal was more than the after-tax return in year T^, this must again be true in year T^+1, so the Fund's assets will again decline. By iterative logic, it must decline in all future years until, under the logic of the contribution rate calculated in year T^, the Fund is exhausted in year T^+39.

The situation of the NZSF declining over every year of the funding horizon, until its assets are exhausted at the end of this period, is mathematically possible, but not very plausible in reality. It would require the NZSF balance in year T^ to be so large that the Fund could cover, via the combination of its accumulated but diminishing capital and the earnings on this capital, the expense of all of the capital withdrawals over the ensuing 40-year interval, before being exhausted in year T^+39. Furthermore, the capital withdrawals need to be consistently greater than the after-tax returns and, unless the return rate was extremely low, this is unlikely, at least in the initial years, if the starting Fund balance were so big. These required conditions are extremely

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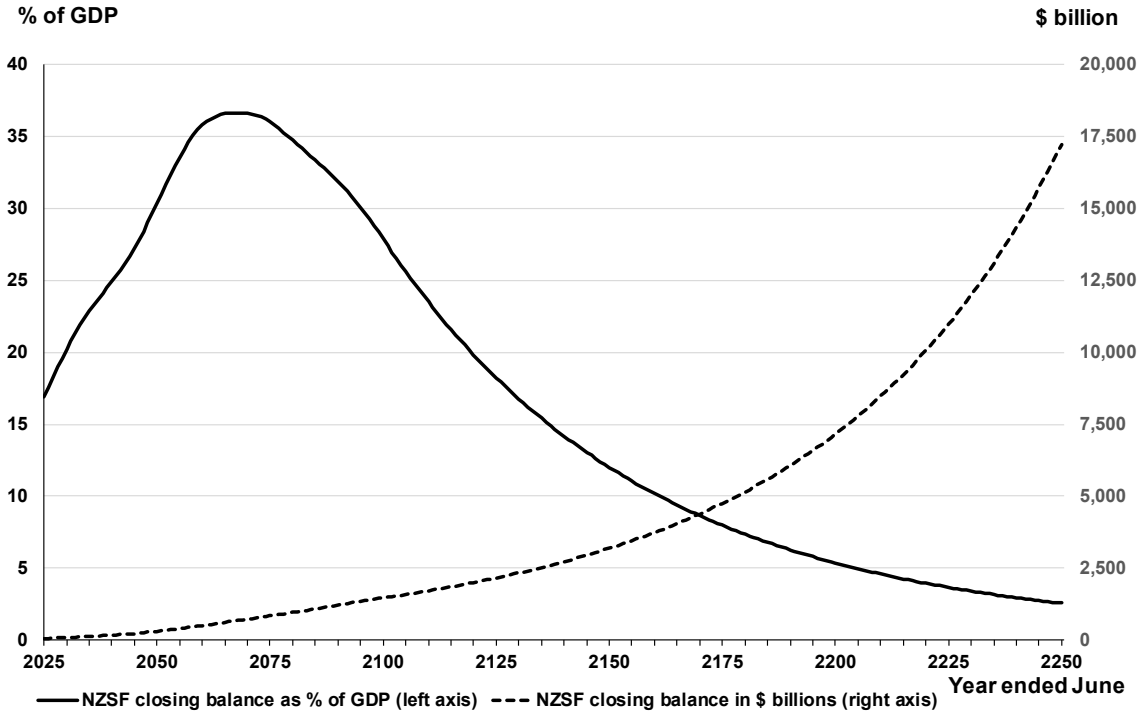
[15] In reality the error bounds on any such forecast would probably be quite large two years out, let alone a decade, a century or 500 years into the future! The Fund analysts' own five year forecasts use fairly stable return rate and tax rate assumptions beyond the first partially complete year.

[16] And, while any investor knows that they can have a few bad years, no-one is going to knowingly set up a long-term fund to consistently lose money!

unlikely to ever occur in reality, especially given the existing relativity between the projected growth of the NZSF and the profile of future net NZS to GDP.

Consequently, the mathematical proof showed that, under the conditions described, if the contribution rate is held constant from a given year and the nominal balance of the Fund declines in that year, then it must decline in every one of the next 39 years too. Beyond that the NZSF cannot cover the annual aggregate net NZS payments. While possible in theory, it was explained why this is not a realistic outcome for the NZSF. This, in turn, means that under the conditions described of net NZS to GDP not consistently falling, the NZSF annual return rate stabilising, and nominal GDP generally increasing, in any realistic scenario the closing balance of the NZSF must increase, in nominal dollar terms, from year to year.

***Figure 10 – NZSF closing balance when net NZS to GDP stabilises in the long run***




Source: The Treasury

Figure 10 illustrates the path of the NZSF closing balance in the same scenario used for Figure 9, where net NZS to GDP stabilises from 2100 onwards. While the solid line shows the NZSF closing balance as a percentage of GDP, and is aligned to the graph's left hand axis, the dotted line depicts it in nominal dollar terms, and corresponds to the right hand axis. As a percentage of GDP, the Fund balance increases until around 2070, before following a long reducing path. The long-term NZSF closing balance, in nominal dollar terms, just continues to rise. For practical purposes the graph has only been extended to 2250, because by 2500 the nominal dollar balance has reached over twelve million billion dollars, while as a percentage of GDP it is down to 0.57 percent.

The following much shorter explanation provides a simpler way of thinking about this. At each calculation of the contribution rate the formula requires a period of building up funds, followed by these being run down and eventually exhausted 40 years later. However, as the contribution rate is re-calculated each year, the formula effectively requires the NZSF to always be building up funds, in nominal dollar terms.

# 8 The NZSF if and when net NZS to GDP does decline

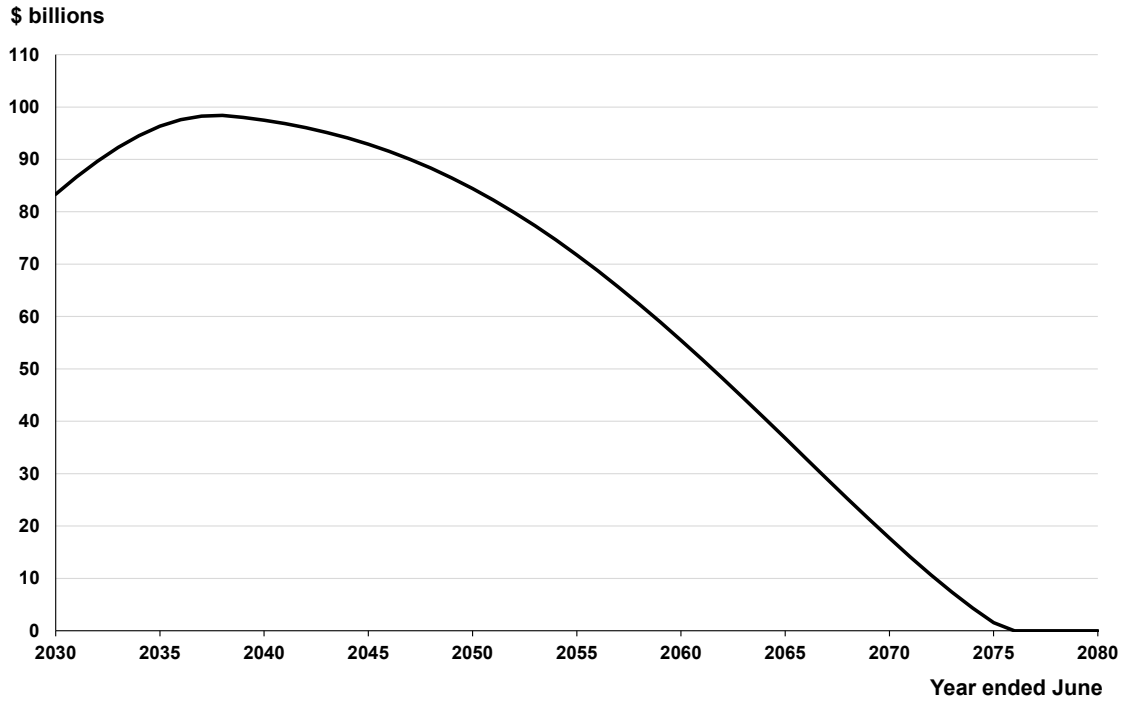
All of the discussion and proofs in Section 7 rested on the assumption that net NZS to GDP does not begin to consistently reduce, relative to GDP, at some point in the future, at least inside the future time frames used in each example or proof.

Under current policy settings for NZS, regarding entitlement and annual indexation of payment rates, combined with the Stats NZ demographic projections, aggregate net NZS expenses are expected to steadily rise relative to GDP over the next century. It is quite likely that ageing of the population structure will continue well beyond this. Future policy settings for NZS are far less predictable. They are in the hands of governments and, indirectly via the electoral process, the majority preferences of the voting public.

While there are changes to NZS policies that could lead to net NZS to GDP decreasing for a consistent period, it is not this paper's intent nor purpose to discuss NZS policy. Hence the following example simply assumes, with no explanation of how it is achieved, a scenario where, for 50 years from 2039/40 until 2088/89 inclusive, NZS to GDP steadily declines at the rate of 0.02 percentage points per year. Both Figures 11 and 12 were produced under this scenario, using the Budget 2020 NZSF model.

The point of this example is to show that, under such circumstances, many of the results about the NZSF and its parameters, proven and illustrated in Section 7, no longer apply. In particular, with a consistently declining net NZS to GDP path, both the contribution rate calculation and the nominal dollar value of the Fund can decline, and it is possible for the NZSF to run down its assets to the point where they are exhausted.

***Figure 11 – NZSF closing balance when net NZS to GDP consistently declines***

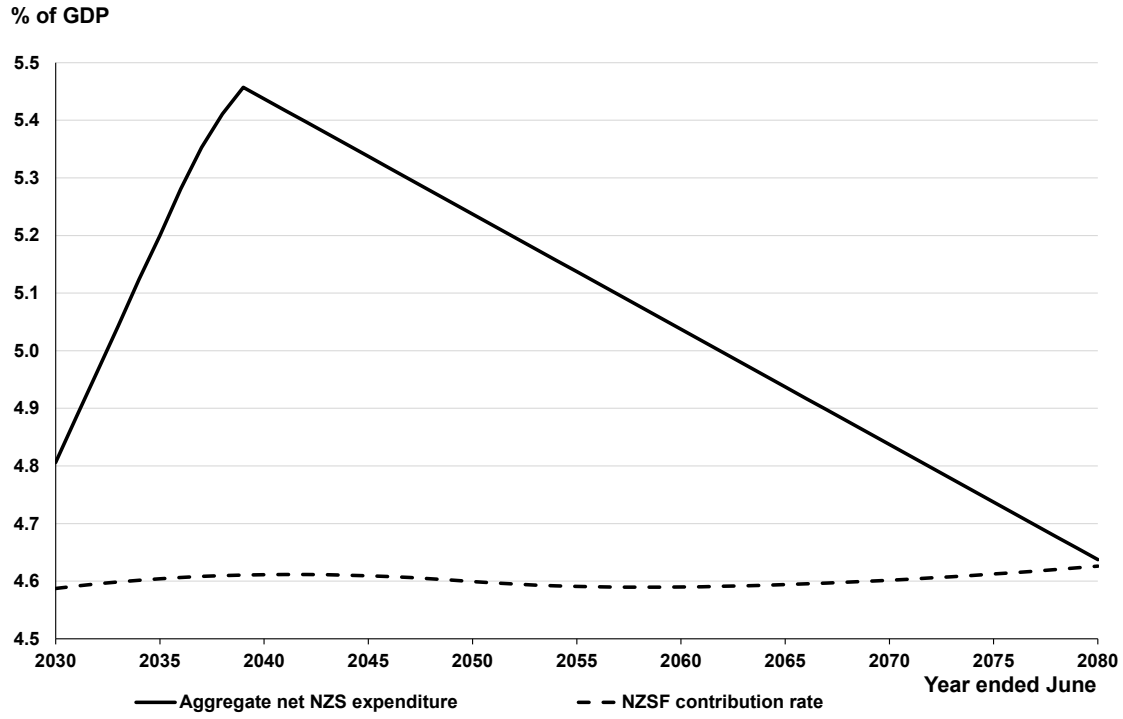



Source: The Treasury

Figure 11 clearly illustrates that the Fund no longer has any assets by 2076, which is actually less than 40 years after NZS to GDP began to decline in this scenario. This exhausting of the assets of the NZSF was proven, in Section 7.4, to be an outcome that could not occur under any realistic scenario for the NZSF where net NZS to GDP did not consistently reduce for an extended period.

The scale of the vertical axis in Figure 12 has been restricted so that it is visibly clear that the NZSF contribution rate (the dotted line) does decline for most of the period between 2040 and 2060. Sections 7.1 and 7.3 proved that such an outcome could not occur if net NZS to GDP did not generally decline.

***Figure 12 – NZSF contribution rate when net NZS to GDP consistently declines***




Source: The Treasury

The modelling behind this scenario has been adjusted to stop any further contributions to or withdrawals from the NZSF beyond 2074/75, which is the last year in the scenario when the NZSF has assets enough to cover the withdrawal. This is because, in reality, the Fund would very likely be wound up once its assets were all gone and taxpayers in 2075/76 and beyond would simply need to meet the entire cost of net NZS from that time forward. At least by then, in this scenario, NZS to GDP is around 0.7 percentage points of GDP lower than it was in 2039/40.

The modelling adjustment to stop further contributions or withdrawals beyond 2074/75 is necessary, because the logic of the NZSF contribution rate formula is driven by a mathematical formula, not practical realities. This results in withdrawals being taken from the Fund, as long as NZS to GDP is higher than the calculated contribution rate, whether or not the NZSF actually has the assets to cover these. That, in turn, leads to growing deficits for the NZSF closing balance, turning it into a financial liability rather than an asset. Such an outcome is not what would be allowed to unfold in reality.

# 9 Tax status of the NZSF

Following on from the discussion in Section 4.5 of tax rates and the role of the after-tax return rate as the discount rate used in the contribution rate calculation, this section provides some further information about the tax status of the NZSF. It has been a subject of interest and debate that has arisen from time to time over the Fund's history.

The NZSF retains its after-tax, after-expenses earnings, and uses these to grow its asset base, but the Inland Revenue Department (IRD) receives the tax assessed on these earnings each year. The Fund has been paying tax virtually from its inception, and between 2003/04 and 2019/20 this amounts to a total of $7.68 billion.

## 9.1 The original decision to make the NZSF taxable

That the income of the NZSF is subject to tax reflects a decision about the Fund's tax status when it was established. The question of the Fund's tax status has been raised since its inception. Just as with policy concerning NZS, it is not the purpose of this paper to discuss or comment on the merits of this policy decision.

The original policy decision weighed up a range of factors. An early planning document for the NZSF stated "*On the face of it, the answer to whether the proposed superannuation fund should be taxable or not appears obvious as it can be argued that the Government would simply be taxing itself. If you consider the wider implications of having a large tax-exempt entity in the midst of an otherwise taxed world, however, it would be best for the fund to be taxable*" (New Zealand Treasury, 2000b).

The same report went on to list two potential problems that could arise if the NZSF was given tax-exempt status. These were summarised as "*The first of these is the tax avoidance opportunities that would be created if the fund was tax-exempt. The second is whether poor incentives would be created regarding investment behaviour.*"

There are contrasting views. For example, the NZSF proposed tax exemption status to the government's Tax Working Group (TWG) in 2018. The Fund noted that a tax exemption would remove the need to liquidate assets in order to pay tax; reduce the size of contributions from the government; assist in obtaining favourable tax treatment on overseas investments as a sovereign wealth fund, as this often relied on a fund's domestic tax status; and lower the Fund's tax compliance costs (NZ Super Fund, 2018).

