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NEW ZEALAND INSTITUTE OF ECONOMIC RESEARCH

State highway network investments

Assessing the wider economic benefits

NZIER report to Northern Infrastructure Forum

August 2023

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The assistance of Sarah Spring is gratefully acknowledged.

How to cite this document:

NZIER. 2023. State highway network investments: Assessing the wider economic benefits. A report for Northern Infrastructure Forum.

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Key points

Transport infrastructure is essential for enabling economic activity growth through connecting people, businesses and economies. The Northern Infrastructure Forum, a transport forum led by Auckland Business Chamber, commissioned NZIER to estimate the economic impact of potential state highway investments in the North Island.

In undertaking this work, we looked at investments previously proposed by Waka Kotahi NZ Transport Agency on the SH1 corridors of Cambridge to Piarere (C2P) and Warkworth to Wellsford (W2W). Both corridors are currently classified as national high-volume routes under New Zealand's One Road Network Classification (ONRC), and they are strategically important for freight movement and connecting ports and economies in the North Island regions. However, the existing SH1 for these two sections on the state highway network do not align with the standards of their ONRC classification regarding travel time efficiency, resilience and safety. As traffic volumes on those corridors could double over the next 20 to 30 years, the performance of the existing SH1 routes will likely deteriorate.

The two proposed investments are a 16 km Cambridge to Piarere (C2P) Expressway and a 26 km offline Warkworth to Wellsford (W2W) highway, each of which may take up to five years to construct. Once in place, these projects are expected to deliver long-term improvements, including:

- Reduced travel time and delay, which will improve efficiency for freight industries.
- Fewer unexpected travel disruptions.
- Providing a viable alternative route to SH1 users, especially heavy vehicles.
- Fewer number of crashes.
- Improved access to businesses and employment across the regional economies connected by the corridors.

Our approach

Existing studies on the economic impact of similar state highway investments in New Zealand suggest that there are also economic benefits to sectors across New Zealand and regional economies from the productivity gains generated by the direct impacts of the investments. To assess the wider economic impact in both the construction and operational phases of the C2P and W2W investments, we use NZIER's computable general equilibrium (CGE) model to capture the flow-on impacts of the investments, based on the inter-relationships between the different sectors of the economy and households.

We drew on the approach used in NZIER's previous work as well as the approach informed by the literature and in Waka Kotahi NZ Transport Agency's Monetised Benefits and Costs Manual (MBCM) to quantify the productivity changes from the investment's direct impacts on supply chain efficiency, resilience, and agglomeration relative to a baseline scenario of the economy without each of the investments. We then input these into our CGE model to estimate the wider economic impacts for the operational phase of each investment.

Our approach differs from that used in the business cases in that we capture the flow-on impacts of each of the investments, rather than just the value of the direct impact on the

affected industries only. We draw on estimates from the business cases, such as travel time savings, to derive the estimates of the productivity gains which form inputs into our CGE modelling. However, our approach using CGE modelling capture much broader impacts of each of the investments across the industries and regions of the New Zealand economy.

We estimated benefits from improved safety due to a reduced number of crashes separately from our CGE modelling analysis. These are estimated following the guidelines and the parameter values for calculating road crashes' social costs in the latest MBCM. Those social cost values in the MBCM are measured as the average New Zealand households' willingness to pay for reducing differing severity of injuries from road crashes.

Our traffic volumes and employment calculations are based on trends prior to the COVID-19 pandemic due to the pandemic's considerable short-term distortion on transport movement and economic activity between 2020 and 2021. Nonetheless, in the context of a transport infrastructure investment spanning several decades, we consider this a minor risk.

We estimate the following benefits:

The C2P Expressway will increase New Zealand's annual GDP by $487 million[1]

During the operational phase, the C2P Expressway will lead to improved supply chain efficiency for the road freight, trades, and postal and courier delivery industries as a result of reduced travel time ($29 million per annum) and vehicle operating costs ($1.7 million per annum). As the new expressway will present as a viable alternative route for all SH1 users during full SH1 closures, there will be additional travel time savings and vehicle operating cost savings to those industries, given the improved resilience of the state highway network on the C2P corridor. We estimate productivity increases from supply chain efficiency and resilience impacts will result in an increase in annual GDP of $253 million for the Waikato economy and $255 million for the Bay of Plenty economy.

The reduced cost of travel on the C2P corridor also enables increased agglomeration of businesses and employment in the Waikato and Bay of Plenty regions, leading to improved productivity of economic sectors, especially in the services, wholesale and trade, and manufacturing sectors. We estimate those agglomeration impacts increase the size of the New Zealand economy by $86 million.

