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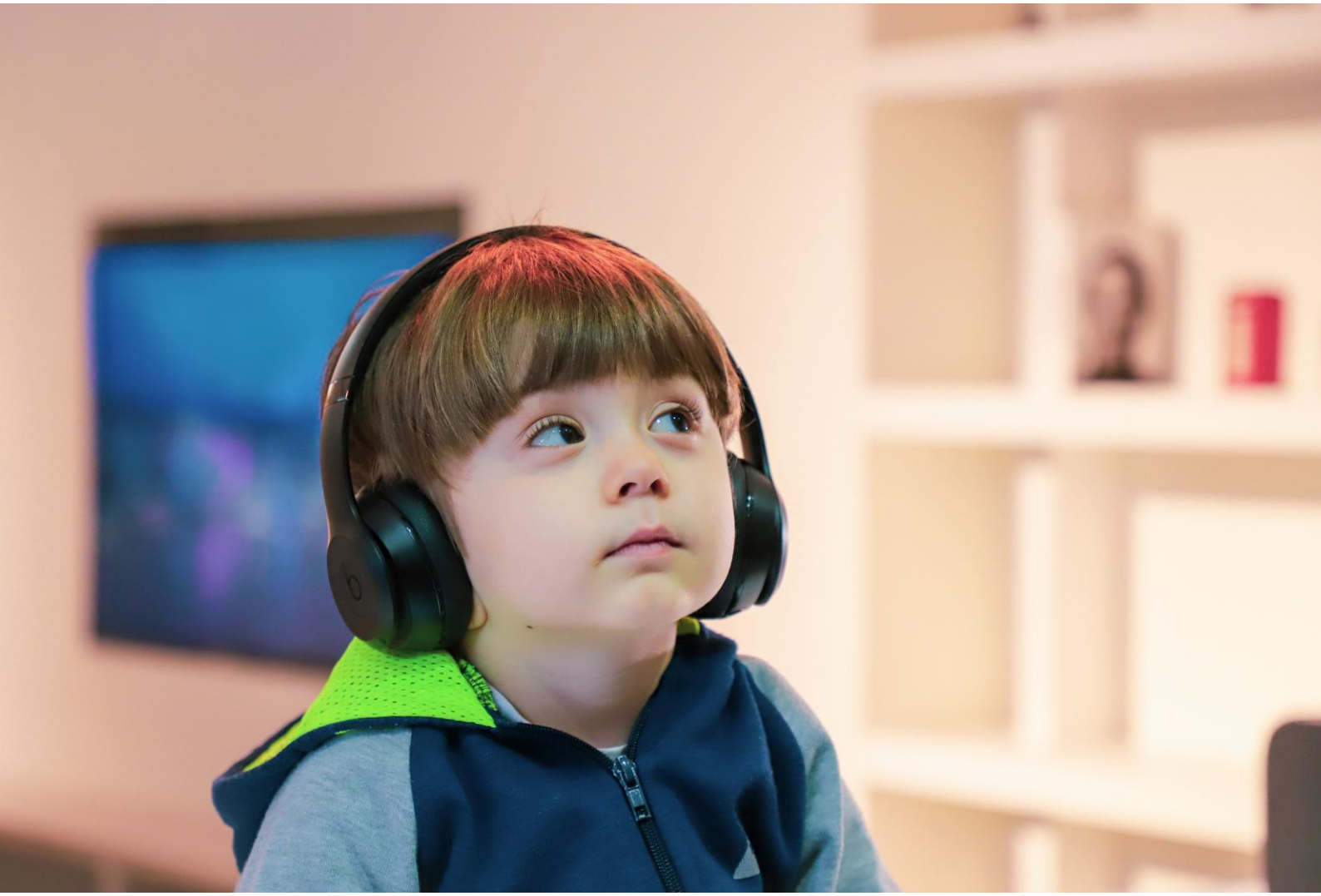

Economic effects of hearing loss

2023 update

NZIER report to New Zealand Hearing Industry Association

March 2023

About NZIER

NZIER is a specialist consulting firm that uses applied economic research and analysis to provide a wide range of strategic advice.

We undertake and make freely available economic research aimed at promoting a better understanding of New Zealand's important economic challenges.

Our long-established Quarterly Survey of Business Opinion (QSBO) and Quarterly Predictions are available to members of NZIER.

We pride ourselves on our reputation for independence and delivering quality analysis in the right form and at the right time. We ensure quality through teamwork on individual projects, critical review at internal seminars, and peer review.

NZIER was established in 1958.

Authorship

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Key points

The New Zealand Hearing Industry Association commissioned NZIER to update our 2020 report, which assessed the social costs of hearing loss and evaluated the economic benefits of mitigating some of the effects of hearing loss

- The prevalence of hearing loss varies from 7.5% to 20.8% across the New Zealand population. The latest estimate indicates that the prevalence of self-reported hearing loss among the working-age population has increased from 7.4% in 2018 to 8.2% in 2022.
- The literature review highlights a wide range of social and economic impacts from hearing loss, such as early retirement, increased needs in aged care and informal care, reduced quality of life, decreased learning ability and development for children with hearing loss, lowered employment and decreased labour productivity.
- The 2023 update builds on the findings from the 2020 report.
- We took the following approach to update the findings, this included:
  - adjusting the results for an increased prevalence of hearing loss in the working-age population
  - accounting for the growth of the economy and the population while assuming that the structure of the economy had not changed materially in a few years
  - reviewing the literature to incorporate more recent findings.

We estimate the potential social and economic benefits of mitigating the hearing loss effects at work

We focus on three main effects of mitigating hearing loss:

- **Labour productivity increase** through less absenteeism and presenteeism.
- **An employment increase** to show what might happen if the unemployment gap was reduced between people with hearing loss and the rest of the population.
- **Social impacts** of hearing loss for those over the retirement age, including the value of participating in society. We use our Computable General Equilibrium (CGE) model to assess the economic impacts of the first two effects and a non-market valuation consistent with Treasury CBAx impacts database to explore the social impacts of hearing loss among the older population.

The labour productivity effects lead to an annual real gross domestic product (GDP) growth of between $718 million and $924 million

Our modelling results for a productivity increase show significant macroeconomic benefits from less absenteeism and presenteeism of workers with hearing loss. Other macroeconomic effects include:

- Real household spending (our measure of living standards) grows by between $408 million and $527 million annually.
- Export volumes grow by $177 million to $227 million annually under the low and high scenarios, respectively.
- Industry outputs increase by an annual $1.26 billion to $1.630 billion to answer the increase in foreign and domestic demands.

The economy-wide employment increases lead to annual GDP growth of between $478 million to $956 million

Modelling a reduction in the employment gap also shows macroeconomic benefits from improving labour market access to workers with hearing loss.

Other macroeconomic effects include:

- Real household spending grows between $217 million and $432 million annually.
- Export volumes grow by an annual $93 million to $187 million annually under the low and high scenarios, respectively.
- Industry outputs increase by between $670 million and $1.34 billion, driven by increased foreign and domestic demands.

The social benefit of addressing the unmet need for hearing aids is in the hundreds of millions of dollars annually

- A conservative estimate indicates that 128,823 people aged 65 and over had an unmet need for hearing aids or other mitigations in 2023.
- The value of the social return on investment from increasing participation in society by mitigating hearing loss among people aged 65 years plus was estimated to range from $241 million and $1.55 billion, depending on the social value of participation and the costs of hearing aids.

More action and New Zealand-based research is needed to lower the impact

- The lack of current research is a major factor hindering policy development and shows the need for investment by Government in research to understand the local situation better.
- Research is only as good as the action that follows it. This report highlights the social cost of unmet need for hearing loss mitigations such as hearing aids.

The 'size of the prize' in terms of gains to GDP and living standards suggests that a better work environment and improved accessibility to the job market for people who have hearing loss is worth further consideration from policy maker

- Reducing the burden of hearing loss through the following actions:
  - Contemporary New Zealand-based research on hearing loss
  - Preventing hearing loss in the workplace, including the unintended consequences of open-plan offices
  - Ensuring access to adequate funding for hearing aids and specialist services
  - Removing the social stigma sometimes associated with hearing loss
  - Consider a national hearing loss strategy.

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1 Introduction

1.1 Purpose

The purpose of the 2020 report was to determine the social costs of hearing loss and investigate the economic and societal benefits of mitigating some of the effects of hearing loss. This report updates those findings.

1.2 Approach

This 2023 update builds on the findings from the 2020 report. To update the findings, we took the following approach:

- Adjusted the results for an increased prevalence of hearing loss in the working-age population
- Accounted for the growth of the economy and the population while assuming that the structure of the economy had not changed materially in a few years
- Reviewed the literature to incorporate more recent findings.

The structure and approach of this update follow that of the previous one. The report applies the following four-stage research approach. The stages reflect a discovery exercise consistent with a burden of disease methodology.

Table 1 Research approach

Name	Description
Prevalence and burden	The prevalence and burden of hearing loss in New Zealand, including the variation in prevalence estimates and the projected prevalence in the future.
Literature review	A wide-ranging literature review about the effects of hearing loss to guide the choice of the modelling scenarios.
Economic analysis	Using a computable general equilibrium (CGE) model to understand the flow-on effects of selected scenarios.
Social impacts analysis	Consideration of non-market effects of selected social impacts.

Source: NZIER

1.3 Scope

This project's scope includes the social and economic effects of hearing loss. Hearing loss covers both gradual hearing loss that occurs over time and hearing loss associated with disability and impairment. The data on hearing loss often combines disability and progressive hearing loss.

1.4 Context

The New Zealand health reforms of 2022 provide a strong legislative mandate with consumer-centric services and improved equity for underserved populations enshrined in the Pae Ora (Healthy Futures) Act 2022.

At the same time, Whaikaha, the new ministry for disabled people, has put forward five elements of system transformation. The key transformation calls for consumer-directed funding and control of resources for health and social services. Assistive technology advances, including hearing aids, are fuelling a revolution. Ultimately it means disability service consumers designing the service mix that best suits their needs from a personal budget for health, social and other services for daily living. How will we know this is working – ask the service user.

Delivering on the promise is a big challenge for siloed public service providers. We see a clear path through this. First up is addressing organisational siloes for improved coordination of needs. The still recent Public Services Act 2020 makes it possible to form joint ventures across government agencies that pool resources to prevent heavy-handed single-agency interests from holding sway.

Second is ensuring that service providers orient to the service user as sovereign. The fast track on this is to have disabled people with both lived experience and, equally as critical, the right professional skill sets running the show. This also includes the big players like Te Whatu Ora, one of the nation's biggest employers, who, with the right service user orientation, now have the agility to make things happen through the service providers they contract.

Third is measuring the individual outcomes to ensure the services work for users – at individual, whānau and system levels. This is needed for accountability but, most importantly, personal service improvement. Recent advances in good and reliable patient-reported experience and patient-reported outcome measures (PREMs and PROMs) are being led by the Health Quality and Safety Commission and a handful of other forward-thinking service providers.

2 The prevalence and the burden of hearing loss

Hearing loss is a common, significant global health issue impacting people's quality of life, employment opportunities, social participation, safety and mental well-being.