## 9.2 The effect of tax on contributions to and withdrawals from the NZSF

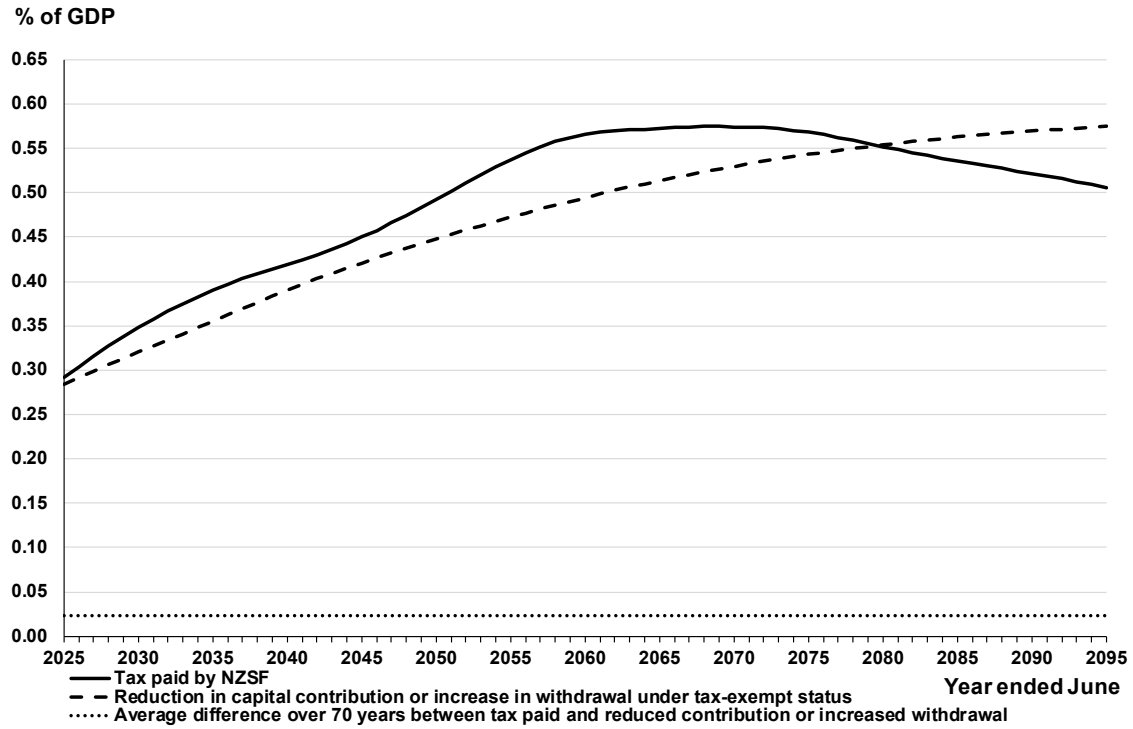
Sections 4, 5 and 6 explain how the legislated contribution rate formula for the NZSF works, and how the discount rate applied in its calculations is an after-tax return rate.

If the NZSF were not taxed, the discount rate used in the contribution rate formula would be the gross return rate, as there would be no after-tax rate. The formula's logic of covering the entire cost of aggregate net NZS expenses over the ensuing 40 years means that the foregone tax payments are, to a large degree, offset by lower capital contributions and higher capital withdrawals. With the Fund able to retain all of its earnings, rather than just the net of tax component of these, it does not need as much

in the way of capital contributions from the government in order to build up enough funds to cover the next 40 years of aggregate net NZS expenses. Likewise, the switch to providing funds to help cover these NZS expenses occurs at an earlier time and these capital withdrawals are larger than under the situation where the NZSF is taxed.

The above holds when contributions follow the legislated formula. If the contributions from the government are fixed, or suspended, then, all else equal, the tax status will have a larger impact on the net flows between the NZSF and the government. This is because a fixed level of contributions would not adjust to take account of the tax status.

***Figure 13 – NZSF tax versus lower contributions and higher withdrawals if tax exempt***




Source: The Treasury

As Figure 13 illustrates, this is not an exact one-for-one trade-off. For most of the 70 year projection shown, the reduction in capital contributions to the NZSF or increase in capital withdrawals from the Fund, under tax exempt status, does not quite match the projected amount of tax that the NZSF would pay under a continuation of the existing situation of the NZSF paying tax on its annual earnings. However, beyond 2080 the situation is reversed and the higher capital withdrawals under tax exempt status actually outweigh the foregone tax payments beyond this point, with that difference growing over ensuing years.

Over the horizon shown in Figure 13 the average difference is that the tax payments are 0.02 percentage points of GDP higher. However, if this projection were extended a further 20 years to 2114/15 the average over the 90 years would actually be a 0.01 percentage points of GDP gain from higher amounts of withdrawals.

A major reason for the differences between tax payments and changes to contributions and withdrawals under tax exempt status is the different time horizons involved in any year between the calculation of the capital contribution or withdrawal and that of the tax payment. The contributions and withdrawals are derived from a forward-looking 40-year series of GDP, aggregate net NZS expenses and NZSF annual closing balances, as well as return rates. The foregone tax payments in any year only depend on the Fund's closing balance in the previous year, plus that year's amount of capital contribution or withdrawal, return rate and tax rate.

Consequently, as a percentage of GDP, tax payments begin to decline around the middle of the 2060s, because that is where the Fund closing balance peaks, before also declining as a percentage of GDP. However, as has been explained in Section 7, net aggregate NZS expenses to GDP are not expected to decline over this period, and so under both taxed and tax exempt NZSF scenarios the contribution rate keeps rising. Under the horizon displayed in Figure 13 this results in the capital withdrawals also continuing to lift relative to GDP, although they do start to reduce a little before 2115.

These pathways are very dependent on the future investment returns of the NZSF, economic variations, and policy decisions around NZS, to name just a few of the key factors that will influence them over the coming decades. Hence, it is not the point of this section to try and estimate any kind of "break even" point between tax payments and higher withdrawals under tax exempt status, and it is certainly not intended to advocate either for or against either position.

The aim of this section is simply to illustrate and explain why the overall outcomes for the NZSF, in terms of receiving funds from, and returning funds to, the government, is not markedly different over the long term, whether the Fund pays tax or is tax exempt. There are timing differences between the two scenarios and advocates for either status could provide reasons to support their positions that go beyond just the mechanics of the NZSF contribution rate formula. However, the logic of that formula is focused on funding aggregate net NZS expenses over a 40-year horizon, which in turn depends on the size of the Fund at the beginning of that period. As such it can largely compensate any change in how much the Fund can retain from its earnings via changes in how much the NZSF requires in capital contributions or pays out in capital withdrawals.

## 9.3 How the NZSF tax payments are treated in the government accounts

Section 1 explained that the NZSF is in the core Crown segment of the three institutional entities that, along with Ministers of the Crown, make up the New Zealand Government Reporting entity. The other two segments are Crown entities (CEs) and State-owned enterprises (SOEs). An example of a CE is the Accident Compensation Corporation (ACC), while New Zealand Post Limited is an example of an SOE (New Zealand Treasury, 2020a).

The government accounts aggregate the financial transactions of all government reporting entities and eliminate any transactions within the group to avoid double counting and other overstatements (or possibly understatements) of public revenue, expenses, assets and liabilities. A good example is in health spending where the consolidated total Crown figure is not very different from the core Crown amount. In any year the CE figure is often around three quarters of the core Crown value, or more, but the majority of this is eliminated when consolidating to the total Crown amount. This

is because a large fraction of core Crown health spending is payments to the District Health Boards in the country, and these are CEs. If these payments were not eliminated, they would be counted twice when adding the core Crown and CE health expenses.

NZSF tax payments are actually eliminated at the core Crown level, because while they are revenue to one core Crown organisation, the IRD, they are an equal and opposite expense to another core Crown entity, the NZSF itself. Consequently, from the overall perspective of the core Crown operating balance, they are fiscally neutral.

Things get a little more complicated with the core Crown residual cash measure, which is a non-GAAP (Generally Accepted Accounting Principles) fiscal indicator that helps to communicate the government's fiscal strategy. This is the annual cash surplus, or deficit, that remains after operating and investing cash requirements are met that, in the case of a surplus, is available for the government to invest or repay debt or, in the case of a deficit, needs to be funded by borrowing or reducing financial assets. Because the NZSF is considered to be "ring fenced" for the purpose of assisting future generations, rather than assisting with current government financing, it is excluded from the core Crown residual cash measure, despite being part of the core Crown.

Possibly the easiest way to think of this is that the core Crown residual cash measure is effectively the "core Crown excluding the NZSF" residual cash measure. This has two major implications for this cash measure. One is that the tax receipts that the IRD gets from the NZSF are included, as there are no offsetting tax payments by the NZSF, which are expenses for that entity, in this measure to counterbalance these. The other impact is that the capital contributions that the government makes to the NZSF have no offsetting capital contributions received by the NZSF, so these are part of the residual cash measure too. And, in later years, when the government starts making withdrawals from the Fund, these will add to the residual cash measure just as the contributions now reduce it.

In effect this means that the two inflows and outflows between the NZSF and the government, namely the Fund's tax payments and the capital contributions it receives, are part of the core Crown residual cash measure. The tax payments increase residual cash, while the capital contributions reduce it, although they will increase it in the future when the contributions are replaced by withdrawals.

It is important to realise that, in regard to the total Crown operating balance, the tax assessed on the income of the NZSF is eliminated from the overall tax revenue recorded for the IRD. This is because it is an expense to another government entity, namely the NZSF.

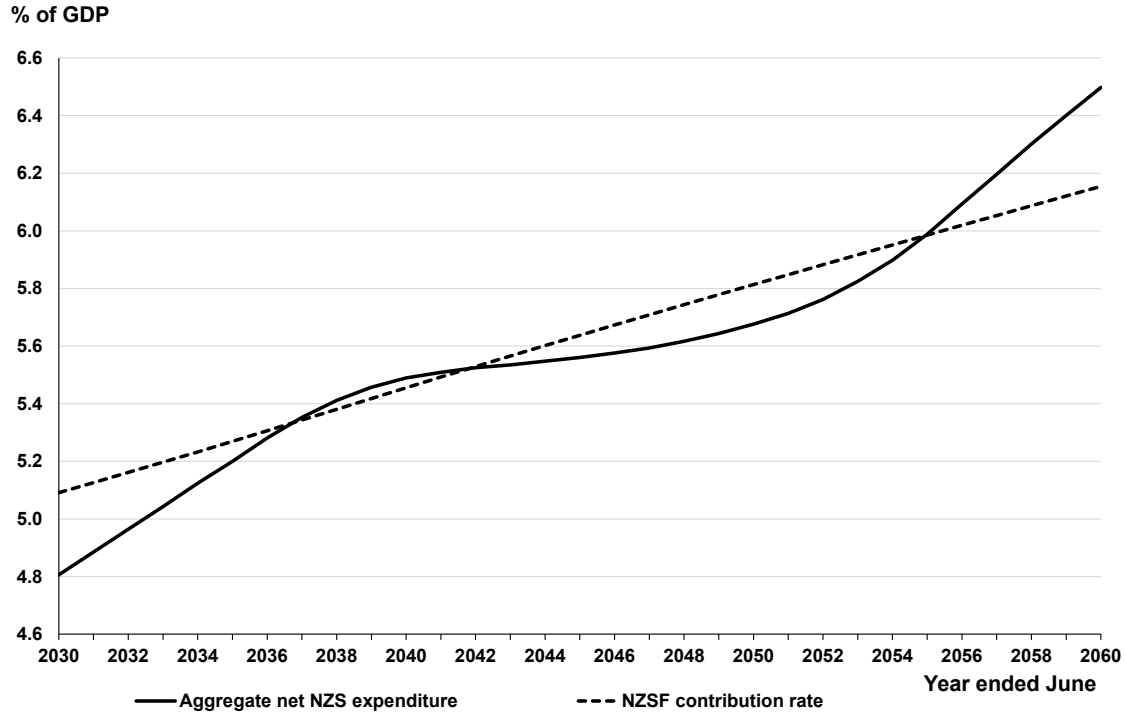
However, with respect to providing a source of cash to meet current financing requirements, the NZSF's tax payments are available in the year that they are generated. By contrast, the offsetting tax expense for the NZSF reduces the potential size of an asset that is regarded as off limits for helping out with current needs, as it is focussed on providing financial assistance to future generations. Similarly the capital contributions reduce the cash available in the year in which they occur, but go towards building up an asset that is not considered liquid because of its purpose.

As explained in Section 9.2, a fair degree of offset via reduced capital contributions would occur if the NZSF did have tax exempt status. Hence the effect on core Crown residual cash would be much less than the complete loss of the NZSF tax receipts.

# 10 Demographic oddities and the NZSF

Figure 14 repeats Figure 6 from the Budget 2020 NZSF model, but limits the period shown to 2029/30 until 2059/60 and expands the vertical axis scale. This makes it visually clearer that the aggregate net NZS expenses line, as a percentage of GDP, first rises above the NZSF contribution rate in 2036/37. It only exceeds it for five years, until 2040/41, before dipping below it again for more than a decade. The net NZS to GDP line does not move permanently above the contribution rate until 2054/55.

***Figure 14 – NZSF contribution rate and net NZS to GDP with expanded scale***




Source: The Treasury

This corresponds to the NZSF receiving capital contributions up until 2035/36, then providing small capital withdrawals to the government until 2040/41, followed by small contributions again up to 2053/54. It is only from the mid-2050s onwards, under the current projections, that the NZSF truly begins to perform its role of assisting taxpayers meet the rising cost of NZS, by providing withdrawals on a sustained basis.

This flipping between contributions and withdrawals for nearly two decades is due to fertility rate changes occurring 65 years before the projected time of these movements.

Around the late 2030s the growth rate of the “65 years and above” age group is projected to decline a little faster than the more gradual rate of reduction it has followed, or is projected to follow, from its peak of just under 4 percent per year in 2011/12. By 2036/37 this age group’s annual growth rate is projected to finally go below 2 percent, but over the next six years its growth decelerates more quickly, hitting a low of 0.7 percent in 2042/43. Beyond this the growth rate is projected to gradually rise again, going past 1 percent again in 2050/51. After this the growth rate of the “65 years and above” age group fluctuates around an average of about 1.4 percent over the next 15 years.

With net NZS to GDP briefly flattening, while for reasons explained in Section 7.1 the contribution rate calculated each year constantly rises, the net NZS to GDP track briefly dips below the contribution rate track. When it does that, as explained in Sections 5.1 and 5.3, capital is contributed to the NZSF rather than withdrawn from it.

Why did the “65 years and above” age group growth rate peak in 2012? Because 65 years before 2012 is 1947, two years after World War 2 ended and when the post-war fertility lift in New Zealand was really underway and had reached 3.6 babies per childbearing-age woman. This compares to only 2.6 four years earlier and was the highest rate reached until 1952.

Why is it projected to hit a low point in growth in 2043? Because 65 years before 2043 is 1978, close to the time when the wide availability of the birth control pill had helped to lower the fertility rate to nearly 2, after which it tended to fluctuate around that level.

Clearly not everyone born in a year lives to 65 and, even of those who do, not everyone stays in New Zealand. Furthermore, immigrants come to New Zealand and they age and qualify for NZS too. However, the fertility rates 65 years previous to the time being examined are strongly correlated to the growth rate of the age group eligible for NZS. This, in turn, heavily influences the path of net NZS to GDP and, because of the way in which the contribution rate of the NZSF works, translates through to variations in the size of capital contributions and withdrawals.

# 11 How and why NZSF projections have changed over time

Projections of the NZSF are made at each Economic and Fiscal Update (EFU). There are normally two EFUs each year, which are the Budget in May and the Half Year EFU in December. Forecasts of GDP and NZS expenses are updated, which also changes the projections that grow from these forecast bases. New forecasts of returns on Fund assets and the tax on these are also provided by the NZSF analysts at an EFU. About once every three years, Stats NZ update their population and labour force projections, which affect the underlying demographic drivers of both GDP and net NZS projections. Occasionally there are policy changes to either the NZSF itself or to NZS. An example of the former was the suspension of contributions from 2009 until 2017. No significant changes to NZS policy have occurred since the Fund was established.