Safety improvements and better design of the state highway network on the C2P corridor contribute to a reduction in the number of road crashes on the corridor, leading to fewer deaths and injuries. We estimate an annual road safety benefit of $7 million resulting from savings in social costs associated with road crashes – over 20 years of the new expressway's operation; we estimate this amount to be $88.5 million. These road safety benefits represent the direct savings in costs to households from the reduced occurrence of crashes on the C2P corridor due to the operation of the C2P investment. Some of the flow-on effects from improved safety are already captured through the investment's resilience impact, given fewer crashes means fewer incidents resulting in road closures on the C2P corridor.

We estimate the total economic benefit to the New Zealand economy over a 20-year operation period of the C2P Expressway amounts to $6.1 billion.

[1] A detailed outline of our results for the C2P investment can be found in Section 4.1.

The W2W highway will increase New Zealand's annual GDP by $497 million[2]

Once the W2W investment becomes operational, 90 percent of the traffic volume on the existing SH1 route between Warkworth and Te Hana will divert onto the new highway. Travel time per trip on both the existing SH1 and the W2W will be reduced between 10 to 16 percent[3] (depending on time period travelled and direction) relative to without the investment in place, increasing freight movement efficiency and other commercial vehicles. Also, there will be additional travel savings from a significant reduction in the occurrence and hours of road closures on the W2W corridor when the new highway is in operation. We estimate that the total economic benefits from the W2W's impacts on supply chain efficiency and resilience will result in an increase in annual GDP of $168 million for the Northland economy and $362 million for the Auckland economy. These result from the productivity gains generated by savings in travel time ($26 million per annum) and vehicle operating cost ($1.5 million per annum) for road freight, trades, and postal and courier delivery industries.

Improved productivity of economic sectors from increased agglomeration, especially services, wholesale and trade, and manufacturing sectors, will increase New Zealand's annual GDP by $95 million.

With a better highway design and substantial traffic diversion from the existing SH1 route, the number of crashes on the W2W will reduce considerably. We estimate an annual road safety benefit of $5 million, with a net present value (NPV) of $62.2 million over a 20-year operational period. The estimated road safety benefit represents the direct savings in costs to households from the reduced occurrence of crashes relative to if the W2W highway was not built.

We estimate the W2W investment can deliver a total economic benefit of $6.2 billion (in NPV) to the national economy over the first 20 years of its operational cycle.

The capital invested during the construction phase of the C2P and W2W will increase the size of the national economy by $10 million and $20 million per annum, respectively

We estimate the C2P and W2W investments increase annual GDP in the New Zealand economy by around $10 million and $20 million, respectively, during the construction phase, reflecting the increased activity the investment catalyses during their five-year construction period. There are long-lasting benefits to the New Zealand economy once each investment becomes operational.

Our results suggest sizeable economic benefits could be foregone if either investment does not go ahead

The regions closest to the highway investments (Waikato and Bay of Plenty and Northland and Auckland) experience the most benefits. The increased activity in these regions will take up resources from the other regions in New Zealand; this will mean less economic activity in these other regions relative to the absence of the investments. Nonetheless, the net impact on the overall New Zealand economy is positive.

Our results illustrate that sizeable economic benefits could be forgone if the C2P or W2W investment did not go ahead. While delaying the investment may not lead to a material

2 Detailed results for the W2W investment can be found in Section 4.2.

3 NZIER's updated calculation based on updated travel time information on Google Maps

change in the amount of economic benefits per se, it defers the timing of when New Zealand can benefit from those gains.

Table 1 Annual economic benefits once investments are operational

Annual change relative to baseline, $ million

Benefit component	Cambridge to Piarere		Warkworth to Wellsford	
	Annual growth	20-year NPV	Annual growth	20-year NPV
Supply chain efficiency	$351.8	$4,384	$399.2	$4,976
Resilience	$48.9	$609.1	$2.6	$31.9
Agglomeration	$86.0	$1,072	$95.3	$1,188
Total	**$486.7**	**$6,065.0**	**$497.1**	**$6,195.4**
Road safety[4]	$7.1	$88.5	$5.0	$62.2

Source: NZIER

[4] Road safety benefits are not strictly additive to other values in Stats NZ's System of National Accounts. This is because the largest share of fatal and serious injuries is a non-market value derived from people's willingness to pay for improved safety. Reducing that portion of those accidents does not save any actual money per se for production in the New Zealand economy. This means some of the estimated safety value extends beyond what the New Zealand GDP measures.

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1 Introduction

Transport infrastructure is essential for enabling economic activity growth through connecting people, businesses and economies. Since 2009, the New Zealand Government has been committed to investments in seven Roads of National Significance (RoNS) across the North and South Islands.[5] These were identified as essential routes that require significant development to reduce congestion, unlock economic growth and productivity for New Zealand, and improve transport safety (SAHA 2010).

The Northern Infrastructure Forum, led by the Auckland Business Chamber, commissioned NZIER to estimate the economic impact of potential state highway investments in the North Island.