At the global level, the World Health Organization (2020) suggests the following:

- Around 466 million people worldwide have hearing loss, and 34 million are children.
- It is estimated that by 2050 over 900 million people will have disabling hearing loss.
- Hearing loss may result from genetic causes, complications at birth, certain infectious diseases, chronic ear infections, the use of drugs, exposure to excessive noise, and ageing.
- 60% of childhood hearing loss is due to preventable causes.
- 1.1 billion young people (aged between 12–35 years) are at risk of hearing loss due to exposure to noise in recreational settings.

- Unaddressed hearing loss poses an annual global cost of US$750 billion. Interventions to prevent, identify and address hearing loss are cost-effective and can greatly benefit individuals.
- People with hearing loss benefit from early identification, hearing aids, cochlear implants and other assistive devices, captioning and sign language, and other educational and social support forms.
- Current estimates suggest an 83% gap in hearing aid need and use, i.e. only 17% of those who could benefit from a hearing aid actually use one.

2.1 The prevalence of hearing loss in New Zealand

There is a range of estimates of the prevalence of hearing loss among the population of New Zealand. Table 2 illustrates the variation in prevalence, aggregated to a total population.

Table 2 Hearing loss prevalence and estimates in New Zealand

Source	Aggregate prevalence of hearing loss
Institute for Health Metrics and Evaluation (IHME) (2017)	20.8%
Exeter et al. (2015)	7.5%
Anovum (2022)	10.3%
Stats NZ (2013)	9%

Source: NZIER

The prevalence varies from 7.5% to 20.8% of the population. The Institute for Health Metrics and Evaluation (IHME) (2017) prevalence estimates are the highest in this case. The IHME uses standardised methods that allow for inter-country comparison drawing on specific country data.

Variation in the prevalence estimates was expected, and the explanations for variation in the estimates include the following:

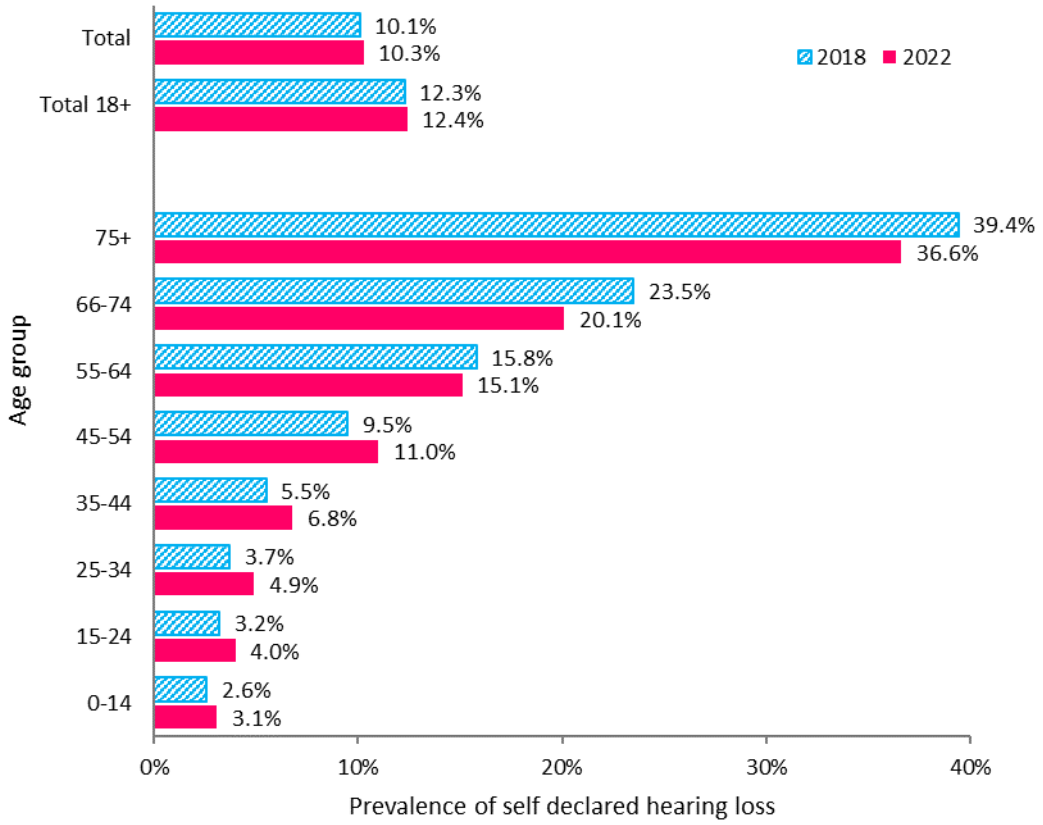
- self-reporting bias
- the definition of hearing loss, which can include disability, impairment, age-related effects and occupation-induced hearing loss –can be confusing for survey respondents.

The New Zealand Hearing Industry Association and NZIER decided to use the prevalence estimates from Anovum (2022) for the following reasons:

- it was the most recent estimate
- it represented a middle ground among the estimates
- the estimate was conservative.

Figure 1 shows Anovum's estimated hearing loss prevalence by age group.

Figure 1 The prevalence of hearing loss by age group in New Zealand



Source: Anovum (2022)

The purpose of the review of prevalence estimates was to establish a credible estimate of the proportion of the population that experiences hearing loss at the age group level (Table 3). We used this to estimate the number of people affected by hearing across different periods by applying the prevalence at the age group level to the projection population.

Table 3 Hearing loss prevalence and estimates in New Zealand, by age group

2023

Age group	Prevalence of hearing loss	Population estimate	Population with hearing loss	Working-age population with hearing loss
0-14	3.1%	955,700	29,627	
15-24	4.0%	642,700	25,708	25,708
25-34	4.9%	734,300	35,981	35,981
35-44	6.8%	677,000	46,036	46,036
45-54	11.0%	641,300	70,543	70,543
55-64	15.1%	629,600	95,070	95,070
65-74	20.1%	487,200	97,927	
75+	36.6%	381,600	139,666	
Total		5,149,400	540,557	273,337

Source: Stats NZ, Anovum (2022)

Since the 2020 report, the prevalence of hearing loss among the working-age population has increased

The prevalence of self-reported hearing among the working-age population was 8.2% in the Anovum 2022 survey, compared to 7.4% in the Anovum 2018 survey. In relative terms, that is an 11.8% increase. As part of the update, we adjusted for the increase in self-reported hearing loss. The increased prevalence increases the size of the economic cost and the social burden. However, it also reinforces the need to address the economic and social consequences of hearing loss. Addressing it requires a multipronged approach that includes:

- prevention of further hearing loss
- support for those impacted directly and indirectly (such as partners and family)
- technological mitigations
- addressing the stigma associated with ageing and using hearing aids.

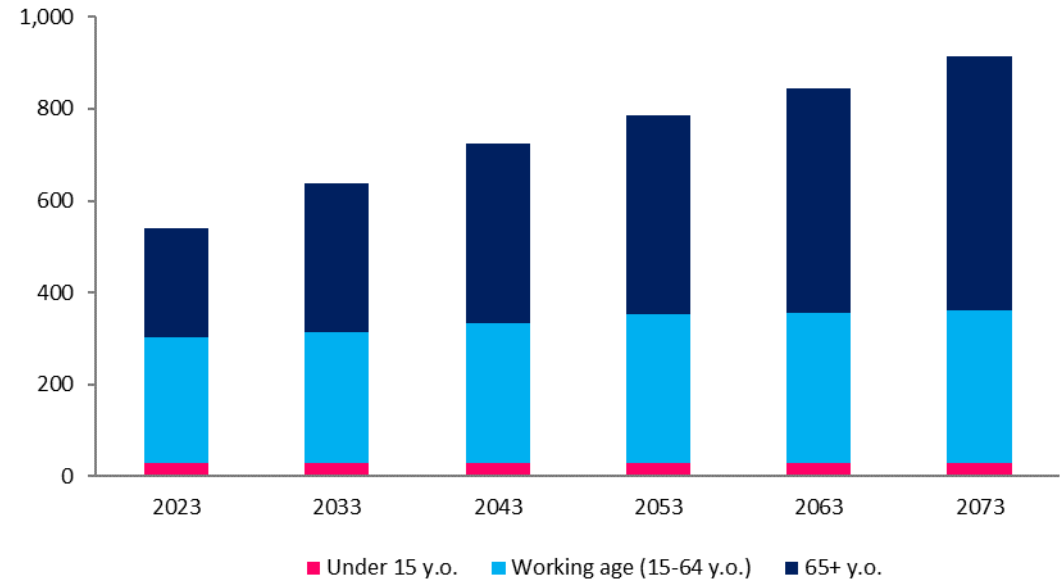
Figure 2 shows the estimated prevalence of hearing loss for past and future Census years. We disaggregate the population into three broad cohorts:

- children under 15 years old
- the working-age population, i.e. those aged between 15 years old and 64 years old inclusive
- those aged 65 years old and over.

Figure 2 shows that hearing loss among the working-age population is predicted to be relatively stable between 2023 and 2073. At the same time, the older population experiences faster growth in the estimated number of people affected with hearing loss due to the ageing population. This result is consistent with age-related hearing loss and probably reflects the long-term effects of occupation-related hearing loss.

Figure 2 The prevalence of hearing loss over time

People with hearing loss (thousands)



Source: NZIER

3 Literature review

3.1 The global cost of hearing loss

The total global cost of hearing has been estimated to be US$981 billion. The loss in health-related quality of life contributed to 47% of the total cost (McDaid, Park, and Chadha 2021). Other components included hearing-loss-related health expenditure, lost productivity and lost potential in education and the labour market.

3.2 The impacts of hearing loss are wide-ranging

Hearing is one of the five senses, and hearing loss will naturally impact all sorts of human experiences and interactions with society and the world around us. The aim of the literature review was to provide an evidence-based foundation for the modelling. We took a funnel-shaped approach to the literature review, which meant from the outset, we looked at all types of sources and didn't exclude any areas.

The effects of hearing loss can be grouped into the following themes:

- the effect of early retirement due to hearing loss
- impact of hearing loss on aged care and quality of life
- impact of children's hearing loss on learning ability
- effect of hearing loss on informal care
- potential impacts of hearing loss on labour productivity, employment and government revenue.

3.3 Hearing loss can lead to early retirement

While there is a certain amount of literature existing on the relationship between health status and retirement (Feldman 1994), we found that little research has been conducted on the impacts of hearing loss on early retirement.

Helvik, Krokstad, and Tambs (2012) found a correlation between the degree of low-frequency hearing loss and early retirement in Norway. Their study also shows that people with perceived hearing impairment are more likely to enter retirement early and are more likely to work part-time.

Fischer et al. (2014) found a correlation between hearing loss and retirement decisions. However, they also found that the decision to retire for people with hearing loss also depended on the effects of age, gender and health.

3.4 Hearing loss affects the quality of life of older people

Research has shown that hearing loss has a negative impact on overall health and is correlated with increased use of healthcare and a higher burden of illness in older adults, even when all other relevant variables are controlled for. Hearing loss is associated with more frequent falls (Lin and Ferrucci 2012) and with several other health conditions such as diabetes (Kakarlapudi, Sawyer, and Staecker 2003), stroke (Gopinath et al. 2009) and sight loss (Chia et al. 2006; 2007).

People with a hearing impairment are more likely to feel socially isolated and lonely, which puts them at a higher risk of depression, cognitive decline, dementia, and other health conditions, which can lead to early dependency and mortality (Davis et al. 2016; Berkman et al. 2000; Karpa et al. 2010).