This section analyses the evolution of the NZSF, both in terms of actual outcomes and forecast and projected ones, using six Budget versions of the NZSF model over a 20-year period, in intervals of four years (New Zealand Treasury, 2020c). Starting with the Budget 2000 projection, which was used for planning before the Fund actually existed, the analysis progresses through Budgets 2004, 2008, 2012 and 2016, ending with the latest Budget projection at the time of writing, which was that produced for the Budget 2020 EFU. The major reasons for changes in the size and profile of the capital contributions and withdrawals, and also of the NZSF closing balance, which are all key parameters of the Fund, in moving from the earlier Budget projection to the one four years later, are discussed and illustrated.

## 11.1 Changes in the projections of NZS to GDP

Figure 15 shows actual, forecast and projected paths of the aggregate net NZS to GDP relationship for Budgets 2000, 2004, 2008, 2012, 2016 and 2020. Littlewood (2013) provides further commentary on such projections made between 2000 and 2013.

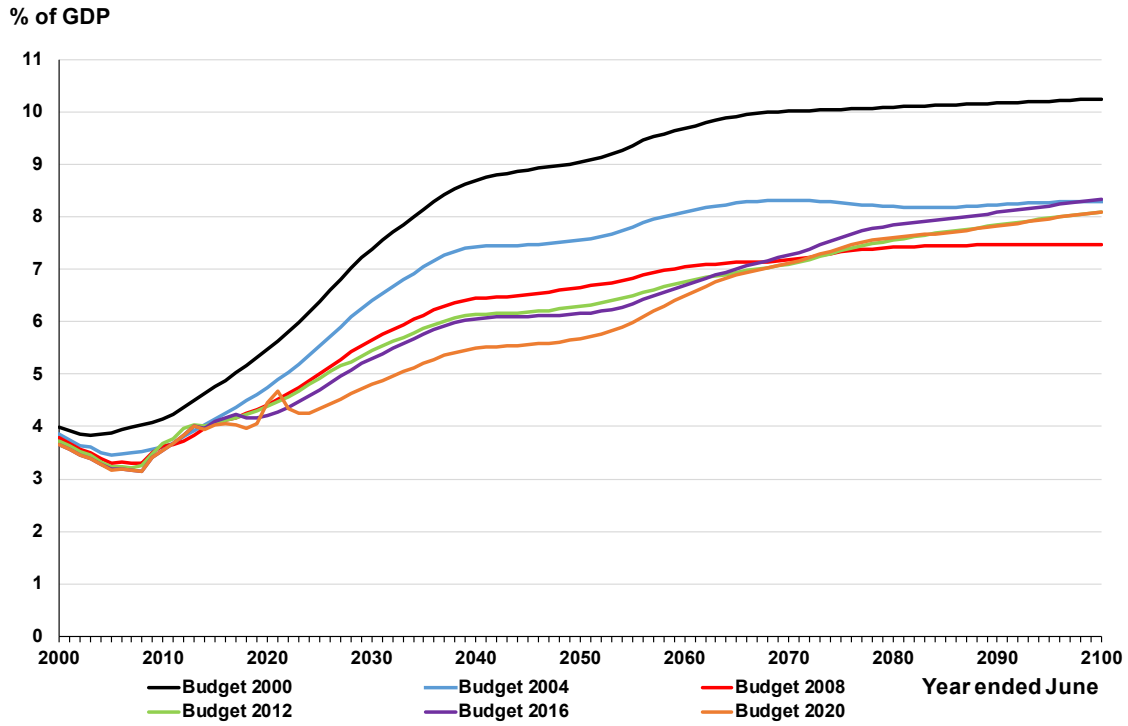
For Budget 2000 the years 2000 to 2100 were almost all a projection. Each later track progressively included a greater proportion of known results in the form of outturns. However, even for Budget 2020, three quarters of the period is still a projection.

What is most noticeable about Figure 15 is how much the NZS to GDP projection changed over time, particularly in the level of GDP reached, but also in the shape of the projection. A big reduction occurred between Budget 2000, when the Fund was being planned, and Budget 2004, and then again to a lesser extent in Budget 2008.

The reductions were less pronounced after this, but from Budget 2012 onwards the net NZS to GDP projections continued to rise beyond around 2070, where in the earlier projections they largely flattened out from about this time onwards.

As Sections 5, 6 and 7 explained, the NZSF contribution rate is highly dependent on the path of aggregate net NZS to GDP, and if the latter reduces in updating a projection, so should the former. From the practical intentions behind the formula this also makes sense, because the lower the differential between current and future costs of NZS, relative to GDP, the less current taxpayers should be required to pay in order to assist future generations meet those higher NZS expenses.

***Figure 15 – Net NZS to GDP over six different Budget projections***




Source: The Treasury

This also means that if an updated projection lowers the path of net NZS to GDP, it will also reduce the projected path of the closing balance of the NZSF as a percentage of GDP, assuming no significant change has occurred in the Fund's projected rate of return. Again this makes sense because if the Fund is required to cover a lower amount of aggregate net NZS expenses, as a percentage of GDP, than was previously expected, then it will not need to build up as high a level of assets, relative to GDP.

## 11.2 Analysing the changes in the projections of NZS to GDP

In the following sections both the changes to the projections of key NZSF variables over these six Budgets will be illustrated, and the reasons for them analysed. By no means is the changing nature of NZS to GDP projections the only factor involved, but as the analysis will show, it does play a very significant role.

Consequently, it is informative to examine the reasons for this in more detail. Many of the changes discussed in this section come from updates to demographic and labour force projections by Stats NZ. These are generally greatest when they are based on a new Census base, although Stats NZ usually do a "between Censuses" update too.

The Budget 2004 projection of GDP was considerably stronger than that of Budget 2000. Some of this was due to higher outturns of GDP in the years between the two projections and the ensuing higher GDP forecasts that formed the base of the Budget 2004 projection. But the largest factor was due to the stronger labour force growth in the Budget 2004 projection, which is an important component of the GDP projection but does not markedly influence the aggregate net NZS expenditure projection. The base of the net NZS projections might be slightly affected through the labour force growth

having an effect on the average wage used to index NZS payments, and via higher secondary tax rates on NZS being chosen by a larger number of superannuitants who are still working, but these smaller effects are not built into NZS projections.

Since 2000, as labour force participation rose, particularly among people aged 60 and over but also among females in most age groups, Stats NZ reflected these changes in the assumptions that they built into their labour force projections. In the Budget 2000 projection, the movement of higher proportions of people into lower participation rate age groups, due to population ageing, resulted in slightly negative labour force growth over the majority of the projection. This component of projected GDP growth reduced, rather than strengthened, GDP in most years. In Budget 2004 an ageing population structure was again projected, as it still is now. However, increases to expected labour force participation rates, particularly in older age groups, meant that labour force growth averaged 0.14 percentage points more over the common projection period for both Budgets from 2008/09 to 2100. That may not sound like much but, accumulating over more than 90 years of projections, it lifts GDP markedly. Over this same period the annual growth of the “65 years and above” age group, which is the demographic driver of NZS expenses, also increased between the two projections. However, it only averaged 0.06 percentage points more, so the net NZS to GDP track reduced overall.

This trend of strengthening labour force projections continued in moving from Budget 2004 to Budget 2008, with an even bigger change of an average of 0.33 percentage points over the common projection years from 2012/13 to 2100. The Budget 2008 labour force projection did not even descend into negative annual growth by 2100. Despite this much greater change in labour force growth, it did not lower net NZS to GDP quite as much as in going from Budget 2000 to 2004. This was because it was accompanied, over the same period, by a considerable strengthening in the average annual growth of the “65 years and above” age group of 0.27 percentage points.

In going from Budget 2008 to Budget 2012 there was not a great change in the labour force projections and this time around the increases to the annual growth of the “65 years and above” group were, on average, greater over the common projection period. However, it is the timing of the differences, rather than the size, that make the greater difference to the net NZS to GDP track between these two Budget projections. Up until around 2050 there is only a small increase in the average annual labour force growth, but the average annual growth for the “65 years and above” age group, over the same period, actually decreases. However, from 2050 to 2100 the average increase between the projections for Budgets 2008 and 2012 of the annual growth of the “65 years and above” age group was 0.37 percentage points, while the lift in average labour force growth was much more moderate at 0.10 percentage points. This pattern of changes resulted in the net NZS to GDP track of Budget 2012 initially dropping below that of Budget 2008, but gradually closing the gap and eventually surpassing it around 2070. Furthermore, while the Budget 2008 projection of aggregate net NZS expenses to GDP levelled out from around 2070, the Budget 2012 projection continued to lift over these years. This change in the shape of the net NZS to GDP projection proved to have a considerable influence on the shape of the Fund’s closing balance to GDP track.

Of all the four year transitions of Budget NZSF projections examined, the least change in the net NZS to GDP projections occurred between Budgets 2012 and 2016. There was not much difference in the size of the increases in average annual growth of the labour force and of the “65 and above” age group in the common projection period up to around 2050. Beyond this point, the increase for the “65 and above” age group was

more than that for the labour force. This was a repeat of what had occurred between Budgets 2008 and 2012, although the difference was not as large as it was between those projections. As a result, the Budget 2016 net NZS to GDP projection tracked that of Budget 2012 fairly closely up until around 2060, but then lifted above it and remained so out to 2100. It is difficult to discern the two tracks moving apart on Figure 15, as from around the time that they do the projection of Budget 2012 is very similar to that of Budget 2020, with both being below that of Budget 2016.

The common projection period between Budgets 2016 and 2020 begins in 2024/25. By the last forecast year of Budget 2020 net NZS to GDP was 0.33 percentage points of GDP lower than its value in the Budget 2016 track. Much of this difference was due to the GDP forecast arising from a higher base caused by upward revisions to outturns by Stats NZ. Fairly similar increases, relative to the Budget 2016 projection, in average annual growth for the labour force and the “65 and above” age group out to 2050 meant that this starting gap actually increased a little out to that point. However, between 2050 and 2070 the annual average growth of the Budget 2020 projection of the “65 and above” age group increased by 0.22 percentage points relative to that of Budget 2016, while that of the labour force decreased by 0.08 percentage points. As a result the Budget 2020 track nearly caught up to that of Budget 2016 by this time. In the remaining 30 years of the projection both annual average growth rates reduced between Budgets 2016 and 2020, with the decrease being a little greater for the “65 and above” age group. Consequently the gap widened again and the Budget 2020 net NZS to GDP track did not rise as high as the Budget 2016 projection.

It is clear from this section that changing demographic and labour force projections have a great effect on the projections of aggregate net NZS expenses to GDP, and as the next sections will show these in turn are highly influential on the projected paths of important NZSF variables. It is not only the overall strength of the projections of the labour force relative to those of the “65 and above” age group that matter, but also the different timing of when they strengthen and weaken in their annual growth rates.

## 11.3 Changes in key NZSF variables projections

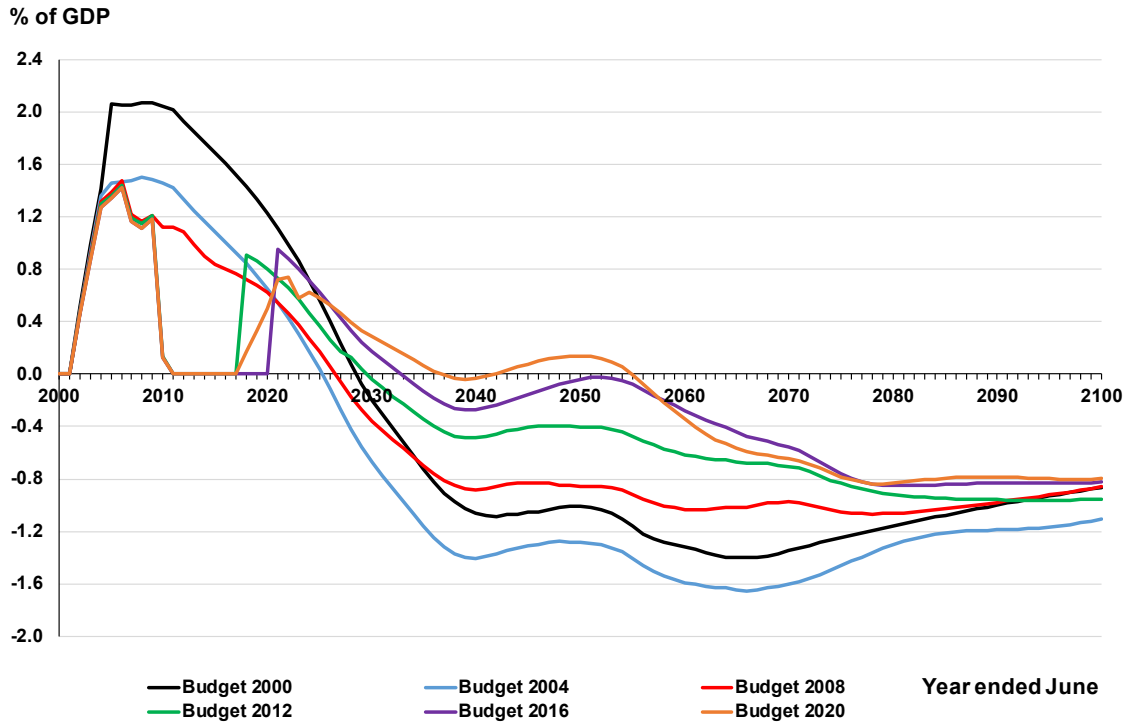
The capital contributions to the NZSF from the government, both actual and projected, along with the projected withdrawals from the Fund in future years, as percentages of GDP, are shown in Figure 16 for Budgets 2000, 2004, 2008, 2012, 2016 and 2020.

When the Budget 2000 projection was made, taxpayers were expected to provide a total of 36.6 percent of GDP in contributions over 27 years, from 2001/02 to 2027/28. Over the remaining 72 years to 2100, a total of 76.0 percent of GDP was projected to be received from the Fund to assist future taxpayers to cover the rising costs of NZS.

Figure 16 illustrates, and Table 1 summarises, how over the 99 year period from 2001/02 to 2100, the ongoing Budget projections have generally resulted in a lower total percentage of GDP for both capital contributions and withdrawals.

By the time of the Budget 2020 projection, relative to that of Budget 2000 the capital contributions that had actually been made or were still expected had more than halved, as a percentage of GDP, from 36.6 to 17.2 percent. The same thing had occurred for withdrawals, reducing from 76.0 to 30.4 percent of GDP.

*Figure 16 – Contributions & withdrawals over six different Budget projections*




Source: The Treasury

*Table 1 – Total contributions and withdrawals over six Budget NZSF projections*

| Budget NZSF projection | 2000 | 2004 | 2008 | 2012 | 2016 | 2020 |
|---|---|---|---|---|---|---|
| Contributions as % of GDP from 2001/02 to 2100 | 36.6 | 23.5 | 20.7 | 15.1 | 14.8 | 17.2 |
| Withdrawals as % of GDP from 2001/02 to 2100 | 76.0 | 95.6 | 65.5 | 46.7 | 32.8 | 30.4 |
| Total years of contributions | 27 | 24 | 25 | 21 | 21 | 41 |
| Total years of withdrawals | 72 | 75 | 74 | 71 | 68 | 51 |
| Total years no contribution | 0 | 0 | 0 | 7 | 10 | 7 |

While there has been the odd exception over the six Budget projections, the general pattern of decrease for both contributions and withdrawals fits with the general pattern of net NZS to GDP projections shifting downward over the ongoing Budgets, as illustrated in Figure 15. In other words, if the lift in public pension costs in the future is expected to be less than was previously projected, then the amount of assistance from current taxpayers to future taxpayers, via tax smoothing, does not need to be as much.