1.1 Scope of this work

The scope of this work looks at two potential state highway investments in the North Island – Cambridge to Piarere (C2P) and Warkworth to Wellsford (W2W), both of which were previously proposed by Waka Kotaki NZ Transport Agency (NZTA).

For each of the two investments, our assessment of the economic impact covers both the construction phase of the proposed routes and their long-term operation. We estimate impacts on the regional economies closest to each of the investments and the total New Zealand economy.

1.2 Overall approach

Our estimate of the economic benefits of state highway investments goes beyond the Capital and Operational Expenditures (CAPEX and OPEX), travel time savings and those benefits traditionally captured in cost-benefit analyses (CBAs). We use NZIER's computable general equilibrium (CGE) model of New Zealand regional economies to assess the following:

- Wider economic benefits from CAPEX to regions and the New Zealand economy over the construction period.
- Flow-on benefits to sectors and the economy from productivity gains generated by the investment's impact on supply chain efficiency, resilience and agglomeration during its operational phase.

We draw on the framework and approach in NZIER's previous work on the benefits of road decongestion in Auckland (NZIER 2017) for translating the direct impact of travel time savings into productivity gains for the most relevant industries affected by supply chain efficiency. For agglomeration impacts, we follow the general approach in Waka Kotahi NZ Transport Agency's (2023c) Monetised Benefits and Costs Manual (MBCM) and Maré and Graham's (2009) work on agglomeration and productivity. We rely on the approach used in

[5] The seven RoNS projects, from north to south, are: Puhoi to Wellsford (SH1), Auckland Western Ring Route (SH20/16/18 including Waterview), Victoria Park Tunnel (SH1), Waikato Expressway (SH1), Tauranga Eastern Corridor (SH2), Wellington Northern Corridor (SH1) and Christchurch motorway projects.

the existing literature to estimate the direct impacts of the investments on resilience and road safety.

2 Background

This section briefly describes the C2P and W2W investments, their potential effects, and existing analyses or studies on the economic impact of similar state highway investments.

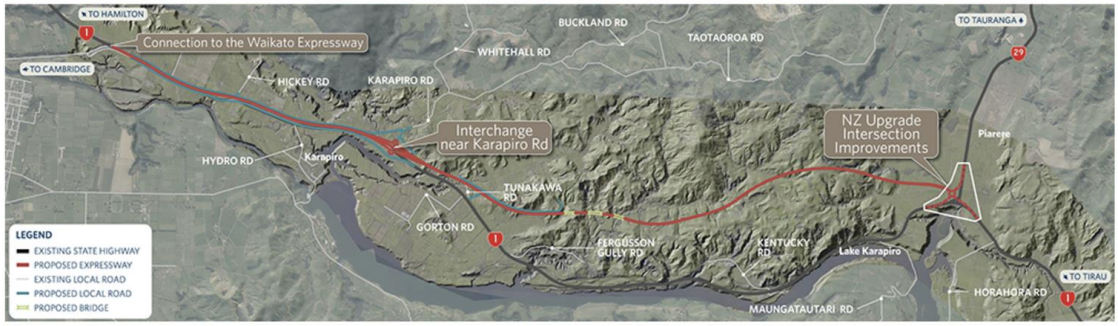
2.1 The proposed investments

Both investments for C2P and W2W on SH1 are expected to take about five years to construct, with current expectations of construction commencing in or after 2030.

2.1.1 Cambridge to Piarere

The C2P long-term improvement project was first proposed by the NZTA in 2017. The proposed route is a four-lane expressway of 16 km long, extending from the southern end of the Cambridge section of the Waikato Expressway to the intersection of SH1 and SH29 at Piarere (see Figure 1). The route alignment broadly follows the existing SH1 from the end of the Waikato Expressway to Karapiro Road, deviating onto a new offline corridor. The project is estimated to take about $635 million to build.[6]

Figure 1 Proposed SH1 Cambridge to Piarere expressway



Source: Waka Kotahi NZ Transport Agency (n.d.)