A study from the Johns Hopkins Center on Aging and Health (Lin et al. 2013) found strong evidence of an association between hearing loss and accelerated cognitive decline or impairment among older adults. The findings of this study are consistent with other studies, such as Yuan et al. (2018), which show that older people with greater levels of hearing disability are at higher risk of cognitive impairment.

An Australian study (Hogan et al. 2009) used the 2003 Australian Survey of Disability, Ageing, and Carers to examine the impact of hearing loss on older people. This study showed that, among older people with hearing impairment, 71% experienced reduced communication. This study also found that hearing loss in older people is associated with reduced physical and mental health, especially for those with more severe hearing loss. An earlier study from Chia et al. (2007) looked at data from 2431 Blue Mountains Hearing study participants and found a correlation between age-related hearing impairment and health-related quality of life among older people.

Research studies from Lin, Ferrucci et al. (2011), Lin, Metter, et al. (2011), Lin et al. (2013) and Lin and Ferrucci (2012) are also widely cited when linking hearing loss with cognitive decline. Their research showed that people with severe hearing loss have a higher risk of developing Alzheimer's disease, having an accelerated cognitive decline due to accelerated atrophy of the brain from the hearing disability.

3.5 Hearing loss in childhood contributes to developmental delays

Children with hearing impairments are likely to be at risk of developmental delays. The American Speech-Language-Hearing Association (2015) identified the following main channels through which children are affected by hearing impairment:

- Developmental delays in children's speech and language skills
- Increased difficulties in learning which leads to lower academic grades and reduced future employment opportunities
- Higher risk of social isolation and poor self-esteem due to increased difficulties in communication.

Yoshinaga-Itano et al. (1998) found that early detection of hearing loss and intervention led to better outcomes in terms of language development among children.

In a 2008 report, the Centre for Allied Health Evidence reviewed 22 research studies to assess the correlation between age at detection of hearing loss and children's outcomes. Their literature review concluded that early detection had favourable outcomes for language and speech skills, but the evidence is mixed regarding social and emotional development, academic achievement, and reading and writing skills.

Barriers to educational achievement can reduce the labour productivity of people with hearing impairment. Rycx, Saks, and Tojerow (2018) found a positive relationship between educational achievement and productivity. Education and human capital development are key to increasing productivity and stimulating economic growth (Barro and Sala-i-Martin 1995).

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Further research is needed as studies are mixed internationally, and no studies in New Zealand have looked at the link between childhood glue ear and adult economic outcomes. Such work would be a significant research project on its own. At a minimum, there is enough evidence for a qualitative discussion on the impacts discussed in this project.

3.6 Hearing loss has a knock-on effect on carers

Little research has studied the correlation between hearing loss, spousal well-being, and mental health. When such studies exist, they present contradictory findings highlighting the need for more research to assess how hearing loss may affect spousal well-being.

Wallhagen et al. (2004) showed that partners of people with hearing disabilities are more likely to experience a decrease in their well-being, whether it is psychological, physical or social. Conversely, Ask, Krog, and Tambs (2010) concluded that a strong correlation between hearing loss and spousal well-being and mental health is unlikely.

Additionally, results from the *New Zealand Disability Survey* (Stats NZ 2006) showed that people with hearing disabilities are the least likely to receive help from informal care compared to those with intellectual or mobility disabilities. Among people with hearing loss, about 5% of those aged between 0–64 and 19% of those aged 65 or older received informal care in New Zealand in 2016.

Parents of children with hearing impairment are also at higher risk of stress, are more likely to face out-of-pocket expenses and take more days out of work than other parents (World Health Organization 2016).

Hearing loss also affects the labour productivity of family members and friends who spend time providing support to people with a hearing disability. (Access Economics (2006) estimated the total cost of informal carers, received from family and friends, at AU$2.6 billion in Australia, split between lost income, forfeited government taxes and deadweight losses.

3.7 Hearing loss reduces employment and productivity

Little research has been conducted in New Zealand about the impacts of hearing loss on employment and labour productivity. The existing literature mainly comes from international studies. We have identified three channels through which hearing loss affects labour productivity:

1. Reduced employment

People with hearing loss are at higher risk of missing out on employment outcomes due to the additional difficulty in searching for jobs or through self-selection out of the labour market. Jensen et al. (2005) used data from the 2001 *New Zealand Disability Survey* to measure the role of people's disabilities, including hearing loss, on their employment prospects. The authors found a 10% decrease in the probability of employment for people with hearing loss in New Zealand. Estimates have not been updated with the 2013 *New Zealand Disability Survey*. Therefore, Jensen et al. (2005) provide the most recent and only country-specific findings when it comes to measuring the effects of hearing loss on employment.

Jensen et al. (2005) findings fall within the range of other studies, which assume a 6% to 24.4% employment gap between general labour force participation and those with hearing loss, as shown in Table 4.

Table 4 Summary of findings on the impact of hearing loss on reduced employment

Reference	Country of study	Reduced employment (employment or labour participation gap)
Mohr et al. (2000)	USA	Labour participation gap (severe to profound hearing loss) is estimated at 18% for the 18–44 age category, 19% for the 45–64 age category and 6% for 65 and older.
Ruben (2000)	USA	Employment gap is found to be 10.4% for people with difficulty hearing and 24.4% for those unable to hear.
Jensen et al. (2005)	New Zealand	Employment gap is 10%.
Australian Bureau of Statistics (2015); Deloitte Access Economics (2017)	Australia	Employment gap is estimated to be 13% for males with hearing loss and 9% for females with hearing loss.

2. Absenteeism

Workers who have hearing loss are more likely to take days off work. Nachtegaal, Festen, and Kramer (2012) estimate that workers with hearing loss take an average of 3.5 days of annual sick leave due to their disability. Based on this assumption, Deloitte Access Economics (2017a) evaluates the total economic cost associated with absenteeism at NZ$66.7 million in 2016. We estimated that this is equivalent to a 1.6% loss in productivity based on the number of business days a year, annual average sick days are taken and four weeks of annual leave.

Table 5 below summarises our findings from the literature review on the impact of hearing loss on absenteeism.

Table 5 Summary of findings on the impact of hearing loss on absenteeism

Reference	Country of study	Increased annual sick days
Joore et al. (2003)	Netherlands	The authors found no difference (0 days) in the number of sick days before and after the hearing aid fitting. However, their sample size (10 people) is not statistically robust.
Kramer, Kapteyn, and Houtgast (2006)	Netherlands	The authors identified a significant difference of 20.3 days between people with hearing loss and normal-hearing people.
Nachtegaal, Festen, and Kramer (2012)	Netherlands	Authors estimated 3.5 days as sick leave due to hearing loss. This study is the most representative, well-constructed and constructed.

3. Presenteeism

Workers with hearing loss are likely to be less productive than other workers (Nachtegaal, Festen, and Kramer 2012). Deloitte Access Economics (2017a) estimated a 3% productivity

decrease due to presenteeism for people with hearing loss compared with other workers. They estimated the total cost associated with presenteeism at NZ$98.4 million for New Zealand in 2016.

4 Methodology and scenario design

Based on the discussion of the literature above and data availability, we focus on three main channels of transmission to explore the potential economic and social benefits of addressing and treating hearing loss, especially in the work environment:

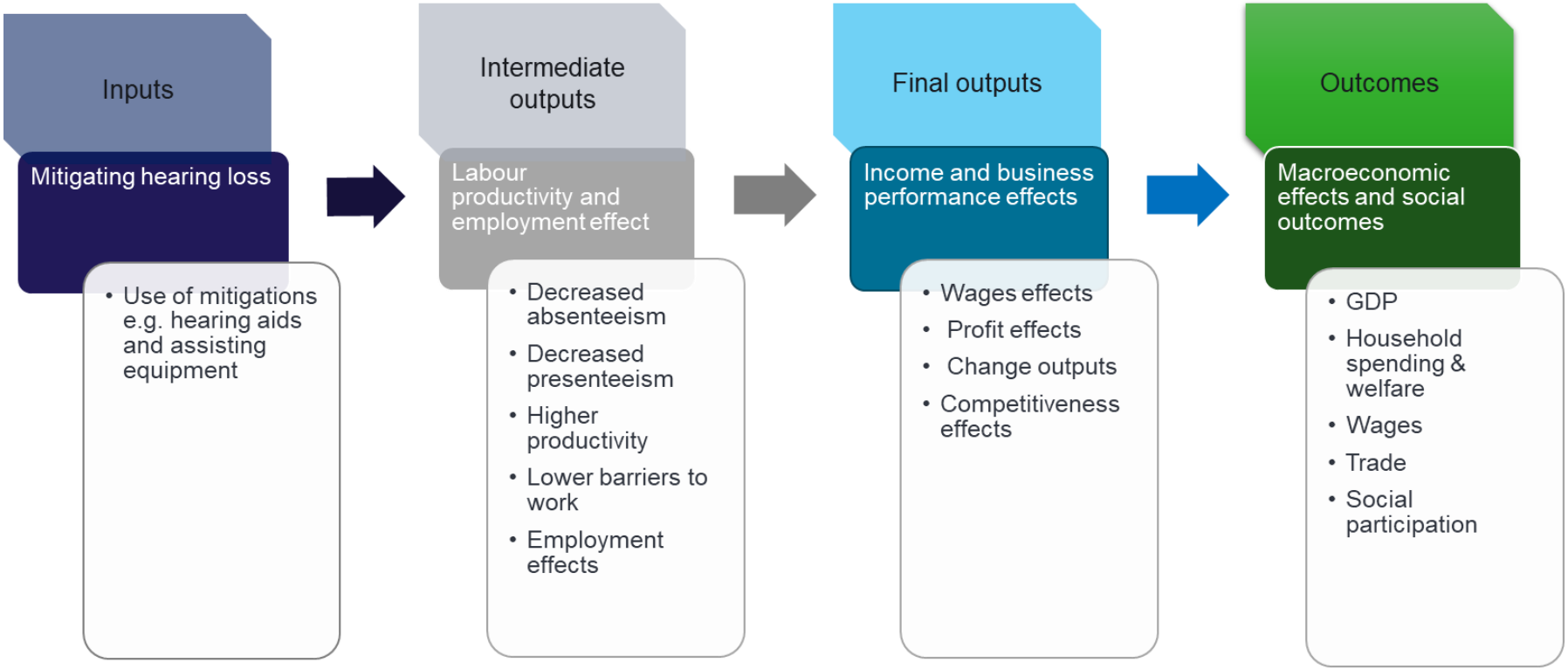
- A labour productivity increase through improved measures within the work environment would translate into lesser absenteeism and presenteeism.
- An employment increase among people with hearing impairment to show what might happen if the unemployment gap was reduced between people with hearing loss and the national unemployment rate.
- Social impacts of hearing loss for those over retirement age, including the value of participation and depression.

We use our Computable General Equilibrium (CGE) model to assess the economic impacts of the first two channels and a non-market valuation consistent with Treasury CBAx impacts database to explore the social impacts of hearing loss amongst the older population. CBAx contains a database of New Zealand-specific publicly available estimates of the value of social impacts used to value impacts (The Treasury 2019). These impacts can be positive or negative from society's perspective. The impacts include market values based on prices and non-market impacts based on quantitative estimates of impacts not reflected in the price of traded goods and services.