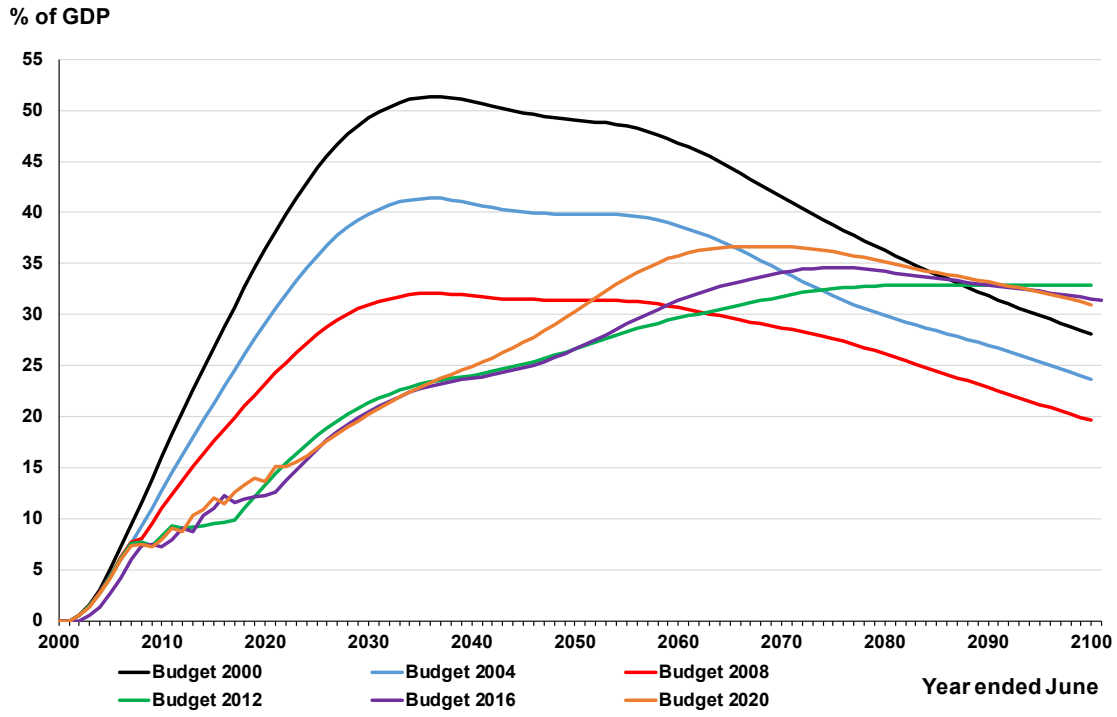
Table 1 also shows how the changes to the number of years of making contributions and receiving withdrawals has not been as great over the Budget projections, with a general pattern of a small decline in both. That was reversed at Budget 2020, but that was partly to do with the period of very small withdrawals explained in Section 10.

***Table 2 – NZSF closing balance features over six Budget NZSF projections***

| Budget NZSF projection | 2000 | 2004 | 2008 | 2012 | 2016 | 2020 |
|---|---|---|---|---|---|---|
| Maximum % of GDP | 51.3 | 41.4 | 32.1 | 32.9 | 34.6 | 36.7 |
| Year maximum is attained | 2035/36 | 2035/36 | 2035/36 | 2088/89 | 2073/74 | 2067/68 |
| % of GDP in 2099/2100 | 28.1 | 23.6 | 19.6 | 32.8 | 31.4 | 31.0 |

Table 2 summarises some important features of the six Budget projections for another important NZSF parameter, which is the closing balance as a percentage of GDP, while Figure 17 displays the paths for Budgets 2000, 2004, 2008, 2012, 2016 and 2020.

***Figure 17 – NZSF closing balance over six different Budget projections***




Source: The Treasury

Two features of Figure 17 and Table 2 stand out. One of these is the marked reduction in the maximum percentage of GDP attained by the Fund balance, especially in going from Budgets 2000 to 2004 to 2008. Again, this makes sense in regard to projections of aggregate net NZS expenses to GDP shifting downwards in later Budgets, as shown in Figure 15. In terms of percentages of GDP, if the future NZS expenses that the NZSF is required to fund are expected to be lower than in earlier projections, then so will the amount of assets that the Fund needs to build up in order to provide that funding.

The other feature is the change in the shape of the path of the closing balance to GDP, which is fairly similar up to Budget 2008, but after that becomes more varied. The projections of Budgets 2000, 2004 and 2008, although reaching successively lower peaks relative to GDP, all attained their maximum values in the middle of the 2030s. By contrast Budget 2012 continues to rise up until the late 2080s, and while the peak is attained earlier than this in the projections of Budgets 2016 and 2020, in both case it is still well beyond the middle of the 2030s, as is observed in the earlier projections.

Of course it is not just the changing nature of net NZS to GDP projections that has produced the changes in the projections of the NZSF variables over these six Budgets' projections. Differences between actual outturns and those assumed in projections, including for the NZSF itself as well as for demographic, economic and fiscal variables that affect the Fund, have played an important role. There have been modelling changes over the years, and some of these have been significant. The break in making contributions that began in 2009 and lasted until 2017, described in Section 2.2, caused changes in expected NZSF outcomes. This produced the actual or expected periods of no contributions listed in Table 1 for Budgets 2012, 2016 and 2020.

However, as already stated, the future path of NZS expenses to GDP are critical to the future path of the NZSF. As is illustrated in the next sections, it is changes to this track between projections that normally produces the biggest changes in the projections of the Fund itself. Over the years it has been the biggest influence on NZSF projections.

## 11.4 Analysing the causes of changes in the NZSF projections

The three step[17] manner in which the analysis was done for the graphs that follow was, starting from the older Budget projection:

- update it for any outturns of NZSF variables that have occurred since the original projection was made, as well as the Fund's forecast base of the later projection
- then update for the outturns, forecasts and projections of nominal GDP and aggregate net NZS expenses from the later Budget, and
- finally update for any modelling changes in the later Budget NZSF model that have been introduced since the earlier projection was made.

After the final step the result is checked to ensure that it now has no differences from the later Budget projection.

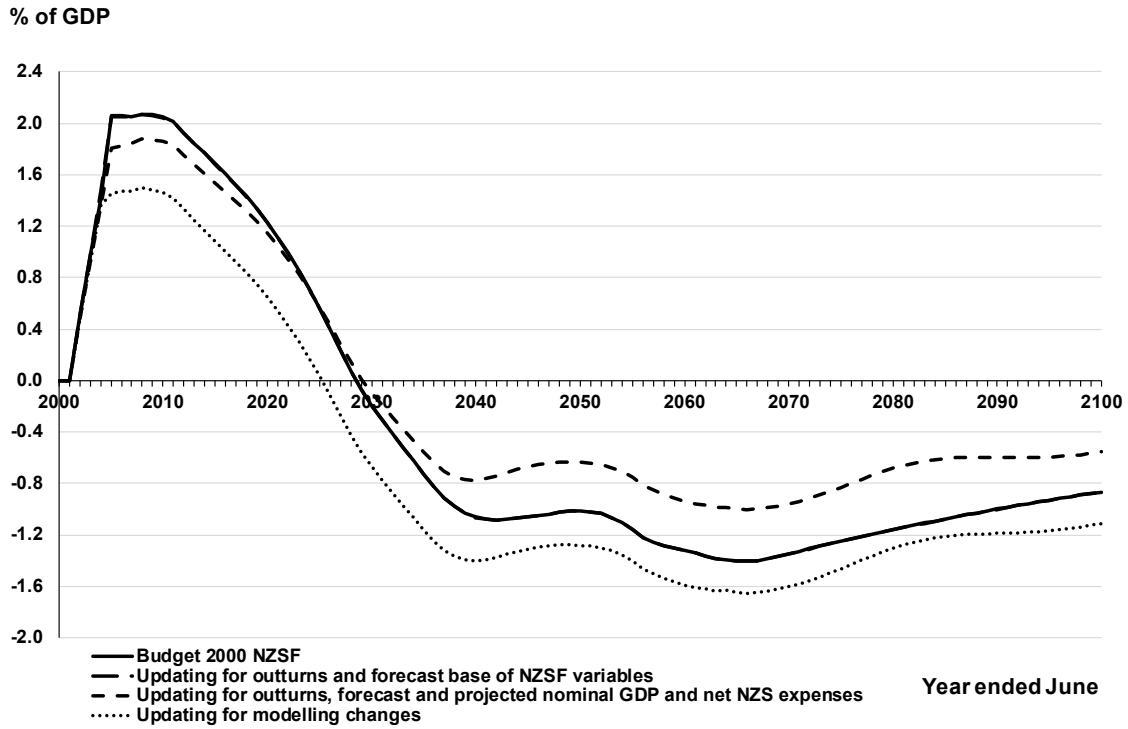
As with any iterative process, the order of the stepwise changes does influence the outcomes. The order used here follows the chronological steps that occur in updating the NZSF model (although that normally occurs in moving from a Budget to a Half Year EFU, or vice versa, rather than for a four year gap). As such it was considered the most accurate way to perform the analysis. However, the amount of change attributed to a particular step would likely be at least a little different if the order were changed.

[17] The transition from Budget 2008 to Budget 2012 applies a four step process, with the extra step analysing the impact of the contribution break that was introduced between these projections.

## 11.5 Budget 2000 to Budget 2004

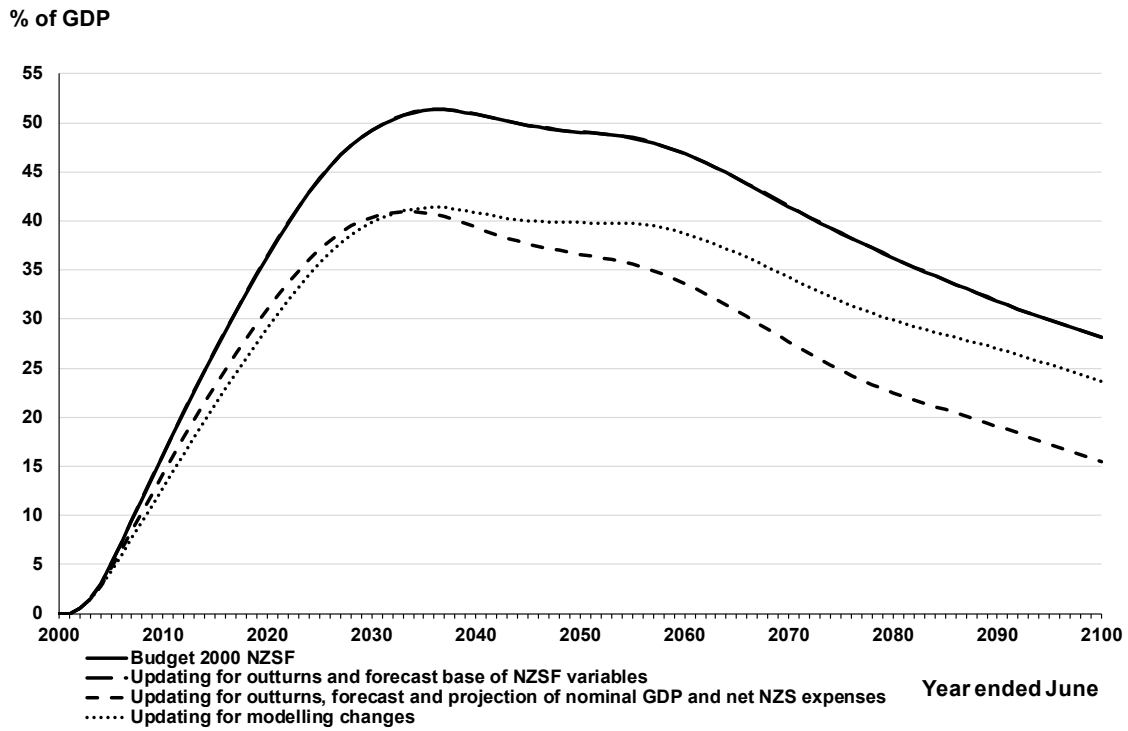
The legends of Figures 18 and 19 state that they have a line depicting the outcome from updating the outturns and forecast base of NZSF variables. This line is not evident on either graph, because it is not discernible from that of the Budget 2000 projection.

***Figure 18 – Updating contributions & withdrawals between Budgets 2000 & 2004***




Source: The Treasury

***Figure 19 – Updating NZSF closing balance between Budgets 2000 & 2004***




Source: The Treasury

This is because the first three years of contributions were planned amounts and the NZSF were not submitting their own forecasts of revenue, tax etc. in these early years of the Fund. Consequently there was little difference between the expected outcomes of the Budget 2000 projection and the actual outcomes and forecasts of the Budget 2004 track in these initial years.

Of more significance, the large changes caused by the updating to Budget 2004 outturns, forecasts and projections of GDP and net NZS expenses are very obvious. For reasons explained in Sections 11.1 and 11.3, this both reduced, relative to GDP, the paths of contributions and withdrawals and the closing balance of the Fund.

The modelling change at Budget 2004 appears to be just as significant, however. It further lowers contributions, but increases withdrawals, and lessens the decline of the closing balance beyond the middle of the 2030s. What was this modelling change? The assumption for the annual rate of return on the NZSF assets was increased by over three percentage points from 7.00 percent to 10.14 percent.

This change was based on shifting from a return assumption based on adding a margin to expectations of interest rates at the time (which, in fairness, was probably too low) to one based on a weighted expected return of the Fund's asset holdings at that time (which, again with the benefit of hindsight, was probably too optimistic). As the tax rate assumed had not changed from 33%, the important after tax discount rate, applied in the contribution rate formula and which calculated the retained earnings of the NZSF, increased from 4.69 percent to 6.79 percent.

With retained earnings markedly higher over the entire projection, the contributions required, to meet the NZS funding logic upon which the contribution rate formula is based, were lower. This also meant that they switched to withdrawals a little earlier, and that withdrawals could be more generous when the stream of retained earnings was higher. Figure 18 illustrates all of these effects of higher retained earnings.

Also, even though higher retained earnings led to increased withdrawals, Figure 19 shows that this was not a one-to-one trade off, as the Fund balance did not decline to the same degree under the modelling change. This is mainly due to the retained earnings in each year being a product of the NZSF assets in that year multiplied by the after tax return rate, so that they are affected by the full change in this rate, while the effects on the capital withdrawals are calculated over a 40 year horizon.

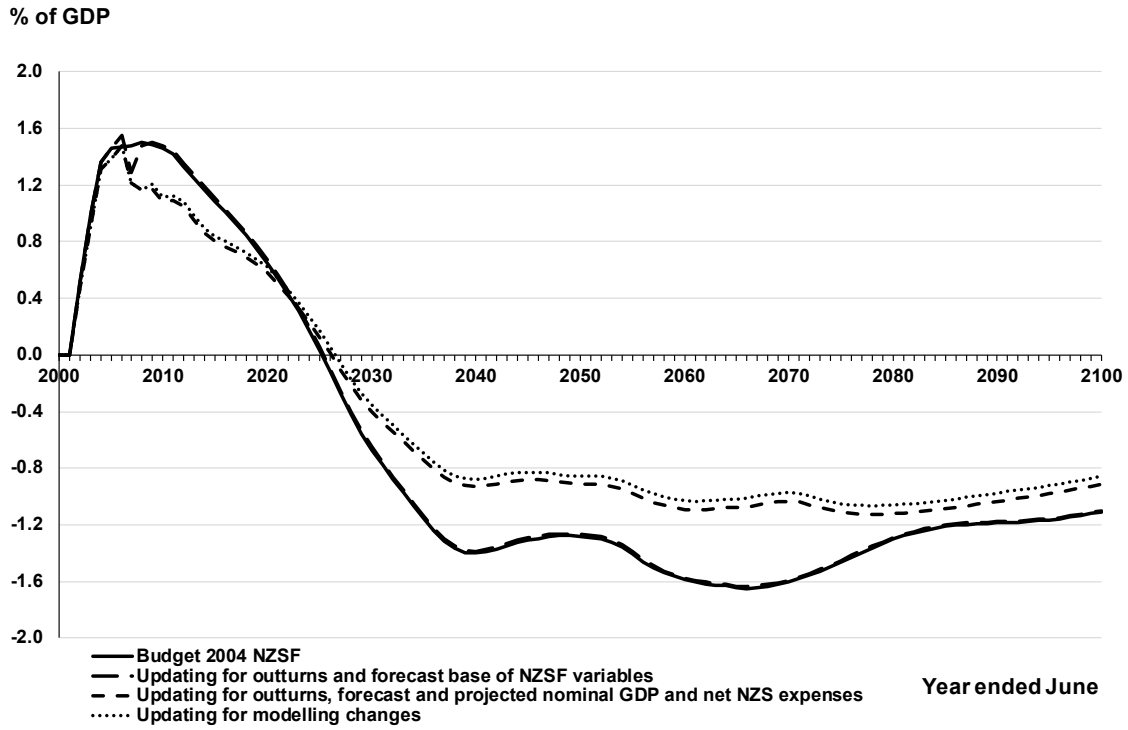
## 11.6 Budget 2004 to Budget 2008

Figures 20 and 21 show that updating for outturns and forecasts of NZSF variables between Budgets 2004 and 2008 had very little impact on the NZSF tracks. However, around the time of Budget 2007 the NZSF began providing forecasts to the Treasury for the ensuing five years. This meant there was at least enough change over these initial years to make the differences just discernible between these projections.