4.1 Organising framework

Figure 3 shows the intervention logic and the pathway from mitigating hearing loss to improved macroeconomic outcomes. Mitigating hearing loss leads to higher productivity and employment, affecting wages and business performance. This leads to positive ripple effects on the New Zealand economy, with increased household consumption, trade and gross domestic product (GDP).

Figure 3 Pathway from mitigating hearing loss to improved macroeconomic outcomes



Source: NZIER

4.2 CGE modelling approach

We use our top-down CGE model of the New Zealand economy, ORANI-NZ,[1] to examine the potential economic impacts of mitigating hearing loss amongst the working population.

ORANI-NZ is based on Stats NZ's Input-Output tables that identify the structure of the industries involved. It contains information on 106 industries and 201 commodities.

CGE modelling is our recommended method for conducting policy analysis or sectoral impact studies, as it delivers more conservative but more realistic estimates of net benefits than commonly used (and widely criticised) alternatives such as multiplier analysis.

CGE shows the full effect of a change which includes impacts from indirect effects which aren't immediately obvious. The cumulative impact of indirect effects can outweigh the direct effect of a change.

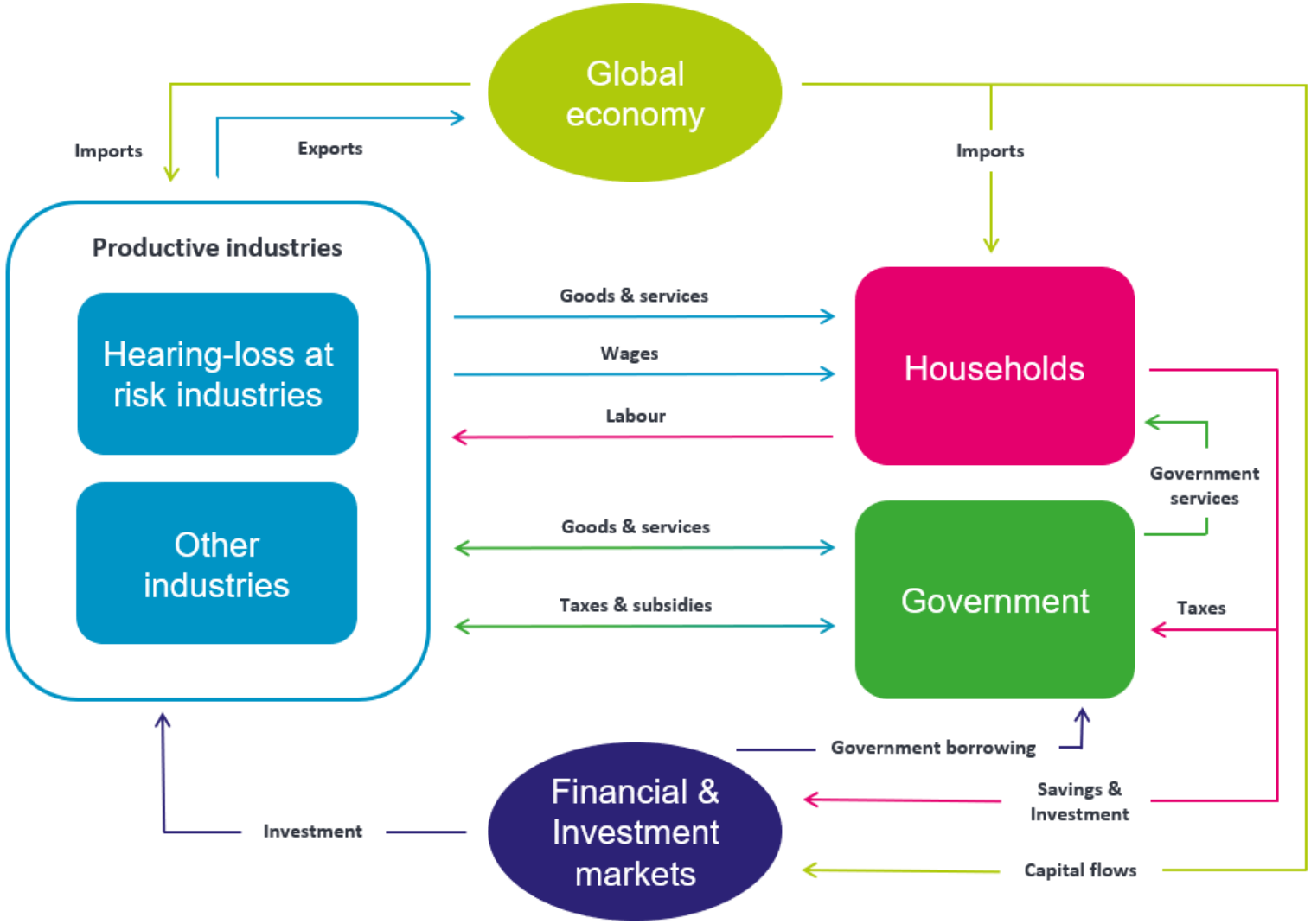
As our CGE model is 'static', it can only look at 'before' (i.e. current situation) and 'after'. We, therefore, do not explicitly model the timing of improving working conditions for people with hearing loss. Instead, we analyse a static, long-term scenario in which the capital that was initially used in various industries can eventually be used elsewhere (if not the physical capital, then the proceeds from selling it). We also assume that labour reallocates across industries which offer higher real wages but is fixed in aggregate as it reaches its natural level in the long run. This is a standard CGE modelling approach when we are thinking about changes to an industry/economy that might take longer than 1–2 years to occur. Further explanations on the closure can be found in Appendix A.6.

Figure 4 shows how our CGE model captures the various interlinkages between sectors, as well as their links to households (via the labour market), the government sector, capital markets and the global economy (via imports and exports). More details on the model can be found in Appendix A.

For reporting purposes, we aggregate the 106 industries into 50 broader sectors. The conversion of industries to sectors is shown in Table 19 in Appendix B.

[1] ORANI-NZ was developed at NZIER and is based on the original Australian ORANI model created by Professor Mark Horridge of the Centre of Policy Studies, Victoria University-Melbourne, Australia (https://www.copsmodels.com/ftp/gpextra/oranig06doc.pdf). NZIER maintains close connections with the Centre, ensuring that our modelling techniques reflect international best-practice.

Figure 4 Our CGE model represents the circular flows between all the agents and activities in the economy



Source: NZIER

4.2.1 Scenario design

For our scenario design, we implement shocks to represent what the national economy would look like if national labour productivity and employment increased as a result of mitigating the negative effects of hearing loss for workers across New Zealand industries.

We model two sets of scenarios:

- Labour productivity increase across all industries through improved measures within the work environment, which would translate into less absenteeism and presenteeism. In this set of scenarios, we assume a 4.6% labour productivity increase for workers with hearing loss if presenteeism and absenteeism were reduced. This percentage is derived from our literature review findings. It is the combination of a 3% labour productivity effect from presenteeism and a 1.6% labour productivity effect from absenteeism.
- National employment increase among people with hearing impairment to show what might happen if the employment gap was reduced between people with hearing loss and the national employment rate. In this set of scenarios, we assume that only a portion of jobs is readily available (i.e. 40%).

These scenarios are intended to establish the potential 'size of the prize'. They indicate the lower and upper limits of the potential benefits before considering the practical challenges and the cost of mitigating them. The scenarios provide a counterfactual 'what if?' By quantifying the 'what if' scenarios, insights are gained into whether an improving labour market and work access for people with hearing loss are worthy of more detailed investigation by policymakers.

Given the lack of recent official data and for sensitivity analysis purposes, we define a low, central and high bound for each of these two scenarios. Table 6 below summarises the different shocks we model. Further detail on the methodology used to estimate these shocks are provided in Appendix A.5.3.

Table 6 Scenarios for labour productivity and employment increases from reductions in hearing loss

Indicator	Low	Central	High
Aggregate labour productivity increase	0.19%	0.22%	0.25%
Aggregate employment increase	0.10%	0.15%	0.21%

Source: NZIER

5 Economic effects of improving working conditions for people with hearing loss

5.1 Expected chain of effects from an economy-wide labour productivity increase

Figure 5 summarises the chain of economic effects from an economy-wide labour productivity increase. When considering these effects, it is important to remember that multiple moving parts are at play within the economy.

On the supply side, higher labour productivity leads to higher profits across all industries. These profits can be reallocated in three ways:

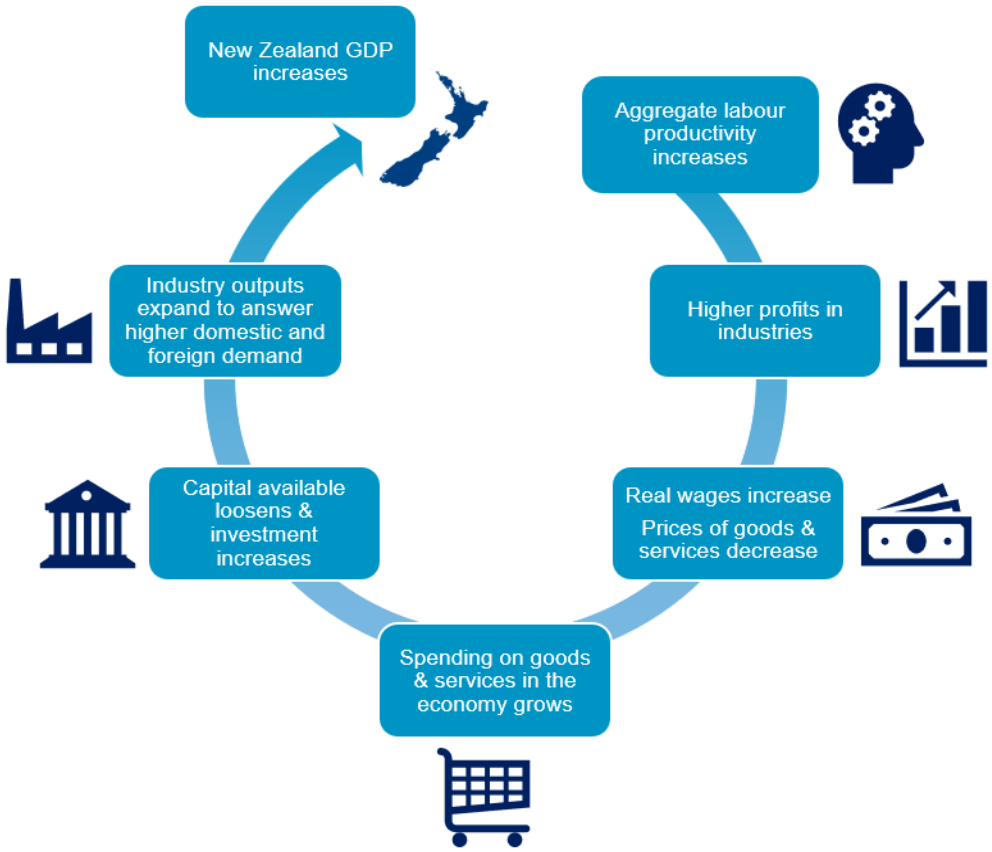
- Part of these profits can be allocated to capital, for additional investment or be distributed to shareholders.
- Firms and businesses can also reduce the price of goods and services to consumers or, at least, raise their prices by less than they would have without the productivity increase. This is especially the case when there is competition among producers.
- Given aggregate labour supply is fixed, firms and businesses are likely to offer higher compensation to their workers in the form of higher real wages. Jobs are reallocated toward industries with higher real wages or those that are more labour-intensive.[2]

On the demand side, the increase in real wages and the reduction in prices encourage spending on goods and services. To respond to the increase in demand, industries in which households spend their money can expand their outputs. With the slight reduction in the terms of trade associated with the decrease in prices, export-oriented industries become slightly more competitive on the international market. This drives them to increase their output to respond to a growing foreign demand for exports.