The modelling change was a reduction in the gross annual return rate assumed for the NZSF from 10.14 percent to 8.65 percent. The reason that this did not affect the NZSF tracks very much this time was because the assumed tax rate was also lowered from 33 percent to 24 percent, and as a result the after tax return rate only reduced from 6.79 percent to 6.57 percent. These return and tax assumption changes arose because the Treasury was receiving forecasts from the NZSF by this time. Because the Fund

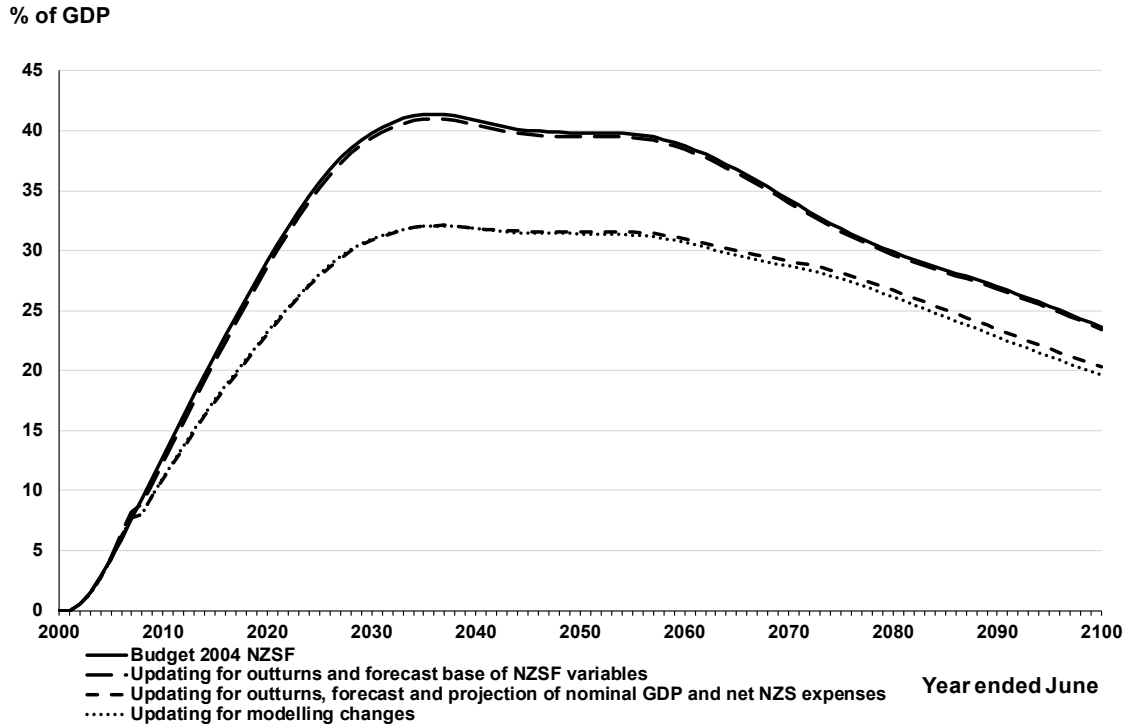
analysts knew the asset base, investment plans and average tax rates applying to their different holdings far better than the Treasury modellers did, it was decided to base the projected parameter values on the assumptions used over the later forecast years.

***Figure 20 – Updating contributions & withdrawals between Budgets 2004 & 2008***




Source: The Treasury

***Figure 21 – Updating NZSF closing balance between Budgets 2004 & 2008***




Source: The Treasury

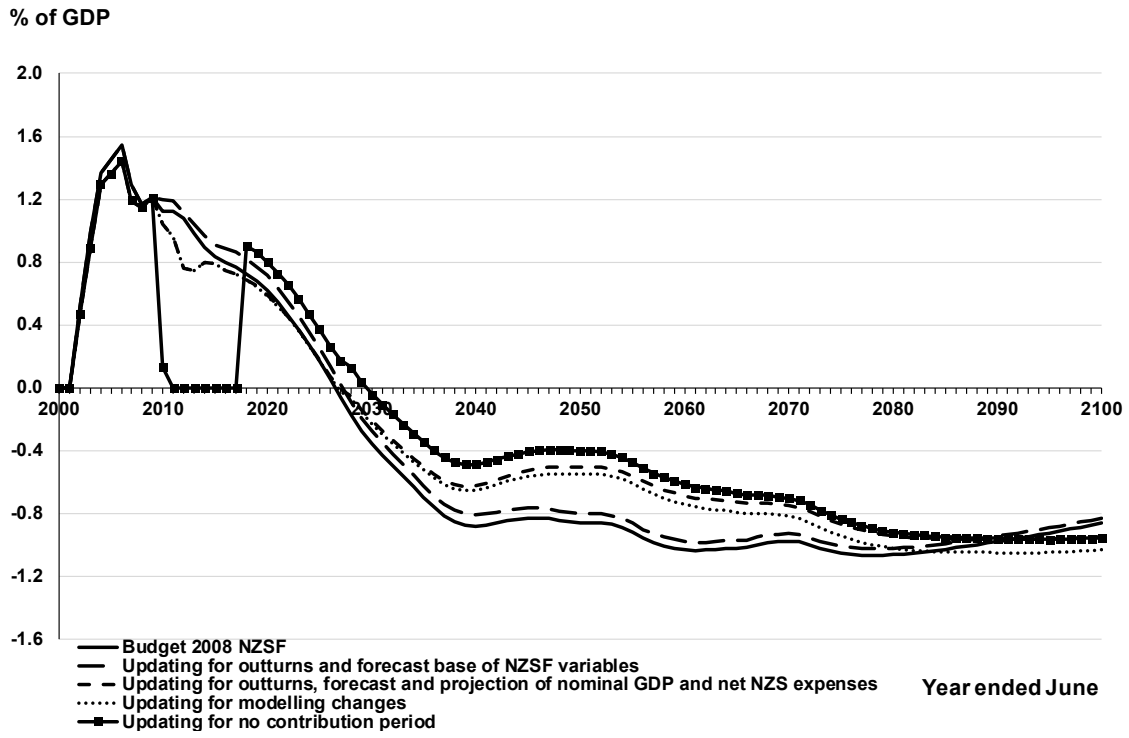
Between the projections of Budgets 2004 and 2008, it is very much the lowering of the net NZS to GDP track, described in Sections 11.1 and 11.2, that lead to the major changes in the two NZSF variable projections depicted.

## 11.7 Budget 2008 to Budget 2012

In analysing the transition from Budget 2008 to Budget 2012, an extra step is required. This is because at the time of Budget 2008 no break in contributions was envisioned, but as detailed in Section 2.2 such a break had been introduced and was forecast to continue for several years by the time of Budget 2012. In the transitions from Budget 2012 to Budget 2016 and then from that one to Budget 2020 this is not treated as a separate step, because it is present in all of those NZSF tracks and its effects are mixed between NZSF outturns and forecast base changes and even modelling changes as the rationale for restarting contributions altered over time.

This does require some adaption to the analysis technique, as, for example, some outturns of zero contributions had occurred by the time of Budget 2012. This step of the transition has been modelled as if the required contributions had been made as normal, in order to isolate the impact of the cessation of contributions into a final transition step. The earnings and tax forecasts supplied by the NZSF at Budget 2012 would likely have been a little different if they had been based on receiving contributions over the forecast years of Budget 2012, but these have just been used as they were supplied.

***Figure 22 – Updating contributions & withdrawals between Budgets 2008 & 2012***



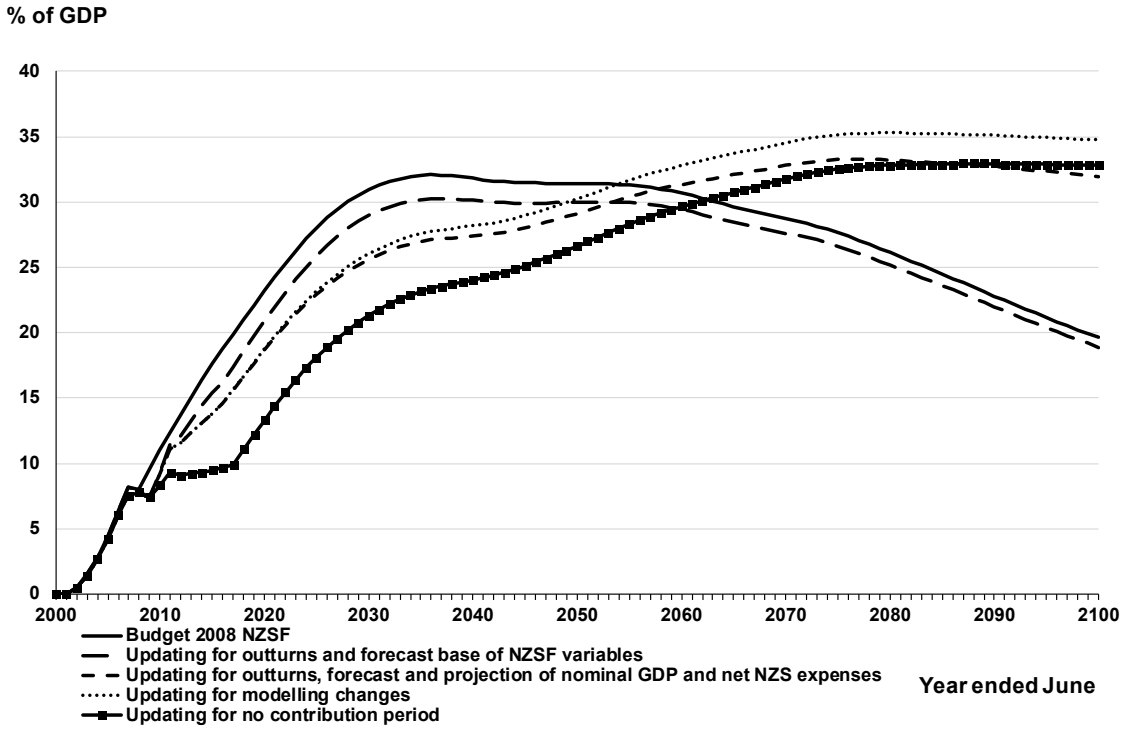

Source: The Treasury

Figures 22 and 23 indicate that updating for outturns and the forecast base of NZSF variables had more of an effect than in the previous two transitions examined, although this still led to relatively minor changes.

As illustrated in Section 11.1 and explained further in Sections 11.2, the update of the net NZS to GDP track did not reduce it as much as in the earlier updates analysed, but it did change its shape so that it continued to lift after 2070, rather than levelling out beyond this time, as in the Budget 2008 projection and the earlier ones too. The effect of this is most evident in Figure 23, where instead of the Fund balance declining from the middle of the 2030s, it now takes until the late 2080s to do so. With an ongoing rising profile of net NZS to GDP now occurring to beyond 2100, rather than its levelling out around the middle of the 2070s, the logic of the NZSF contribution rate formula requires it to keep building up assets to cover these higher future costs of NZS.

It also results in the track of contributions and withdrawals, as percentages of GDP, which was lowered for both contributions and also saw reductions in withdrawals up to the late 2090s, eventually cross below the Budget 2008 withdrawals line after this time. The contribution rate logic is reflecting that, with higher future costs of NZS relative to GDP, more tax smoothing is needed in the form of larger withdrawals from the Fund in these later years. This can be achieved because less was withdrawn in earlier years, allowing the NZSF to build up a greater accumulation of assets.

***Figure 23 – Updating NZSF closing balance between Budgets 2008 & 2012***




Source: The Treasury

The main modelling change was the introduction of modelling “Other movements in reserves”. These non-operating balance increases (and occasionally decreases) to the closing balance, which tend to be quite small for the NZSF, had not been projected out before the Budget 2012 model. The result was a small but growing increase in the Fund balance track, which allowed the withdrawals track to increase a little.

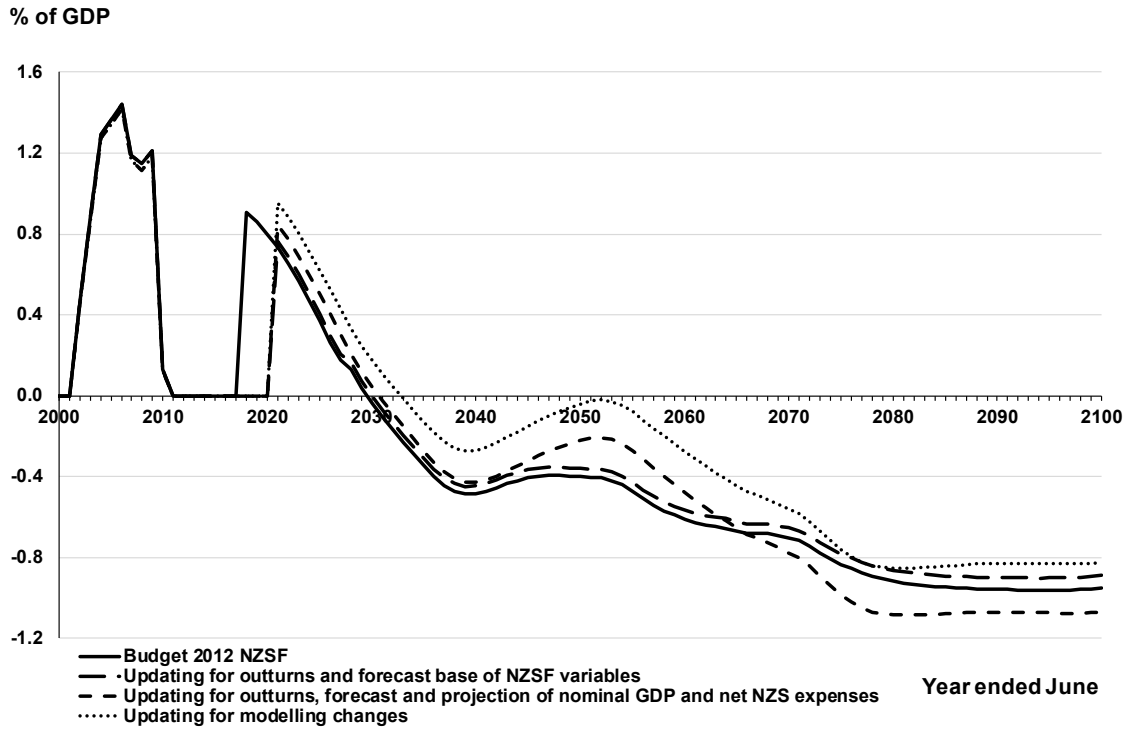
Possibly the most interesting aspect of the difference between the NZSF tracks for Budgets 2008 and 2012 is in the effect of the contribution break. A much reduced contribution of only $250 million in 2009/10 was followed by an expected seven years, in the Budget 2012 NZSF model, of zero contributions. This period is quite evident in both Figures 22 and 23, but it is the changes it causes once contributions resume that are informative. These begin in 2017/18 at a higher level than they were at even in the Budget 2008 track, take longer to shift to withdrawals and follow a lower track of withdrawals than all of the updated assumptions produced. However the gap for withdrawals does close over time with the track for Budget 2012 modelled without a contribution break, until it is almost imperceptible by 2100. Likewise, in Figure 23 the closing balance starts from a much lower position, but gradually closes the gap as less withdrawals are removed than had the contribution break not occurred.

One of the two things that stands out from this is how the logic of the contribution rate formula adjusts to such a break. Nothing has changed, in any year in which the contribution rate is calculated, regarding the aggregate amount of net NZS as a percentage of GDP that the NZSF needs to fund over the next 40 years. Consequently, if a break in contributions has lowered the Fund's asset base, it needs to take in more contributions and pay out less in withdrawals until it makes up this funding shortfall. This is achieved by raising the contribution rate calculated each year. The contribution break causes a shift in the timing of tax smoothing as, if current taxpayers do not contribute for some period, then taxpayers at the time of resumption need to contribute more and taxpayers further out in the future receive less for quite some time.

The other notable thing that Figure 23 illustrates is that the shift in the shape of the Fund's balance as a percentage of GDP has nothing to do with the contribution break, but rather is entirely due to the profile of net NZS to GDP continuing to rise rather than flatten out. It might have been tempting to think that several years of not contributing may have been behind this change, but for reasons that have been explained the contribution rate formula adjusts for this over time. However, that same formula is recalculated every year and if it is based on a different profile of net NZS to GDP then that is what will influence it to build up or reduce assets at a different rate.

## 11.8 Budget 2012 to Budget 2016

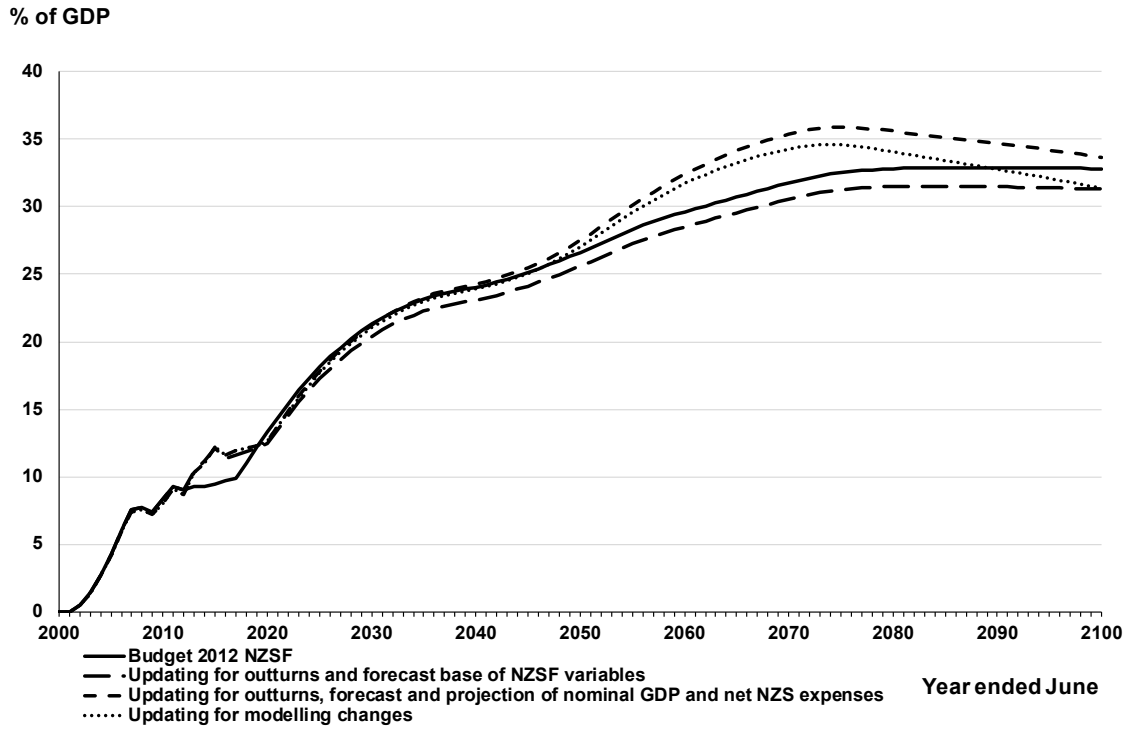
***Figure 24 – Updating contributions & withdrawals between Budgets 2012 & 2016***




Source: The Treasury

The NZSF tracks of both Budgets 2012 and 2016 incorporated the contribution break, although it was three years longer in the later projection. As the break fell entirely within the Budget 2012 forecast horizon, these differences have been included in that first updating step. Their impact was partially negated by much stronger earnings between 2012/13 and 2014/15 than had been forecast at Budget 2012. This meant that the closing balance was still quite close to that of the Budget 2012 track by the time the contribution break was expected to finish in 2019/20. As a result this updating step did not significantly alter either of the NZSF variable tracks illustrated in Figures 24 and 25.

***Figure 25 – Updating NZSF closing balance between Budgets 2012 & 2016***




Source: The Treasury

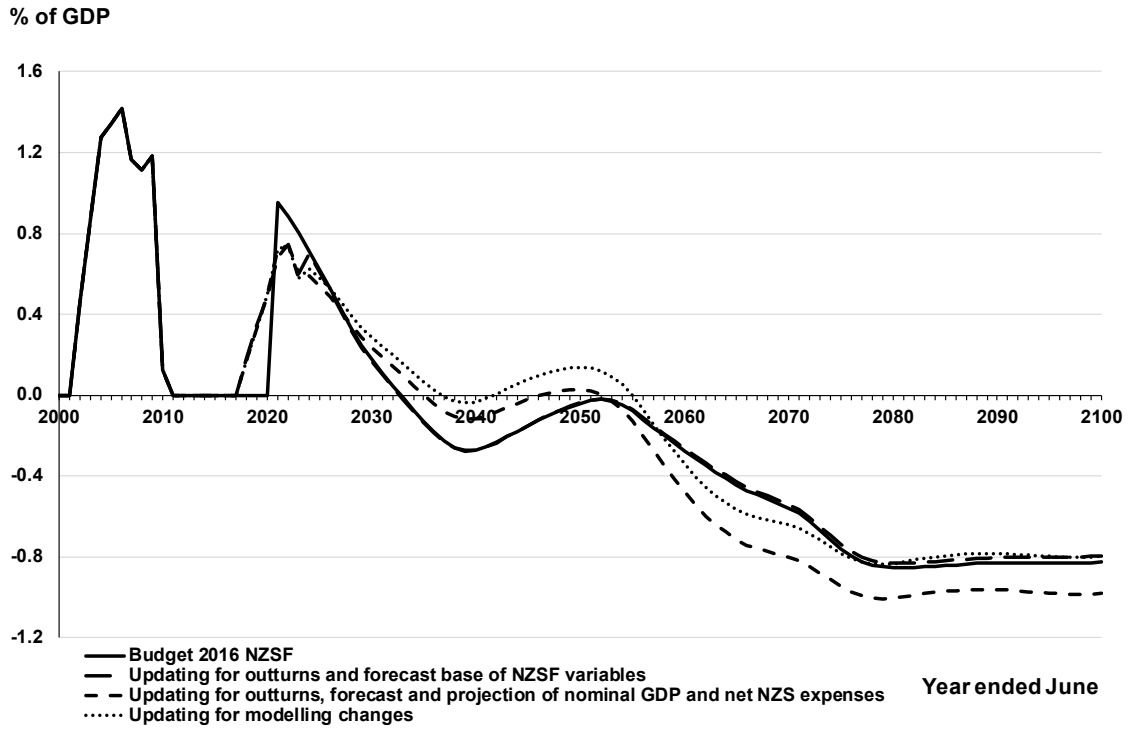
As was outlined in Section 11.2, the change in the net NZS to GDP track between Budgets 2016 and 2020 was the least of any of the transitions examined. However, beyond 2060 the Budget 2016 track did rise above the Budget 2012 one. This caused, for reasons that by now are hopefully becoming quite familiar in respect to the way that the contribution rate formula works, withdrawals in earlier years to reduce and in later years to increase, and the closing balance to GDP track to lift to a higher level.

The main modelling change that occurred between Budgets 2012 and 2016 once again involved the projected return rate. At Budget 2013 this had been linked to a projection of the government 10-year bond rate, plus an additional margin of return to reflect the NZSF's investment strategies. A key driver of this change was lingering low interest rates following the GFC, which suggested that using a constant projected gross return rate of 8.65 percent might be too optimistic, at least in the early years of projections. Even though the return rate was stabilised early in the projection, this was at a level so that the important after tax return rate was 0.72 percentage points lower than in the Budget 2012 projection. This was the opposite of what had occurred in the modelling change between Budgets 2000 and 2004, although the increase in the return rate then was greater than the decrease in this transition. Consequently, for the reverse of the reasons explained for that change, contributions lifted, withdrawals reduced, and the closing balance was reduced, to the point where in the late 2080s it actually dropped below the levels of GDP attained by the Budget 2012 projection in these years.

## 11.9 Budget 2016 to Budget 2020

The Labour-led coalition government restarted contributions to the NZSF, starting with $500 million in 2017/18 and then $1 billion and $1.46 billion in the following two years. These amounts were less than those calculated by the legislated formula, and actually strong earnings outturns up to 2018/19 did more to lift the closing balance. However, a forecast loss in 2019/20 due to the impact of the Covid pandemic on financial markets undid some of these gains relative to the Budget 2016 track (although we now know that that loss did not actually eventuate for the NZSF). As a result, by the time the Budget 2020 forecast ended in 2023/24, updating for changes in outturns and forecasts had only lifted the closing balance by about 0.3 percentage points of GDP. As Figures 26 and 27 display, this step had only a small effect on the tracks of the NZSF variables.

***Figure 26 – Updating contributions & withdrawals between Budgets 2016 & 2020***

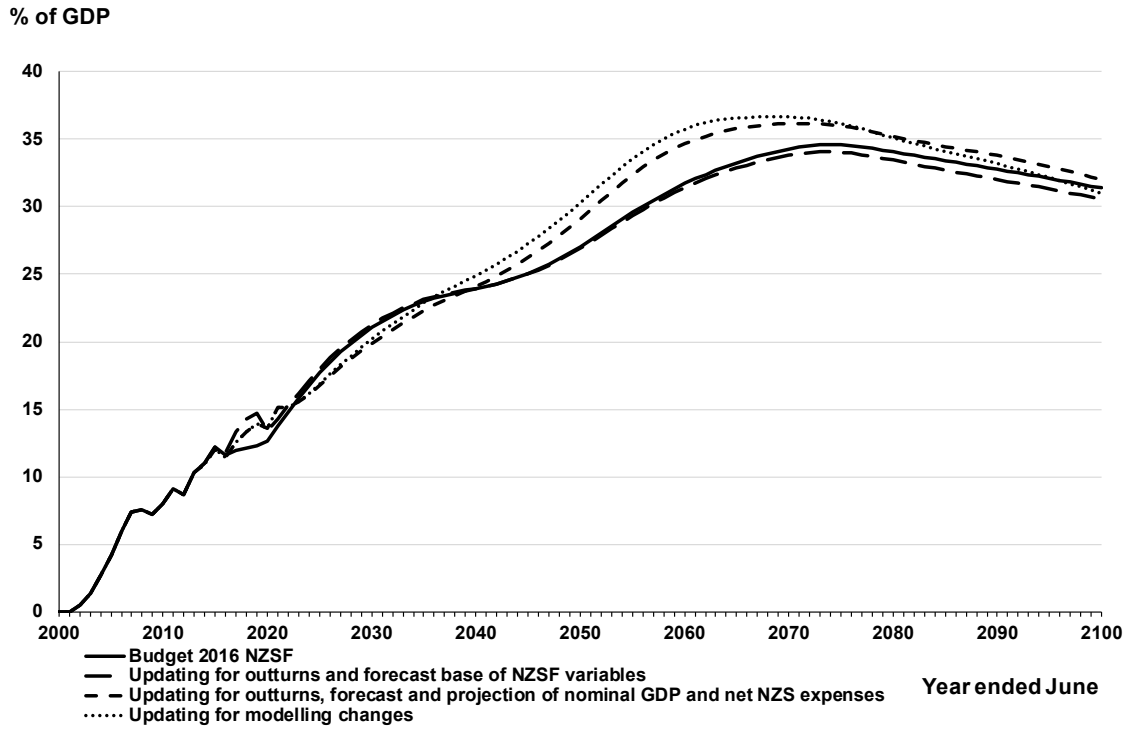



Source: The Treasury

Section 11.1 shows that the Budget 2020 net NZS to GDP projection is lower than that of Budget 2016 although it largely closes the gap by 2070, just to then fall back below it again in later years. This pattern was explained in Section 11.2. The update of the net NZS to GDP track leads to slightly higher contributions and lower withdrawals over the earlier years of the projection, when the Budget 2020 contribution rate is rising on a steeper incline than that of Budget 2016, as the net NZS to GDP gap closes. However, given the 40 year horizon of the contribution rate formula, around 2050 the Budget 2020 withdrawals become larger, as a percentage of GDP, than those of the Budget 2016 track, which is well before the two net NZS to GDP tracks move apart again.

Figure 27 illustrates that this updating step lifts the closing balance to GDP track above that of Budget 2016, until the difference is greatest at around 2060. After that the gap reduces, as the overall amount of net NZS to GDP to be funded over the next 40 years reduces with each passing year, relative to the Budget 2016 track. By 2100 the NZSF closing balance to GDP is only marginally above that of the Budget 2016 projection.

***Figure 27 – Updating NZSF closing balance between Budgets 2016 & 2020***




Source: The Treasury

Perhaps somewhat ironically, the modelling change introduced at Budget 2020 was basically a reversal of that which had occurred between Budgets 2012 and 2016. With increasingly low forecasts of interest rates in recent years, the drop in the return rate in moving from the forecasts of the NZSF analysts to the projected assumption was getting quite large. It also meant that using the interest rate, even increased by an assumption for an additional margin of return, produced a return rate track that was quite low for a number of years and did not reflect the Fund's historical performance. Hence it was decided to return to basing the projected return rate on that used by the NZSF analysts in the later years of their forecasts, although the "value add" margin that they apply was gradually reduced over 40 years to nothing. However, this change was introduced due to low interest rate forecasts in recent years leading up to Budget 2020, and those of Budget 2016 had still been high enough that its projected return rates were higher by 2027/28 than this modelling change produced. Furthermore, as the "value add" margin decreased over 40 years while the Budget 2016 return rates had stabilised, the margin between the after tax return rates widened going out to 2063/64, when it stabilised at 0.68 percentage points. Consequently, the effects of the projected return rates of Budget 2016 being replaced were like those explained for the modelling change between Budgets 2012 and 2016, rather than between Budgets 2000 and 2004, because effectively the projected return rate had been lowered. However they were more muted than those between Budgets 2012 and 2016, as the difference was not constant but grew over time and did not get quite as large. Figure 26 shows the increased contributions and decreased withdrawals that this final updating step produced. Because the projected rate change was gradual at first, and grew over time, rather than constant as it had been between Budgets 2012 and 2016, the impact on lifting contributions and reducing withdrawals was initially greater than on reducing returns, so that it pushes the closing balance to GDP track higher. However, in later years, as a stable difference dominates, this trend is reversed and from the late 2070s the closing balance to GDP decreases to be close to the Budget 2016 level by 2100.

## 11.10 Key messages from the Budget changes

Over the twenty years of NZSF Budget projections analysed, the future profile of the Fund, both in terms of its tax smoothing role and the size of its assets, has changed noticeably from those envisioned when the NZSF was being planned. This analysis has shown that, while things like modelling changes and contribution breaks have definitely played a role in these changes, the most significant influence has been the cost of the public pension relative to the size of the economy. Changes to outturns, forecasts and particularly projections of net NZS to GDP have had the biggest effect on projections of the amount and timing of tax smoothing and the size and profile of NZSF assets.

This should not really come as a surprise, especially if the logic of the contribution rate formula is understood. In every year that the contribution rate is calculated it takes into account the next 40 years of the net NZS to GDP track. The contribution rate's path, relative to that of net NZS to GDP, determines the size and timing of contributions and withdrawals, and these define the tax smoothing profile over that 40 year period.

Furthermore, the contribution rate formula is based around fully funding the total of net NZS, as a percentage of GDP, over the next 40 years. As this increases or decreases, so does, without major changes in return rate expectations, the level of assets that the Fund needs to build up, rise or fall. This has been observed in this analysis, both in the decrease in the NZSF's size relative to GDP, especially out to around 2050, and also in changing its shape, as the later projections of net NZS to GDP continued to rise, rather than flatten as in the earlier projections. As depicted in Figure 17, the projection of the Fund's closing balance to GDP at Budget 2020, while only reaching about half the level of that of the Budget 2000 track in the middle of the 2040s, has risen above it by 2100.