Overall, the benefits of an initial labour productivity increase can have a ripple effect throughout the economy and drive growth in national GDP, household spending, output and trade.

[2] Employment is considered fixed at the national level, but labour is perfectly mobile between industries and moves based on real wage differences across sectors.

Figure 5 Main economic effects of an increase in labour productivity



Source: NZIER

5.2 Expected chain of effects from an economy-wide employment increase

Figure 6 summarises the chain of the economic effects of higher employment at the national level.

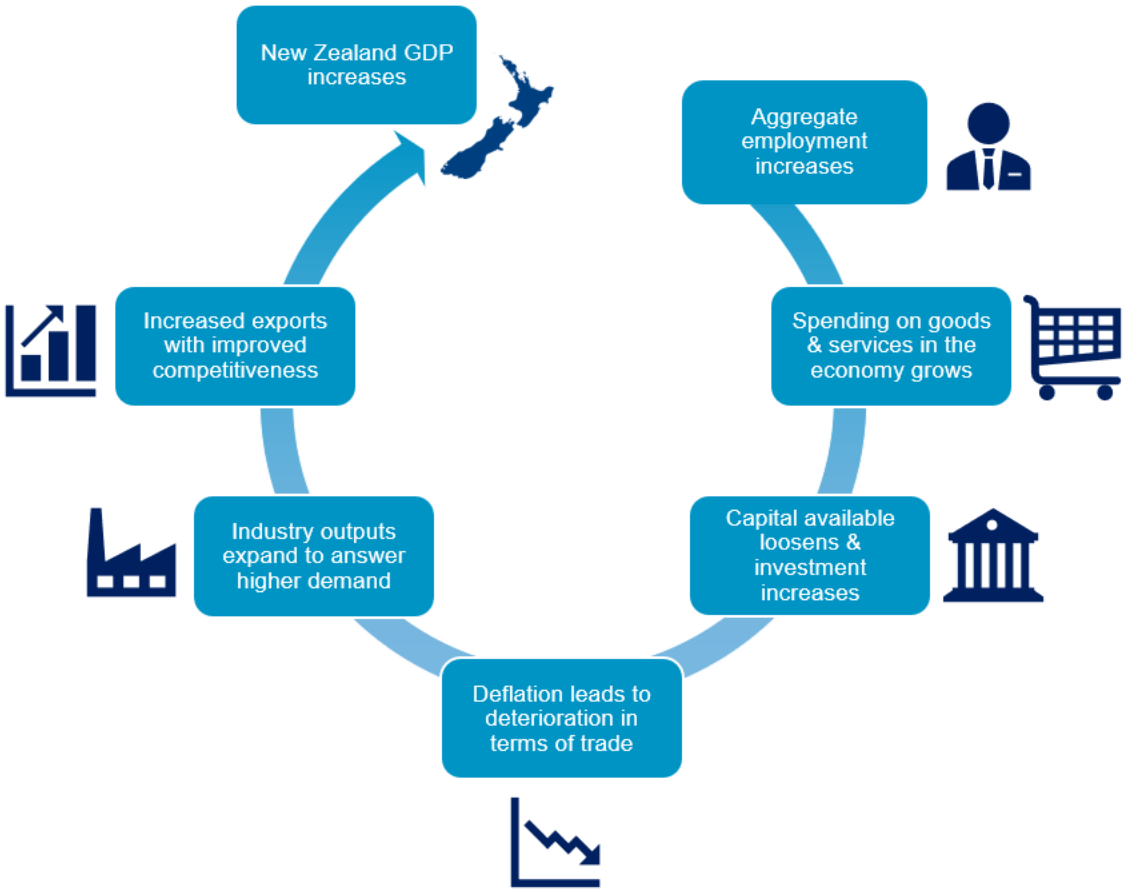
On the supply side, better access to the labour market for people with hearing loss leads to an increased aggregate level of employment. In turn, aggregate real wages decrease to reflect this new level of labour supply.

On the demand side, households' overall wealth and confidence increase which stimulates spending on goods and services. To meet the growth in household demand, industries increase their productive capacity through investment.

The increase in the aggregate supply leads to a fall in the prices of goods and services, which in turn, generates a slight deterioration in the terms of trade. Export-oriented industries become more competitive in the international market, which drives them to increase their output to respond to a growing demand for exports. In the short run, deflation also increases the purchasing power of households and encourages spending on goods and services.

Overall, the benefits of the increasing employment level can have a ripple effect throughout the economy and drive growth in household spending, investment, output, trade and GDP.

Figure 6 Main economic effects of an increase in employment



Source: NZIER

5.3 Headline economic impacts

The overall impacts on the New Zealand economy are analysed by focusing on key economic metrics, particularly GDP, household welfare (measured by household consumption), wages, trade, capital stock and national output.

As discussed previously, both direct and indirect effects from labour productivity and employment increases of people with hearing loss are expected to positively impact these key macroeconomic indicators.

5.3.1 2020 results from a labour productivity increase under our scenarios

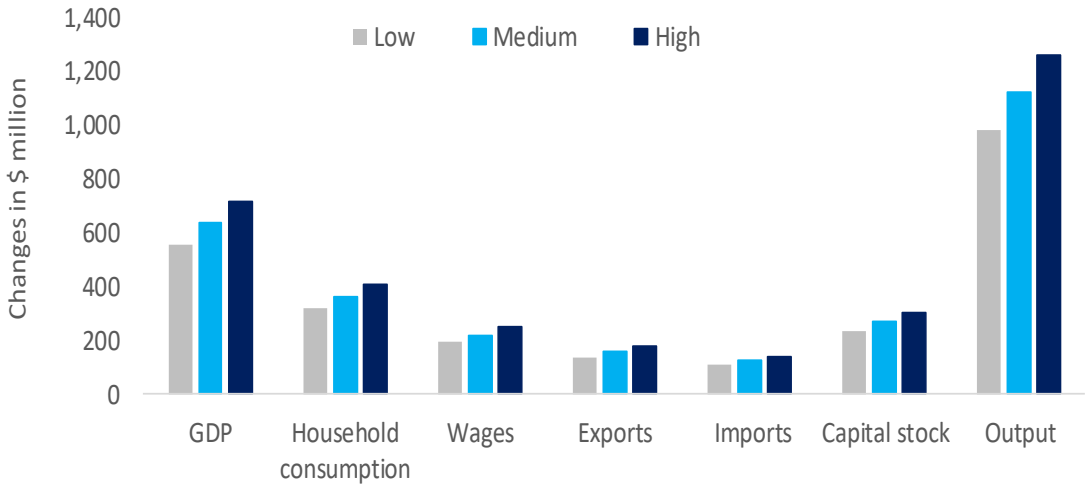
Figure 7 and Table 7 present the annual economy-wide effects of increasing labour productivity of workers with hearing loss by 4.6%, which at the national level, and depending on the assumptions on the participation rate of people with hearing loss in the labour force, translates into a labour productivity increase of 0.19%, 0.22% and 0.25% under the low, central and high scenarios, respectively. (See Appendix A.5.3 for further detail on the scenario design.)

- Economy-wide real GDP expands by $556 million (0.18%) to $716 million (0.24%) annually.

- Annual real household spending, our measure of living standards, rises by between $316 million (0.18%) and $408 million (0.24%), depending on the level of labour productivity increase (from low to high scenarios).
- The average annual real wage rises relative to the baseline by between $192 million (0.15%) and $248 million (0.19%) as the national average labour productivity increases.
- Annual export volumes (excluding price changes) grow by between $137 million (0.16%) and $176 million (0.21%) annually under the low and high scenarios, respectively. This is due to an increase in the competitiveness of export-oriented industries due to a slight deterioration in the terms of trade.
- Industry outputs increase by an annual $979 million or 0.18% (low scenario) to $1,263 million or 0.24% (high scenario) to answer the increase in domestic and foreign demand.
- The volume of capital increases, through higher investment, by an annual $236 million (0.18%) to $305 million (0.24%) to ensure higher productive capacity and accommodate the growth in production.

Figure 7 Macroeconomic benefits from higher labour productivity

Annual changes from the 2019 baseline, in $ millions (real terms)



Note: Changes from the baseline are net effects, taking into account the flow-on effects from our CGE modelling.

Source: NZIER

Table 7 Macroeconomic effects from an increase in labour productivity

Annual changes from the 2019 baseline, in $ millions (real terms) and in percent

Indicator	Low scenario		Central scenario		High scenario	
	% change	Level ($m)	% change	Level ($m)	% change	Level ($m)
GDP	0.18%	$556	0.21%	$636	0.24%	$716
Household consumption	0.18%	$316	0.21%	$362	0.24%	$408
Wages	0.15%	$192	0.17%	$220	0.19%	$248
Exports	0.16%	$137	0.19%	$156	0.21%	$176
Imports	0.13%	$109	0.15%	$125	0.17%	$141
Capital stock	0.19%	$236	0.21%	$271	0.24%	$305
Output	0.18%	$979	0.21%	$1,121	0.24%	$1,263

Note: Changes from the baseline are net effects, taking into account the flow-on effects from our CGE modelling.

Source: NZIER

5.3.2 The 2023 updated labour productivity results

The 2023 updated labour productivity results were based on two key components:

- The increasing prevalence of self-reported hearing loss among the working-age population (15–64 years old) since the 2020 report
- The growth of the population and the economy since 2020.

The combined effect of a larger economy and increased prevalence of self-reported hearing loss equates to a 29% increase in the results. It was assumed that in the few years since the original modelling was completed, the relative structure and composition of the economy were the same. Structural economic changes tend to occur over the long term.

Table 8 shows the updated findings for the potential labour productivity benefits of addressing loss. Our modelling results for a productivity increase show significant macroeconomic benefits from less absenteeism and presenteeism of workers with hearing loss. Other macroeconomic effects include:

- The labour productivity effects lead to an annual real GDP growth of between $718 million and $924 million
- Real household spending (our measure of living standards) grows by between $408 million and $527 million annually.
- Export volumes grow by $177 million to $227 million annually under the low and high scenarios, respectively.
- Industry outputs increase by an annual $1.26 billion to $1.630 billion to answer the increase in foreign and domestic demands.