None of the above is intended to downplay the effects of the contribution break, or how future results might be improved if some of the more optimistic past projections of the return rate do eventuate over the long term. The contribution break definitely affected the pattern of tax smoothing and the build-up of Fund assets, but the contribution rate formula adjusts for this over time. It increases contributions when they restart and lowers initial withdrawals, so that the Fund assets are still enough to meet the formula's 40 year funding requirement. The projected return rates probably are conservative, particular given the Fund's performance over its history, but it is preferable to plan in this way and be able to adjust contributions down and withdrawals up if better outcomes occur, rather than vice versa if returns turn out to be lower than expected.

However, the general pattern of lowering the net NZS to GDP projection is important, not just for how it effects the NZSF, but also for the messages it sends. Usually it has occurred due to actual and expected strengthening of labour force growth, which lifted GDP but not NZS costs. The message to politicians, policy makers, media and the public is that growing the economy, through more people participating in the labour force, makes providing not only NZS, but for any future expenses, more affordable.

This does not mean that funding the public pension in the future is no longer an issue, as there is little doubt about the ongoing ageing of New Zealand's population structure, which is already underway. However, "growing the economic pie" can be a means of lowering the disparity between what current taxpayers are funding and what future generations of taxpayers are expected to face. If it can be achieved, then the amount of tax smoothing between generations should be able to be reduced.

# 12 Conclusion

The primary role of the New Zealand Superannuation Fund (NZSF) is to provide a means of tax smoothing between current and future taxpayers. Contributions from tax revenue into this financial asset have been made for about half of the years since 2002 and are currently expected to continue for most of the next three decades. These are invested in order to grow, so that, at some future time, withdrawals can be taken from the NZSF on an ongoing basis to assist with funding the public pension, New Zealand Superannuation (NZS). Relative to the economy's size, as measured by nominal gross domestic product (GDP), NZS expenses are expected to significantly rise over coming decades. This is because New Zealand's ageing population structure means that the "65 years and above" age group, which is the demographic driver of NZS expenditure, is growing at a faster rate than the labour force, which is GDP's demographic driver. This is projected to continue over at least the next century, and likely beyond this.

The entire logic of the NZSF's projected outcomes is determined by its contribution rate formula, which is defined in legislation. The most significant factors in determining projected outcomes for the NZSF are the 40 year time horizon used for tax smoothing and the projections of the future paths of aggregate net (of tax) NZS expenditure and nominal GDP and the relationship between them. As a 40 year horizon has always been applied, it is changes in the net NZS to GDP projections that have had the most impact in altering the paths of the NZSF's parameters, such as the contributions and withdrawals and the closing balance to GDP, over ongoing projections.

The contribution rate formula sets, as a percentage of GDP, the amount that taxpayers need to provide in order to fund the cost of aggregate net NZS over the next 40 years. Unless the cost of NZS to GDP consistently falls for an extended period, the logic of the formula means that the contribution rate will, over time, move towards the level of net NZS to GDP in an asymptotic manner. This means that it will continue to play a tax smoothing role, although the withdrawals from the Fund will get consistently smaller, as a percentage of GDP, over time. Under these conditions the assets of the NZSF will also decline, as a percentage of GDP, although not in nominal dollar terms.

The statements in the last paragraph refer to outcomes driven by the mathematical logic of the NZSF. It may be that, sometime in the future, decisions are made by future governments that result in different outcomes for the Fund, which have been sanctioned by the electorate. That is for the voters, politicians and taxpayers of the future to decide.

However, hopefully when they, or their current day contemporaries, have these discussions and debates about the NZSF, they do so with knowledge of:

- why the NZSF was established
- its history and milestones
- how the logic driving it works, and the reasons why it is done in this manner
- how and why the projections of its parameters have changed over the years, and
- how it is likely to progress with no change to the policy settings around NZS.

Adding to that knowledge has been the main goal of this paper.

# References


Frances, J., and McCulloch, B. (2001) “Financing New Zealand Superannuation” New Zealand Treasury Working Paper https://treasury.govt.nz/publications/wp/financing-new-zealand-superannuation-wp-01-20

Frances, J., and McCulloch, B. (2003) “Governance of Public Pension Funds: New Zealand Superannuation Fund” Paper for the 2nd Public Pension Fund Management Conference of the World Bank https://www.nzsuperfund.nz/assets/documents-sys/Governance-of-Public-Pension-Funds-NZSF-2003.pdf

Littlewood, M. (2013) “New Zealand Superannuation’s real costs – looking to 2060” Paper in the *Pensions briefing* series published by the Retirement Policy and Research Centre of the University of Auckland’s Business School https://cdn.auckland.ac.nz/assets/business/about/our-research/research-institutes-and-centres/RPRC/PensionBriefing/2013-6%20New%20Zealand%20Superannuation's%20real%20costs%20-%20looking%20to%202060.pdf

Mackenzie, D. (2017) “Govt resumes payments to NZ super fund today” Article on the Otago Daily Times website https://www.odt.co.nz/business/govt-resumes-payments-nz-super-fund-today

McCulloch, B. (2003) “Geometric Return and Portfolio Analysis” New Zealand Treasury Working Paper https://treasury.govt.nz/publications/wp/geometric-return-and-portfolio-analysis-wp-03-28

New Zealand Government (2009) “New Zealand Super Fund – fact sheet” Information page published on the New Zealand government’s Beehive website https://www.beehive.govt.nz/release/new-zealand-super-fund-fact-sheet

New Zealand Government (2019) “Building a productive nation: Filling the venture capital gap” Press release issued alongside the Budget 2019 publication https://www.beehive.govt.nz/release/building-productive-nation

New Zealand Legislation (2018) “New Zealand Superannuation and Retirement Act 2001” Reprint as at 1 April 2018 of New Zealand legislation http://www.legislation.govt.nz/act/public/2001/0084/126.0/DLM113924.html

NZ Super Fund (2018) “Submissions on the Future of Tax: Submissions Background Paper” Submission to the Tax Working Group by the NZ Super Fund https://taxworkinggroup.govt.nz/sites/default/files/2018-09/twg-subm-3983321-nz-superannuation-fund.pdf

NZ Super Fund (2020a) “NZ Super Fund Explained: The NZ Super Fund Story” Information page on the website of the NZ Super Fund, the public agency that manages, invests and administers the New Zealand Superannuation Fund https://nzsuperfund.nz/nz-super-fund-explained/nz-super-fund-story/our-story/

NZ Super Fund (2020b) “NZ Super Fund Explained: Governance” Information page on the NZ Super Fund website https://nzsuperfund.nz/nz-super-fund-explained/governance/

NZ Super Fund (2020c) “Performance: Monthly Returns” Page on the NZ Super Fund website providing data on the NZSF’s performance against various benchmarks https://nzsuperfund.nz/performance/investment/monthly-returns/

NZ Super Fund (2020d) “Statement of Performance Expectations 2020-21: Statement of Estimated Fund Performance” Annual report on the NZ Super Fund website providing information about the NZSF’s own expectation for their performance https://nzsuperfund.nz/publications/statement-intent/

New Zealand Treasury (2000a) “Pre-funding New Zealand Superannuation: Funding Arrangements” Treasury Report to the Cabinet Policy Committee https://treasury.govt.nz/publications/information-release/pre-funding-nzs-information-releases

New Zealand Treasury (2000b) “Pre-funding New Zealand Superannuation: (Working Document)” A compilation paper of a series of Treasury Reports on the details of the establishment of the Fund and its fiscal implications and affordability https://treasury.govt.nz/publications/information-release/pre-funding-nzs-information-releases

New Zealand Treasury (2013) “Fiscal Strategy Report – Long-term Fiscal Objectives – Box 2 – Contributions to the New Zealand Superannuation: Fund” New Zealand Government Fiscal Strategy Report https://treasury.govt.nz/publications/fiscal-strategy-report/fiscal-strategy-report-2013-html#child-1

New Zealand Treasury (2019) “Labour productivity growth in the Treasury’s fiscal projections” Background paper on the Treasury website https://www.treasury.govt.nz/publications/background/labour-productivity-growth-in-treasurys-fiscal-projections

New Zealand Treasury (2020a) “Half Year Economic and Fiscal Update 2020 – Forecast Financial Statements – Notes to the Forecast Financial Statements – Note 11: NZ Superannuation Fund https://www.treasury.govt.nz/system/files/2020-12/hyefu20.pdf

New Zealand Treasury (2020b) “Budget Economic and Fiscal Update 2020 – Forecast Financial Statements – Government Reporting Entity as at 25 April 2020” New Zealand Government Budget Economic and Fiscal Update https://treasury.govt.nz/publications/efu/budget-economic-and-fiscal-update-2020-html#child-28

New Zealand Treasury (2020c) “Archive of New Zealand Superannuation Fund (NZSF) Contribution Rate Models” Archive of New Zealand Superannuation Fund models on the New Zealand Treasury website https://treasury.govt.nz/publications/information-release/archive-new-zealand-superannuation-fund-nzsf-contribution-rate-models

New Zealand Treasury (2020d) “New Zealand Superannuation Fund (NZSF) Model Guide” Manual explaining the logic and workings of the New Zealand Superannuation Fund model on the New Zealand Treasury website https://www.treasury.govt.nz/system/files/2020-09/nzsf-model-guide-sep20.pdf

Preston, D. (2008) “Retirement Income in New Zealand: the historical context” Paper commissioned by the Retirement Commission (now the Commission for Financial Capability https://cffc-assets-prod.s3.ap-southeast-2.amazonaws.com/public/Uploads/Retirement-Income-Policy-Review/Background-papers/History-and-trends/27b4c9b6d8/RI-Review-BP-Retirement-Income-History-2008.pdf

Reserve Bank of New Zealand (2021) “KiwiSaver ($m) – T43” Statistics about KiwiSaver assets provided on the Reserve Bank website https://www.rbnz.govt.nz/statistics/t43

Small, V. (2017) “Labour’s first move will be to resume Cullen fund payments, Little promises” Article on the Stuff news website https://www.stuff.co.nz/national/politics/94858605/labours-first-move-will-be-to-resume-cullen-fund-payments-little-promises

Statistics New Zealand (2017), “Life Expectancy” Information page on the Stats NZ website https://www.stats.govt.nz/topics/life-expectancy

Statistics New Zealand (2018), “Parenting and fertility trends in New Zealand: 2018” Report on the Stats NZ website https://www.stats.govt.nz/reports/parenting-and-fertility-trends-in-new-zealand-2018

Statistics New Zealand (2020a), “National Population Projections: 2020(base)-2073” Information page on the Stats NZ website https://www.stats.govt.nz/information-releases/national-population-projections-2020base2073

Statistics New Zealand (2020b), “Births and deaths: Year ended December 2019” Information page on the Stats NZ website https://www.stats.govt.nz/information-releases/births-and-deaths-year-ended-december-2019

Statistics New Zealand (2021), “Annual net migration down in 2020” Information page on the Stats NZ website https://www.stats.govt.nz/news/annual-net-migration-down-in-2020

Todd, J. (2008) “Superannuation Task Forces in the 1990s and The Political Accord” Report published by the Retirement Policy and Research Centre, University of Auckland http://docs.business.auckland.ac.nz/Doc/Paper-PensionMonograph-Superannuation-task-forces-in-the-1990s-and-the-political-accord.pdf

Tolerton, J. (2018) “Contraception and sterilisation – The pill” Article from Te Ara, The Encyclopedia of New Zealand https://teara.govt.nz/en/diagram/26984/the-pill-timeline

# Appendix One – Explanation of the contribution rate formula

The legal wording in Section 43 of the New Zealand Superannuation and Retirement Act (2001), which explains how the required annual capital contribution to the NZSF is calculated, is quite lengthy, and possibly a little difficult to follow. What it actually means in practice is as follows.

The contribution rate, in the year that it is calculated for, is the combination, as a percentage of nominal gross domestic product (GDP), of the capital contribution (or, in later years, withdrawal) and aggregate net (of tax) NZS expenditure.

Of more relevance to the tax smoothing role of the NZSF is this interpretation of the contribution rate:

> *If this percentage of GDP was provided by taxpayers in each year of the funding horizon, with, in each year, any amount remaining after paying for aggregate net NZS going to the NZSF and any deficit taken out of the NZSF, then this would cover the cost of aggregate net NZS over this period. However, at the end of this funding horizon period, the funds of the NZSF would be depleted*.

A numerical example may help to make the above interpretation clearer.

Suppose in a particular year, call it Year 1, the contribution rate is calculated to be 5.00 percent and in this year net NZS to GDP is 4.60 percent. This means that in this year the Fund will receive a capital contribution of (5.00 – 4.60) = 0.40 percent of GDP.

Net NZS to GDP gradually rises over the next 40 years, reaching 5 percent in Year 6 and 7 percent in Year 40, the final year of the 40 year funding horizon. If taxpayers provide 5 percent of GDP to the NZSF in each of these 40 years, then up until Year 6 the Fund receives capital contributions, due to net NZS to GDP being under 5 percent. From Year 7 to Year 40, net NZS to GDP is above 5 percent. Withdrawals are taken out of the NZSF in these years, in order to make up the difference between whatever aggregate net NZS is equal to as percentage of GDP in the year and 5 percent of GDP.

Taxpayers across the full 40 year horizon contribute 5 percent of GDP in each year to pay for aggregate net NZS expenditure, meaning taxpayers in the early years pay more than the cost of net NZS, while those in the later years do not fully fund net NZS. The tax smoothing function of the Fund relates to how this process allows current taxpayers to assist future generations of taxpayers, because an ageing population structure will drive up the cost of the public pension as a percentage of GDP.

However, it is not obvious why the value of the contribution rate keeps rising over the years in the NZSF model, given that the legislated formula is apparently supposed to produce a flat percentage of GDP level of funding of aggregate net NZS.

There are a few reasons for this. Foremost among these is that, if this percentage of GDP were retained as the contribution rate value in every year, then the funds of the NZSF would be depleted at the end of the 40 year horizon. The Fund is not designed to be depleted in 40 years' time, but rather is intended to act as a tax smoothing vehicle for considerably longer than that. Consequently the contribution rate is recalculated

each year, and because the aggregate net NZS expenditure is projected to continue to rise as a percentage of GDP over the next century (and likely beyond that too), the recalculated value of the contribution rate also keeps rising.

This does not prevent the NZSF performing a tax smoothing role, because the contribution rate does not rise at the same rate as net NZS to GDP does. Hence the lines still cross at some future point, after which withdrawals from the Fund proceed.

The mathematical interpretation of the contribution rate formula is derived by solving the equation shown immediately below. More information about this equation and how it is derived can be found in Frances and McCulloch (2001).

$$E_0\left[B_{j-1}\prod_{t=1}^{H}(1+r_{j+t-1})+\sum_{t=1}^{H}k_j\,G_{j+t-1}(1+m_{j+t-1})\prod_{i=t+1}^{H}(1+r_{j+i-1})\right.$$
$$\left.-\sum_{t=1}^{H}P_{j+t-1}\,(1+f_{j+t-1})\prod_{i=t+1}^{H}(1+r_{j+i-1})\right]=0$$

where:

$E_0[\ldots]$ = expected value given information available at the beginning of year j

$B_{j-1}$ = closing balance of the NZSF in year j-1, which equals opening balance in year j

$P_t$ = aggregate net (of tax) New Zealand Superannuation (NZS) expenses in year t

$G_t$ = nominal GDP for year t

H = time horizon for the calculation (while it can be varied, it has always been 40 years)

$k_j$ = contribution rate as a proportion of nominal gross domestic product (GDP) in year j

$r_t$ = annual after-tax rate of return on the NZSF in year t

$m_t$ = annualised after-tax return on the NZSF in year t to reflect the monthly pattern in which capital contributions are received by the NZSF during the year

$f_t$ = annualised after-tax return on the NZSF in year t to reflect the fact that NZS entitlements are paid to superannuitant recipients in fortnightly instalments.