Table 8 Updated macroeconomic effects from an increase in labour productivity

Annual changes, in $ millions (real terms) and in percent

Indicator	Low scenario	Central scenario	High scenario
	Level ($m)	Level ($m)	Level ($m)
GDP	$718	$821	$924
Household consumption	$408	$467	$527
Wages	$248	$284	$320
Exports	$177	$201	$227
Imports	$141	$161	$182
Capital stock	$305	$350	$394
Output	$1,264	$1,447	$1,630

Source: NZIER

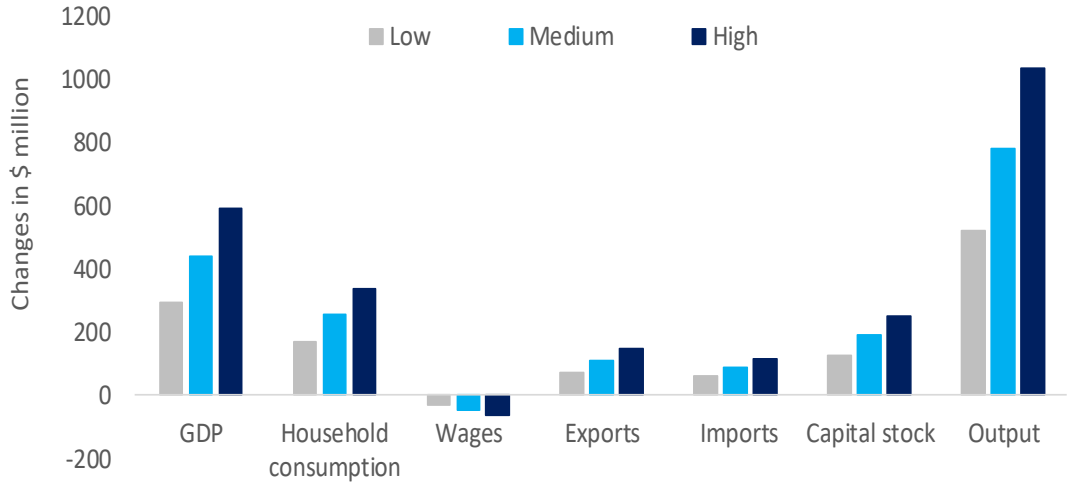
5.3.3 2020 results from increasing the employment level

Figure 8 and Table 9 show the annual economy-wide effects of a 40% reduction in the unemployment gap between people with hearing loss and the national population. If we assume different levels of the unemployment rate for people with hearing loss (7%, 8.5% and 10%), a reduced unemployment gap translates into a 0.10%, 0.15% and 0.21% increase in national employment level under the low, central and high scenarios, respectively. (See Appendix A.5.3 for further detail on the scenario design.)

- Economy-wide real GDP expands by $294 million (0.10%) to $588 million (0.20%) annually.
- Annual real household spending, our measure of living standards, rises by between $168 million (0.10%) and $335 million (0.20%), depending on the level of labour productivity increase (from low to high scenarios).
- The average annual real wage falls relative to the baseline by between $32 million (-0.02%) and $64 million (-0.05%) as economy-wide employment increases.
- Annual export volumes grow by between $72 million (0.09%) and $145 million (0.17%) annually under the low and high scenarios, respectively.
- Industry outputs increase by an annual $519 million or 0.10% (low scenario) to $1,037 million or 0.19% (high scenario) to answer the increase in domestic and foreign demand.
- The volume of capital increases, through higher investment, by an annual $125 million to $250 million to ensure higher productive capacity and accommodate the growth in production.

Figure 8 Macroeconomic benefits from increased employment

Annual changes from the 2019 baseline, in $ millions (real terms)



Note: Changes from the baseline are net effects, taking into account the flow-on effects from our CGE modelling.

Source: NZIER

Table 9 Macroeconomic effects from an employment increase

Annual changes from the 2019 baseline, in $ millions (real terms) and in percent

Indicator	Low scenario		Central scenario		High scenario	
	% change	Level ($m)	% change	Level ($m)	% change	Level ($m)
GDP	0.10%	$294	0.15%	$441	0.20%	$588
Household consumption	0.10%	$168	0.14%	$251	0.19%	$335
Wages	-0.02%	-$32	-0.04%	-$48	-0.05%	-$64
Exports	0.09%	$72	0.13%	$108	0.17%	$145
Imports	0.07%	$58	0.10%	$87	0.14%	$116
Capital stock	0.10%	$125	0.15%	$188	0.20%	$250
Output	0.10%	$519	0.15%	$778	0.19%	$1,037

Note: Changes from the baseline are net effects, taking into account the flow-on effects from our CGE modelling.

Source: NZIER

5.3.4 The 2023 updated employment level results

The 2023 updated employment level results were based on two key components:

- The increasing prevalence of self-reported hearing loss among the working-age population (15–64 years old) since the 2020 report
- The growth of the population and the economy since 2020.

The combined effected of a larger economy and increased prevalence of self-reported hearing loss equates to a 29% increase in the results. It was assumed that in the few years

since the original modelling was completed, the relative structure and composition of the economy were the same. Structural economic changes tend to occur over the long term.

Table 10 shows the updated findings for the potential employment-level benefits of addressing hearing loss. Our modelling of reducing the employment gap also shows macroeconomic benefits from improving labour market access to workers with hearing loss. The key results were:

- The economy-wide employment increases lead to annual GDP growth of between $478 million to $956 million. Other macroeconomic effects include:
  - Real household spending grows by between $217 million and $432 million annually
  - Export volumes grow by an annual $93 million to $187 million annually under the low and high scenarios, respectively
  - Industry outputs increase between $670 million and $1.34 billion, driven by increased foreign and domestic demands.

Table 10 Updated macroeconomic effects from an increase in employment levels

Annual changes, in $ millions (real terms) and in percent

Indicator	Low scenario	Central scenario	High scenario
	Level ($m)	**Level ($m)**	**Level ($m)**
GDP	$379	$569	$759
Household consumption	$217	$324	$432
Wages	-$41	-$62	-$83
Exports	$93	$139	$187
Imports	$75	$112	$150
Capital stock	$161	$243	$323
Output	$670	$1,004	$1,338

Source: NZIER

6 Social impacts of hearing loss

Hearing loss affects the ability to participate in society and interact with others in a one-on-one or group environment. In this section, we investigate the non-market cost of the effects of hearing loss on those 65 years and over. As discussed in the literature review, social participation can include market benefits from increased consumption. Hearing loss and social isolation associated with hearing could therefore lead to a decrease in consumption with flow-on effects on businesses and industries. However, we found insufficient detailed research to support the development of a consumption-based scenario. Instead, we considered the value of the non-market effects utilising the estimates of the value of participation used in Treasury's CBAx impacts database. This allows a consistent comparison with other appraisals.

The unmet need for hearing aids was estimated to quantify the potential scale of the social impacts of hearing loss for the population aged 65 years and over. Table 11 shows that in 2023, an estimated 237,593 people aged 65 years and over experienced hearing loss. Of those, 57% or 128,823 currently haven't started using hearing aids, which represents the unmet need for hearing aids among the population aged 65 years old and over. This cohort represents the group most likely to experience adverse social effects from hearing loss.

Table 11 Estimating the unmet need for hearing aids

In 2023

Hearing loss severity	People affected (65+)	Share of affected people	Aid adoption rate	Unmet need %	No. of people with unmet need
Severe + profound	42,767	18%	71%	29%	12,402
Moderate	114,045	48%	47%	53%	60,444
Mild	73,654	31%	24%	76%	55,977
Total people with hearing loss aged 65+	237,593	27%	43%	57%	128,823

Source: NZIER and Anovum (2022)

Table 12 shows the range estimates for the social value of participation in society from the Treasury's CBAx impacts database. The approach to the values changed between the previous report and this update. Therefore a range of values was applied. This reflects the level of uncertainty in subjective wellbeing benefits. These values suggest that the value of social participation is difficult to consistently define, estimate and monetise A midpoint value of $7,475 and a range of $2,100-$12,850 was applied in the updated analysis to reflect the participation from addressing hearing loss.

Table 12 Social values of participation

Social benefits of participation	Value per person (2023 $)
Being a member of a club	$1,100-$3,300
A 20% reduction in loneliness	$3,100-$22,400
Average range	$2,100-$12,850
Midpoint	$7,475

Source: NZIER analysis based on The Treasury (2019)

Table 13 shows the estimated social benefit of addressing the unmet need for hearing aids based on the estimated cohort of 128,823 people in 2023. The social benefit ranges from $271 million to $1.66 billion, depending on the social value of participation. Obviously, hearing loss has much broader implications than the ability to participate in a club because hearing loss affects many activities in everyday life.

Table 13 Social benefit of addressing the unmet need for hearing aids

Annually

Social benefits of participation	Value to the affected cohort ($ million)
Lower	271
Central	963
Upper	1,655

Source: NZIER

What would it cost the government to provide more hearing aids?

The cost of addressing the unmet need for hearing aids would be $30 million and 104 million annually. This was based on the following assumptions:

- The cost per hearing after the government subsidy is applied between $210-$2,121 (ex. GST)[3]
- a government subsidy of $511.11 (ex. GST) per hearing aid
- an average hearing aid life of 6 years
- 1.8 hearing aids per person
- a cohort of 128,823 people over 65 years
- a specialist appointment fee of $110 per person, which is based on the total cost of 20 minute GP visit without government subsidies.

The cost of hearing varies according to the user's preferences for functionality. The lower bound covers essential hearing needs. The social return on investment would be between $241 million and $1.55 billion. There is considerable uncertainty about the value of the social benefits for people over 65 years old. The most conservative benefit-cost ratio was 9.

[3] https://www.tritonhearing.co.nz/hearing-aid-cost-pricing/prices/

The challenge is to overcome the behavioural barriers and stigma associated with hearing loss to increase uptake.

7 Next steps

This scenario modelling exercise demonstrates the potential benefits of mitigating hearing loss in the New Zealand economy. The 'size of the prize' in terms of gains to GDP and living standards suggests that a better work environment and improved accessibility to the job market for people who have hearing loss are worth further consideration by policymakers.

The next steps based on the findings of this report are:

- More research is needed to better understand the potential policy interventions to:
  - increase hearing aid adoption rates and
  - fund the unmet need for hearing loss mitigations.
- More research into the impacts of hearing among children and the effects over their life course.
- Further efforts to reduce hearing loss in the workplace should include the risks associated with an open-plan environment.
- More regular and consistent surveys on hearing loss and hearing as a disability.
- Increased action on hearing loss is also needed to make a difference to the most underserved populations.
- Engagement with health and disability service funders and commissioners about the potential for improved hearing aid uptake to contribute to health, social and economic objectives, including equity.

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Appendix A CGE modelling

A.1 CGE modelling captures the full impact of hearing loss

We use our CGE model to capture the full impact of national labour productivity and economy-wide employment increases from mitigating the negative effects of hearing loss on workers across New Zealand industries.

CGE models are data-driven and used to capture the effects of a new policy or technology or other external shocks affecting economic activity. They capture the economy-wide effects of changes ('shocks' in modelling jargon) directly on the affected industry, as well as indirectly on supplying industries, competing industries, and factor markets (labour and capital). CGE models show the full effect of a change which includes impacts from indirect effects which aren't immediately obvious. The cumulative impact of indirect effects can outweigh the direct effect of a change.

CGE models also estimate the effect of a shock on macroeconomic variables such as GDP, employment, wages and trade.

CGE models are a powerful tool, allowing economists to explore empirically many issues on which econometrics or multiplier analysis would be unusable. For these reasons, CGE models have become widely used internationally (e.g. by OECD, IMF, and World Bank) for economic impact analysis.

A.2 Why do we prefer CGE over multipliers?

Multiplier studies[4] are popular for economic impact analysis as they are relatively cheap and produce big appealing figures. However, they are based on several assumptions, which require them to be interpreted and considered with considerable care.

Key caveats include that multiplier studies:

- Do not consider the impacts of policy changes on the price of goods, services, intermediate inputs, labour (wages) and capital
- Assume that land, labour, and capital are available in unlimited quantities and at no additional cost to firms
- Cannot consider the opportunity cost of using additional resources in one industry on the rest of the economy – there are almost never any losers (i.e. contracting industries) in multiplier studies.

Because of these assumptions, multipliers overestimate the impacts of a change in an industry on the rest of the economy. Both the Ministry of Business, Innovation and Employment (MBIE) and the Treasury have highlighted the inherent flaws in using multiplier studies for serious economic analysis.[5]

[4] Also known as 'input-output studies'.

[5] For an overview of these weaknesses, see the New Zealand Treasury and MBIE. Both documents, and Gretton (2013), clearly state that multipliers over-state economic impacts and thus lack credibility for economic analysis. Or in Treasury's words: "Unless there is significant unemployment of people with the requisite skills, **it is therefore likely that multiplier effects do not exist**".

For all these reasons, we prefer to use CGE models as they better align with our independence and reputation for delivering high-quality, data-driven analysis.

A CGE model estimates opportunity costs (between action and inaction), winners and losers. Resources are limited. It also considers the price impacts of shocks and can capture linkages between industries and spill-over effects.

NZIER's CGE models are highly regarded amongst government agencies with whom we have worked to conduct policy analysis or sectoral impact studies. This includes MBIE, the Treasury, the Ministry of Foreign Affairs and Trade, the Ministry for Primary Industries and the Ministry for the Environment.

A.3 How do CGE models work?

A CGE model consists of equations which describe model variables. It also uses detailed data on the structure of the economy that is consistent with these model equations.

This data provides a snapshot of the economy in a particular year, which is used as a starting point for a baseline (or business as usual (BAU)) against which to compare policy simulations or economic changes.

The model data is linked together through a set of equations which capture how the economy evolves over time in response to a shock. These equations, which are based on the economic theory of general equilibrium, ensure supply and demand for goods, services and factors of production in the economy are balanced and determine how firms and households react in response to changes in incentives.

Most CGE models are written and solved in a specific software system, usually GAMS[6] or GEMPACK.[7]

In any CGE model, we must choose what is to be determined within the model (the endogenous variables) and what is to be considered external to the model (the exogenous variables). A CGE model is just a way of explaining the endogenous variables in terms of the exogenous variables.

Where we draw the line between endogenous and exogenous variables and which ones can vary or must remain fixed depends on several factors, including the purpose for which the model simulations are to be used. The choice that we make is called the model closure.

Determining the closure is a key part of any modelling exercise, and it is very important that the modeller be transparent about what is a result of the modelling and what has been imposed by assumption via the closure.

The difference between the initial and the new equilibrium can then be analysed to determine the effect of the shock on a range of economic indicators, such as GDP, employment, wages and living standards.

6 General Algebraic Modelling System: https://www.gams.com/

7 General Equilibrium Modelling Package: https://www.copsmodels.com/gempack.htm

A.4 Our CGE model ORANI-NZ

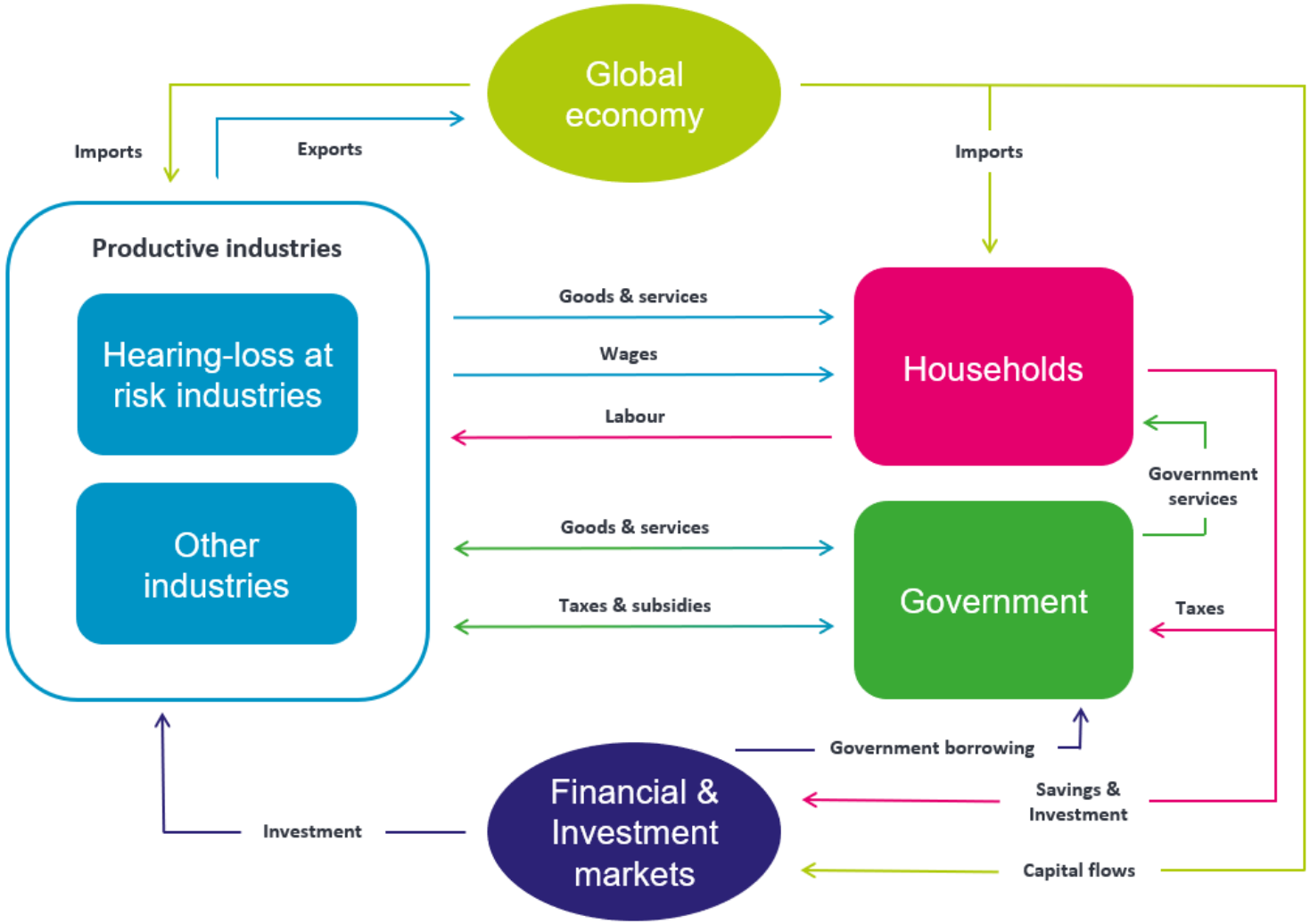
NZIER's ORANI-NZ[8] model is a top-down CGE model of the New Zealand economy.

ORANI-NZ is based on Stats NZ's Input-Output table that identifies the structure of the industries involved. It contains information on 106 industries and 201 commodities. It, therefore, offers a unique capability to highlight the benefits of mitigating some of the effects of hearing loss on the New Zealand economy, especially those related to the work environment.

Figure 9 shows how the model captures the complex and multidirectional flows between the various actors of the national economy and how they interact with the rest of the world. More technical details on the model are available upon request.

[8] ORANI-NZ was developed at NZIER based on the original Australian ORANI model created by Professor Mark Horridge of the Centre of Policy Studies, Victoria University-Melbourne, Australia. https://www.copsmodels.com/oranig.htm. NZIER maintains close connections with the Centre, ensuring that our modelling techniques reflect international best-practice.

Figure 9 Our CGE model represents the circular flows between all the agents and activities in the economy



Source: NZIER

A.5 Our modelling approach

A.5.1 Core data is based on Stats NZ's Input-Output tables

The structure of the database is broadly similar to traditional Input-Output tables. For example, commodities may be used as intermediate inputs for further production, used in investment, exported or consumed by households and the government. Industry costs include the cost of intermediates, margins, taxes and primary factor costs for labour, land and capital.

The database was sourced initially from Stats NZ's 2013 Input-Output tables (released in November 2017).

A.5.2 Business-as-usual 2019

Our first step is to develop a baseline or BAU picture of the economy. To do so, we calibrate our model of the national economy to the latest available data from Stats NZ's National Accounts (2019). This allows us to ensure we correctly benchmark the size of the various industries and gives us a BAU snapshot of the national economy.

A.5.3 Scenario design

As stated, we are interested in estimating the economic benefits of mitigating hearing loss in the working population.

For our scenario design, we implement shocks to represent what the national economy would look like with different levels of labour productivity and employment increases associated with measures taken to encourage employment and reduce absenteeism and/or presenteeism of people with hearing loss.

These scenarios are intended to establish the potential 'size of the prize'. They indicate the lower and upper limits of the potential benefits before considering the practical challenges and the cost of mitigating the challenges. The scenarios provide a counterfactual 'what if?' By quantifying the 'what if' scenarios, insights are gained into whether improving the labour market and work access for people with hearing loss is worthy of more detailed investigation by policy makers.

Given the lack of recent official data and for sensitivity analysis purposes, we define a low, central and high bound for each of these two scenarios. Table 6 below summarizes the different shocks we model.

Labour productivity increase

In this scenario, labour productivity increases across all industries through improved measures within the work environment, which would translate into lesser absenteeism and presenteeism.

In this set of scenarios, we assume a 4.6% labour productivity increase for workers with hearing loss if presenteeism and absenteeism were reduced. This percentage is derived from our literature findings. It is the combination of the 3% labour productivity effect from presenteeism and the 1.6% labour productivity effect from absenteeism.

To design a shock on labour productivity at the aggregate level, we used data from official sources (Stats NZ) and from the literature to estimate:

- Labour force participation rate for people with hearing loss
- People employed with hearing loss and their share in the total labour force
- Labour productivity effects of people with hearing loss.

From these estimates, we translate the labour productivity increase of people with hearing loss into a labour productivity shock at the national level. Given the lack of official statistics regarding the labour force participation rate of people with hearing loss, we model a national labour productivity increase with three different ranges:

- Low scenario: 0.19% labour productivity increase
- Central scenario: 0.22% labour productivity increase
- High scenario: 0.25% labour productivity increase.

Table 14 and Table 15 highlight the data used, their sources and the different steps to estimate our labour productivity shocks for the low, central and high scenarios.

Table 14 New Zealand labour market

2018

Indicator	Indicator	Population	Source
National population	Unemployed in the labour force	119,000	Stats NZ, 2018
	Employed in the labour force	2,587,100	
	Total labour force	2,706,100	
	Labour force participation rate	71%	
	Unemployment rate	4%	
People with hearing loss	Working age population	231,576	Derived from Table 3, Stats NZ 2018
	The potential of labour productivity increase (3% for presenteeism, 1.6% for absenteeism)	4.60%	Derived from the literature review, NZIER

Source: Stats NZ (2018), NZIER

The last row in Table 15 presents our national labour productivity shock estimates under our low, central and high scenarios.

A 4.6% labour productivity increase in workers with hearing loss (Table 14) translates into a national labour productivity increase of 0.19%, 0.22% and 0.25% under the low, central and high scenarios, respectively, depending on various assumptions on the participation rate of people with hearing loss in the labour force.