In deriving the solution for the contribution rate, kj, in a given year *j* the following logic will drop the expected value notation, E[…]. However, it should always be appreciated that the calculations are forward looking, based on forecasts and projections of the NZSF balance, GDP and aggregate net NZS expenditure, rather than known values.

Rearranging the smoothing equation that equates to zero gives:

$$\sum_{t=1}^{H}k_j\,G_{j+t-1}(1+m_{j+t-1})\prod_{i=t+1}^{H}(1+r_{j+i-1})$$
$$=\sum_{t=1}^{H}P_{j+t-1}\,(1+f_{j+t-1})\prod_{i=t+1}^{H}(1+r_{j+i-1})-B_{j-1}\prod_{t=1}^{H}(1+r_{j+t-1})$$

As kj is not changing as *t* changes in this formula it can be taken outside the term on the left hand side of this equation and then the right hand side of the equation can be divided by the remaining multiplier term to give:

$$k_j = \frac{\sum_{t=1}^{H} P_{j+t-1}\left(1+f_{j+t-1}\right)\prod_{i=t+1}^{H}\left(1+r_{j+i-1}\right) - B_{j-1}\prod_{t=1}^{H}\left(1+r_{j+t-1}\right)}{\sum_{t=1}^{H} G_{j+t-1}\left(1+m_{j+t-1}\right)\prod_{i=t+1}^{H}\left(1+r_{j+i-1}\right)}$$

This is the formula that calculates the contribution rate in any year. It lies at the heart of all calculations in the NZSF model.

The contribution rate formula involves the:

- two key input tracks into the model, that of forecast and projected fiscal year values of nominal GDP and aggregate net NZS expenditure
- projected value of the NZSF at the time that the calculation is done, and
- after-tax return rates on all of these components in each year of the funding horizon that stretches out from the calculation year.

$$\sum_{t=1}^{H} P_{j+t-1}\left(1+f_{j+t-1}\right)\prod_{i=t+1}^{H}\left(1+r_{j+i-1}\right)$$

The term shown above is the summation, over all of the years in the funding horizon, of the annual aggregate net NZS expense amounts, with each multiplied by the after-tax return rates on it over the remaining years of the funding horizon. Depending on when each aggregate net NZS expenditure amount occurs in the funding horizon, it has a certain number of years remaining in which to generate returns.

In the year in which each aggregate net NZS expenditure amount occurs, because superannuitants receive NZS on a fortnightly basis, the in-year return generated is calculated via an annualised return rate that reflects this fortnightly timing. Appendix Two has more detail about this. It suffices here to state that the first fortnightly payment of the year has the entire rest of that year to generate a return, one made halfway through the year only has the remaining half of the year to do this, and the last fortnightly payment of the year has no time left in that year. The term $P_{j+t-1}(1+f_{j+t-1})$ represents the value of the aggregate net NZS expenditure and the in-year return generated on it for each year *t* in the funding horizon.

For the remaining years of the funding horizon, for each aggregate net NZS expense amount, the full annual after-tax return rates apply. If that expense occurs in the calculation year, and a 40 year funding horizon is used, then there will be 39 years left for the expenditure and its in-year return to generate returns. If the expense occurs in the 25th year of this 40-year funding horizon, there will only be 15 years left to generate returns on it and its in-year return. If it occurs in the 40th year, there will be no years left in the funding horizon to generate returns on the expenditure and its in-year return.

The product expression $\prod_{i=t+1}^{H}\left(1+r_{j+i-1}\right)$ represents the cumulative return generated on each annual aggregate net NZS expense and its in-year return over the funding horizon. This multiplier starts in year *t+1* for a net NZS expense occurring in year *t* of a funding horizon of *H* years, and ends in year *H*. This means that no multiplier is

calculated for year *H*, as it would start in the year after which it was meant to finish. In effect the value of the multiplier is one in year *H*, the final year of the funding horizon.

When this is all accumulated via the summation term shown, the result is a single value. This value represents the sum of all of the annual aggregate net NZS expenditures, as well as the returns generated upon each one, over the funding horizon beginning in the year for which the contribution rate is calculated.

$$B_{j-1}\prod_{t=1}^{H}(1+r_{j+t-1})$$

The expression displayed above is the other term in the numerator of the formula. $B_{j-1}$ represents the NZSF closing balance in the year previous to the one for which the contribution rate is calculated ie, the value of the Fund at the beginning of the contribution rate calculation period. This has the entire funding horizon in which to generate returns, so the product expression covers from year $t = 1$ to $t = H$. The product expression has been described above and, when applied as a multiplier to the NZSF closing balance term, allows for the combination of this closing balance and the returns generated on it over the funding horizon to be calculated.

This expression is subtracted in the numerator from the one related to the aggregate net NZS expenditures and their returns. This is because, with respect to paying for net NZS expenditure over the funding horizon, which the contribution rate formula is based upon, the NZS expenses and their returns build up this cost, while the size of the NZSF and its returns reduce it.

$$\sum_{t=1}^{H} G_{j+t-1}\left(1+m_{j+t-1}\right)\prod_{i=t+1}^{H}\left(1+r_{j+i-1}\right)$$

The expression shown above occurs in the denominator of the formula. It is very similar to the one described for the aggregate net NZS expenditure terms over the funding horizon, except for two key differences. The first of these is that the aggregate net NZS expense values in each year, $P_{j+t-1}$, are replaced by nominal GDP values in these same years, $G_{j+t-1}$. The second difference is that the annualised return rates that reflect the fortnightly timing of the NZS payments, $f_{j+t-1}$, are replaced by annualised return rates, $m_{j+t-1}$, that reflect the monthly timing of the capital contributions to, and in later years withdrawals from, the NZSF.

The logic behind this expression is no different to that explained for the similar one that relates to the NZS expenses, except that the in-year returns are calculated on a monthly basis rather than a fortnightly one.

It may seem odd to think of GDP amounts generating returns, but that is not what this expression represents. This term is in the denominator because it was divided out from being a multiplier of the contribution rate $k_j$, in order to isolate $k_j$ as the subject of the formula. When multiplied by the constant value $k_j$, the annual GDP amounts in this expression give the total contributions by taxpayers to fund NZS in each year of the funding horizon. It is these funding amounts that are generating returns within the year in which they are paid and in all remaining years of the funding horizon, not GDP itself.

# Appendix Two – Derivation of the annualised return rates

As has been discussed in Appendix One, both the capital contributions to the NZSF (and, presumably, the withdrawals once they begin) and the aggregate net NZS expenses are made in instalment periods that are more frequent than once a year. They both used to be made on a fortnightly basis, but once the Labour-led coalition government reinstated contributions, after the previous government's contribution break from 2009/10 until 2016/17, the contributions were switched to a monthly basis.

This adjustment only takes place in the first year of the 40-year horizon of interest-generating potential for contributions and net NZS expenditures. It does not apply to the closing Fund balance from the previous year to that for which the contribution rate is being calculated. This is because this amount, which is the same as the opening Fund balance in the calculation year, has the whole of this first year to generate interest, just like in any other year of the 40-year horizon.

Imagine an amount *P* that is paid out in *N* equal instalments over the year. If the payment schedule was fortnightly, as with aggregate net NZS expenses, *N* would be 26[18] and if it was monthly, as is now the case for capital contributions, *N* would be 12.

If the annual return rate in the first year is denoted by *r*, then the return rate *s* that compounds over *N* periods in the year to give the same return must satisfy:

$$(1+s)^N = 1 + r \qquad \rightarrow \qquad 1 + s = (1+r)^{1/N}$$

If each payment is made at the end of the payment frequency period, ie, the end of each fortnight or the end of each month, then the first payment has *N*-1 periods to generate a return with an interest rate *s* in a compounding manner, the second payment has *N*-2 periods to do this, and so on until the (*N*-1)th payment has 1 period left in the year to generate a return and the *N*th payment has no time left to do this.

Furthermore, each payment will be of amount *P* divided by *N*, so at the end of the year the value of the series of payments will be:

$$\sum_{j=0}^{N-1} \frac{P}{N}(1+s)^j = P \sum_{j=0}^{N-1} \frac{1}{N}(1+s)^j$$

If *z* is the annual rate of return that would have produced the same value, at the end of the year, had the amount *P* been invested for the whole year, then:

$$P(1+z) = P\sum_{j=0}^{N-1}\frac{1}{N}(1+s)^j \rightarrow 1 + z = \sum_{j=0}^{N-1}\frac{1}{N}(1+s)^j \qquad \rightarrow 1 + z = \frac{1}{N}\sum_{j=0}^{N-1}(1+s)^j$$

[18] About once in every dozen years there will be 27 fortnightly payments in the year, if the payment schedule adhered to is strictly every fortnight. While that is accepted as a reality, it is not accounted for in this formula, and is likely to be a very small source of inaccuracy. Likewise, if monthly payments occur at the end of each month, there is a small inaccuracy caused by the fact that this does not result in twelve equally spaced payments over the year.

However, from above, $1 + s = (1+r)^{1/N}$ $(1 + s)^j = [(1+r)^{1/N}]^j$ $(1 + s)^j = (1+r)^{j/N}$

Therefore $1 + z = \frac{1}{N}\sum_{j=0}^{N-1}(1+r)^{\frac{j}{N}}$

The summation term here is:

$$\frac{1}{N} + \frac{1}{N}(1+r)^{\frac{1}{N}} + \frac{1}{N}(1+r)^{\frac{2}{N}} + \frac{1}{N}(1+r)^{\frac{3}{N}} + \cdots + \frac{1}{N}(1+r)^{\frac{N-2}{N}} + \frac{1}{N}(1+r)^{\frac{N-1}{N}}$$

This can further be expressed in the form:

$$\frac{1}{N} + \frac{1}{N}(1+r)^{\frac{1}{N}} + \frac{1}{N}\left[(1+r)^{\frac{1}{N}}\right]^2 + \frac{1}{N}\left[(1+r)^{\frac{1}{N}}\right]^3 + \ldots + \frac{1}{N}\left[(1+r)^{\frac{1}{N}}\right]^{N-2} + \frac{1}{N}\left[(1+r)^{\frac{1}{N}}\right]^{N-1}$$

This is a geometric series of $N$ terms, with constant multiplier $1/N$ and power term $(1+r)^{1/N}$ and so has a solution given by:

$$\frac{\frac{1}{N}\left[1-\left\{(1+r)^{\frac{1}{N}}\right\}^N\right]}{1-(1+r)^{\frac{1}{N}}} = \frac{\frac{1}{N}[1-(1+r)]}{1-(1+r)^{\frac{1}{N}}} = \frac{\frac{1}{N}(-r)}{1-(1+r)^{\frac{1}{N}}} = \frac{\frac{1}{N}(r)}{(1+r)^{\frac{1}{N}}-1} = \frac{r}{N\left[(1+r)^{\frac{1}{N}}-1\right]}$$

Consequently the relationship between $r$, the annual return rate in the first year, and its annualised equivalent on amounts spread out in equal instalments over this year, $z$, is:

$$z = \frac{r}{N\left[(1+r)^{\frac{1}{N}}-1\right]} \text{-1}$$

# Appendix Three – Simplification of the contribution rate formula

The mathematical version of the contribution rate formula, presented in Section 6, can be simplified if the annual after-tax rate of return on the NZSF is stable at a constant value. When this condition is met the formula can be expressed as:

$$k_j = \frac{\sum_{t=1}^{H} P_{j+t-1}(1+v)(1+\mu)^{-t} - B_{j-1}}{\sum_{t=1}^{H} G_{j+t-1}(1+w)(1+\mu)^{-t}}$$

*v* = stable value of annualised after-tax return on the NZSF that reflects that NZS payments are made in fortnightly instalments

*w* = stable value of annualised after-tax return on the NZSF that reflects that capital contributions are made in a sub-annual frequency of instalments, presently monthly

$\mu$ = stable value of annual after-tax rate of return on the NZSF

It is the normal nature of projections, more so than forecasts, to assume a long-run stable level or growth rate is achieved and maintained at some point in the projection horizon. The stable value chosen may reflect an historical average, or it may be based on some policy rationale. An example of the former is the annual labour productivity growth assumption of 1.0 percent, which is currently used in real GDP projections (although this was higher, at 1.2 percent, in the Budget 2020 NZSF model). An example of the latter is the 2 percent midpoint of the band set in remit for the Reserve Bank's Monetary Policy Committee at which to try and maintain Consumers Price Index annual inflation, on average, over the medium term horizon.

There are exceptions to achieving stability, such as Stats NZ's century-long demographic projections that are used in aggregate NZS expense projections in the NZSF model. In these the annual growth rate of the "65 years and older" age group, while changing by a smaller degree as the projections proceed, never stabilises.

In the projected tracks used in the NZSF model, it is assumed that the after-tax rate of return on the Fund eventually reaches a constant rate. However, with the modelling logic of gradually reducing the one percent reward for value-adding activities to zero, as described in Section 4.4, this can be more than 50 years into the projected years. Actual outturns of return rates on the Fund's assets will likely always change from year to year. However, shifting portfolio weightings, economic upturns and downturns, periods of strong and weak performance for stock markets etc. are not things that can be predicted over a long future time frame. Consequently eventually settling to a stable track, which assumes an economy growing on-trend and free of cycles, follows a middle-ground path that seeks to average out the high and low returns that will occur.

Now consider a year that has been reached in the projection horizon where the annual after-tax return rate on the NZSF's assets is assumed to have stabilised. Once this occurs the $r_{j+t-1}$ terms in the product components of the formula for the contribution rate kj will not be changing from year to year. Consequently they can be replaced by a constant after-tax rate of return term $\mu$.

The annualised return terms, for the capital contributions and aggregate net NZS expenses that are made in instalment periods that are more frequent than once a year, were derived in Appendix Two.

If the annual rate of return on which they are based has stabilised, then the annualised return term will have stabilised too. This means they too can be replaced, by *v* for the aggregate net NZS payments, which occur in fortnightly instalments, and *w* for the capital contributions to (or withdrawals from) the NZSF, which now occur monthly.

Then the equation derived in Appendix One for the contribution rate in year j, kj, becomes:

$$k_j = \frac{\sum_{t=1}^{H} P_{j+t-1}\,(1+v)\prod_{i=t+1}^{H}(1+\mu) - B_{j-1}\prod_{t=1}^{H}(1+\mu)}{\sum_{t=1}^{H} G_{j+t-1}\,(1+w)\prod_{i=t+1}^{H}(1+\mu)}$$

Now consider the expressions $\prod_{t=1}^{H}(1+\mu)$ and $\prod_{i=t+1}^{H}(1+\mu)$.

The first of these is simply $(1+\mu)^H$, while the second depends on the value of *t* and contains all the terms in the first expression except for the first *t* of them. For example, if *t*=4, the second expression equates to $(1+\mu)^{H-4}$, which, using the rules of power terms, could be written as $(1+\mu)^H(1+\mu)^{-4}$. Using this logic, for any value of *t*, the expression $\prod_{i=t+1}^{H}(1+\mu)$ can be written $(1+\mu)^H(1+\mu)^{-t}$ and so the equation above can be written:

$$k_j = \frac{\sum_{t=1}^{H} P_{j+t-1}\,(1+v)(1+\mu)^H(1+\mu)^{-t} - B_{j-1}(1+\mu)^H}{\sum_{t=1}^{H} G_{j+t-1}\,(1+w)(1+\mu)^H(1+\mu)^{-t}}$$

Dividing through top and bottom by the term $(1+\mu)^H$ can further simplify this to:

$$k_j = \frac{\sum_{t=1}^{H} P_{j+t-1}\,(1+v)(1+\mu)^{-t} - B_{j-1}}{\sum_{t=1}^{H} G_{j+t-1}\,(1+w)(1+\mu)^{-t}}$$

This is the simplified expression for the NZSF contribution rate formula that applies once the annual after-tax return rate for the Fund has been assumed to stabilise.

Note that, in terms of the formula derived in Appendix Two for the annualised equivalent return on amounts spread out in equal instalments over the year:

$$v = \frac{\mu}{26\left[(1+\mu)^{\frac{1}{26}}-1\right]}\text{-1} \qquad \text{and} \qquad w = \frac{\mu}{12\left[(1+\mu)^{\frac{1}{12}}-1\right]}\text{-1}$$