Table 15 Labour productivity shocks

2018

Indicator	Low	Central	High	Source
Estimated labour force participation rate for people with hearing loss	47%[9]	54%[10]	61%[11]	Stats NZ, Jensen et al. (2005)
People employed with hearing loss	108,841	124,588	140,335	Derived from estimates on the working-age population with hearing loss (Table 14) and labour force participation rate for people with hearing loss (this table)
Share of employed people with hearing loss in the total labour force	4.21%	4.82%	5.42%	Derived from total labour force estimates (Table 14) and employed people with hearing loss (this table)
Pro-rated labour productivity shock-	**0.19%**	**0.22%**	**0.25%**	Derived from the potential of labour productivity increase (Table 14) and share of employed people with hearing loss in the total labour force (this table)

Source: NZIER

Employment increase

Under this scenario, the national employment increase among people with hearing impairment reflects what might happen if the employment gap was reduced between people with hearing loss and the national employment rate. In this set of scenarios, we assume that only a portion of jobs are readily available (i.e. 40%).

Similarly to the labour productivity scenario, we used data from official sources (Stats NZ) and estimates from the literature to define three different levels of economy-wide employment increase:

- Low scenario: 0.10% national employment increase
- Central scenario: 0.15% national employment increase
- High scenario: 0.21% national employment increase.

Table 16 below describes the data used and steps to estimate an economy-wide shock on employment for the low, central and high scenarios.

We assume that the unemployment gap for people with hearing loss is reduced by 40% and that existing employees are not displaced. A reduced unemployment gap, therefore, translates into a 0.10%, 0.15% and 0.21% increase in national employment level under the low, central and high scenarios, respectively, if we consider different levels of the unemployment rate for people with hearing loss (7%, 8.5% and 10%).

9 Stats NZ, Disability and the labour market: Findings from the 2013 Disability Survey. http://archive.stats.govt.nz/browse_for_stats/health/disabilities/disability-and-labour-market/labour-force-partic.aspx

10 Our own assumption calculated as the median labour participation rate for people with hearing loss between low and high estimates.

11 Jensen et al. (2005)

Table 16 Employment shocks

2018

Indicator	Low	Central	High	Source
Unemployment rate for people with hearing loss	7%[12]	8.5%[13]	10%[14]	Stats NZ, Jensen et al. (2005)
Unemployment gap between people with hearing loss compared to the national average	3%	4.5%	6%	Derived from the national unemployment rate (Table 14) and unemployment rate estimates for people with hearing loss (this table)
Unemployment gap, population	6,947	10,421	13,895	Derived from the working-age population with hearing loss (Table 14) and unemployment gap rate (this table)
Unemployment gap for people with hearing loss is reduced by 40%[15]	2,779	4,168	5,558	Derived from the unemployment gap population (this table) and a 40% reduction of unemployment gap assumption
Pro-rated employment shock	**0.10%**	**0.15%**	**0.21%**	Reduction of the employment gap as a share of the total labour force

Source: NZIER

Table 17 summarises the different scenarios we modelled to simulate labour productivity and employment increases at the national level.

Table 17 Labour productivity and employment increases scenario

Changes from the 2019 baseline in percent

Indicator	Low	Central	High
Industry labour productivity increase	0.19%	0.22%	0.25%
National employment increase	0.10%	0.15%	0.21%

Source: NZIER

A.6 Closure

As noted previously, in any CGE model, it is important to understand which factors have been allowed to vary and which remain fixed by assumption (also known as exogenous variables). The particular combination of fixed factors is known as the closure.

We choose a long-term closure as labour productivity and employment increases resulting from mitigating the negative effects of hearing loss tend to happen with some delay. This is because the adoption of measures and policies which can improve work access and

12 Stats NZ, Disability and the labour market: Findings from the 2013 Disability Survey. http://archive.stats.govt.nz/browse_for_stats/health/disabilities/disability-and-labour-market/labour-force-partic.aspx

13 Our own assumption calculated as the median unemployment rate for people with hearing loss between low and high estimates.

14 Jensen et al. (2005)

15 Assumption based on our literature review.

According to the NZ Disability survey (NZ Stats, 2013), about 50% of people with hearing disability find it difficult to get into the labour market. Another study focusing on the UK (RNID 2006) states that 20% of the people with hearing loss and sampled in the survey were unemployed and looking for work.

productivity of people with hearing loss might require some organisational adjustments to fulfil its potential.

Table 18 lists the main variables included in the modelling underlying this report.

- National employment is fixed, but labour is completely mobile between industries, and real wages adjust to labour market changes. This is consistent with the idea that both the labour force and the rate of employment are, in the long run, determined by mechanisms outside the model.
- Household and government expenditures move together to accommodate a fixed balance of trade as a share of GDP. This is to prevent negative welfare effects from having an unsustainable trade deficit.
- Rates of return are exogenous, and capital is mobile between industries. This mobility can occur either in the form of machinery etc., being physically moved or capital in one industry being allowed to depreciate without replacement while investment builds up the stock of another industry.
- Foreign currency prices of imports are naturally exogenous.
- Real government consumption is also exogenous.

Other exogenous variables include rates of production tax, technological coefficients, national population, and national labour supply.

Table 18 Fixed elements of the CGE model

Variables
Taxes on production
Technological change
Government demand
Gross growth rate of capital
Gross rate of return on capital
Number of households
National population
National labour supply
Import prices, foreign currency
Foreign demand for New Zealand exports
Land use

Source: NZIER

A.7 Assumptions and caveats

Below is a list of assumptions and caveats we made for our modelling exercise.

- Given the lack of sectoral data regarding the prevalence of hearing loss among workers, we have modelled economy-wide labour productivity and employment increases to reflect the economic benefits of mitigating hearing loss, especially amongst workers.

- There is also little recent literature and data on how hearing loss might affect labour productivity and employment in New Zealand.
- We have tried to reflect the uncertainty associated with the lack of recent literature and data available by modelling a range of scenarios (low, central, high). As more information and data become available on hearing loss, its prevalence and associated costs, we can carry out further economic modelling as required.
- The analysis is static, looking at the impacts of the changes on the New Zealand economy at a point in time. In reality, the benefits of mitigating the negative effects associated with hearing loss will be spread over a few years. We do not explicitly model the dynamics of increased labour productivity and employment over time.
- While the model database is highly disaggregated, it still invariably suffers from aggregation bias – we are modelling the effects of mitigating hearing loss effects on entire industries rather than at the firm level.
- The CGE model is based on Stats NZ's 2013 Input-Output tables and updated to 2019 levels using Stats NZ's latest national accounts available.
- The CGE model is based on neoclassical economics. Structural changes to the economy that may arise with the uptake of cloud computing are therefore not captured in the modelling, nor are any non-competitive market structures. This means the actual distribution of costs and benefits may differ in reality if firms with market power absorb price and cost movements in their profits.

Appendix B Sectoral mapping

Table 19 Concordance table from 106 industries to 50 sectors

106 Industries	50 aggregated sectors
Horticulture and fruit growing	Horticulture
Sheep, beef cattle, and grain farming	Sheep and beef
Dairy cattle farming	Dairy cattle
Poultry, deer, and other livestock farming	Poultry
Forestry and logging	Forestry
Fishing and aquaculture	Fishing
Agriculture, forestry, and fishing support services	Agriculture services
Coal mining	Coal mining, oil and gas extraction
Oil and gas extraction	Coal mining, oil and gas extraction
Mining and quarrying	Mining and exploration
Exploration and other mining support services	Mining and exploration
Meat manufacturing	Meat processing
Seafood processing	Seafood processing
Dairy product manufacturing	Dairy processing
Food manufacturing	Fruit processing
Beverage manufacturing	Beverages and tobacco
Textile and leather manufacturing	Textile and clothing
Clothing and footwear manufacturing	Textile and clothing
Wood product manufacturing	Wood processing
Pulp and paper product manufacturing	Pulp, paper and print
Printing	Pulp, paper and print
Petroleum and coal manufacturing	Petrol manufacturing
Basic chemical manufacturing	Chemicals manufacturing
Fertiliser and pesticide manufacturing	Fertiliser manufacturing
Pharmaceutical manufacturing	Pharmaceuticals
Polymer and rubber manufacturing	Rubber
Non-metallic mineral product manufacturing	Metals manufacturing
Metal product manufacturing	Metals manufacturing
Fabricated metal product manufacturing	Metals manufacturing
Transport equipment manufacturing	Transport equipment
Electronic and electrical equipment manufacturing	Electrical equipment
Machinery manufacturing	Machinery
Furniture manufacturing	Other manufacturing
Other manufacturing	Other manufacturing
Electricity generation and on-selling	Electricity generation
Electricity transmission and distribution	Electricity generation

106 Industries	50 aggregated sectors
Gas supply	Gas and water supply
Water supply	Gas and water supply
Sewerage and drainage services	Sewerage/waste
Waste collection, treatment, and disposal services	Sewerage/waste
Residential building construction	Construction
Non-residential building construction	Construction
Heavy and civil engineering construction	Construction
Construction services	Construction
Basic material wholesaling	Wholesale
Machinery and equipment wholesaling	Wholesale
Motor vehicle parts wholesaling	Vehicle wholesaling
Grocery and liquor product wholesaling	Wholesale
Other goods wholesaling	Wholesale
Motor vehicle parts retailing	Retail
Fuel retailing	Retail
Supermarkets and grocery stores	Retail
Specialised food retailing	Retail
Furniture and hardware retailing	Retail
Recreational and clothing retailing	Retail
Department stores	Retail
Other store-based retailing	Retail
Accommodation	Accommodation
Food and beverage services	Food and beverages
Road transport	Road transport
Rail transport	Rail transport
Other transport equipment	Other transport equipment
Air and space transport	Air transport
Postal and courier services	Transport and storage
Transport support services	Transport and storage
Warehousing and storage services	Transport and storage
Publishing	Media and communication services
Motion picture and sound recording activities	Media and communication services
Broadcasting and internet publishing	Media and communication services
Telecommunications services	Media and communication services
Library and other information services	Media and communication services
Banking and financing	Finance and insurance
Life insurance	Finance and insurance
Health and general insurance	Finance and insurance
Superannuation and individual pension services	Finance and insurance
Auxiliary finance and insurance services	Finance and insurance
Rental and hiring services	Property services

106 Industries	50 aggregated sectors
Residential property operation	Property services
Non-residential property operation	Property services
Real estate services	Property services
Owner-dwelling	Property services
Architectural and engineering services	Architectural services
Legal and accounting services	Business services
Advertising, market research, and management services	Business services
Professional services	Business services
Computer system design services	Business services
Travel agency services	Business services
Employment and other services	Business services
Building cleaning and other support services	Business services
Local government services	Local and central government
Government services	Local and central government
Defence	Local and central government
Public order, safety, and regulatory services	Local and central government
Preschool education	Education and health
School education	Education and health
Tertiary education	Education and health
Adult, community, and other education	Education and health
Hospitals	Education and health
Medical and other health care services	Education and health
Residential care and social assistance	Education and health
Heritage and artistic activities	Education and health
Sport and recreation services	Sport and recreation services
Gambling activities	Sport and recreation services
Repair and maintenance	Other personal services
Personal services	Other personal services
Labour unions and other interest groups	Other personal services

Source: NZIER