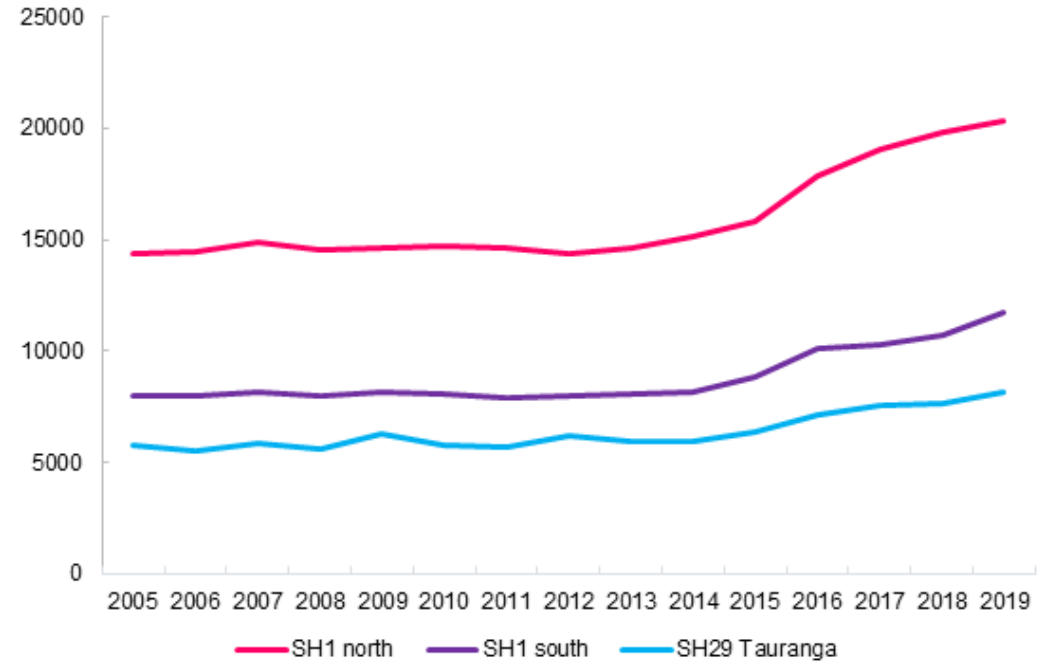
Currently, the C2P section on the state highway network is about 16.6 km long and classified as an ONRC (one road network classification) of national high-volume (Waka Kotahi NZ Transport Agency 2021b). In 2019, the average daily flow on SH1 between Cambridge and Piarere travelling to and from Upper North Island was more than 20,000 vehicles per day (Figure 2), with about 11 percent being heavy commercial vehicles (HCVs). At the SH1/29 intersection, the state highway splits into the SH1 corridor to the south and SH29 corridor to Tauranga, with 59 percent and 41 percent of the traffic volume on these two routes, respectively, and 16 percent or more being HCV movements (Waka Kotahi NZ Transport Agency 2023b). Overall, C2P is a major transport corridor and strategically important nationally, especially for freight and commercial vehicle movements. It connects the regional economies of Auckland, Waikato and the Bay of Plenty and provides an

[6] NZTA's estimate of the construction cost as at 2020.

important connection between the ports of Auckland and Tauranga (Waka Kotahi NZ Transport Agency 2021c).

Figure 2 Annual average daily traffic on the C2P corridor 2005–2019

Number of vehicles per day



Source: Waka Kotahi NZ Transport Agency (2021a; 2023b)

Previous traffic assessment has predicted that, by 2061, daily traffic flow on the C2P corridor will increase by 95 percent or more from the 2019 level[7] (Waka Kotahi NZ Transport Agency 2021c). However, NZTA's business case for C2P investment (Waka Kotahi NZ Transport Agency 2021b) contains a number of concerns with the C2P corridor's current performance in terms of efficiency, resilience and safety.

The average speed of vehicles travelling on the C2P corridor has been below the expected standard for average travel speed for a national high-volume state highway. With the predicted growing traffic and capacity on the corridor, the average speed on C2P is expected to fall below 80 km/h by 2060. As for freight trips on C2P, their travel time often vary by +12 percent on average, which is significantly greater than the standard of 5 percent freight travel time variation for a national high-volume ONRC.

Between 2015 and 2019, there were 179 unplanned events on the C2P corridor, and 13 recorded incidents resulted in full road closures with closure times ranging from 2 to 36 hours. Such frequency of unplanned incidents and duration of closure is considered unacceptable for a national high-volume state highway. While alternative routes are available during closures, they represent a significant increase in journey time and are not viable for heavy vehicles.

[7] Faster rate of growth in traffic is expected in the years immediately following the completion of the Waikato Expressway and revert to a long-run growth rate similar to the 2006-2019 period thereafter.

Regarding road safety, the C2P section on SH1 is still currently classified as a High-Risk Rural Road despite the short-term safety works already in place (Waka Kotahi NZ Transport Agency 2021b). NZTA's Crash Analysis System (CAS) data shows that between 2015 and 2019, 24 high severity crashes on this route resulted in 5 deaths and 27 serious injuries (Waka Kotahi NZ Transport Agency 2023a).

As outlined in NZTA's business case, the proposed new C2P expressway is expected to deliver the following outcomes:

- More than an 18 percent reduction in travel time per trip for SH1 users and around a 58 percent decrease in average delay per trip for freight.
- 90 percent reduction in road closures and unplanned events and ensuring that the C2P expressway will always be available as an alternative route during SH1 closures.
- Over 70 percent reduction in high-severity crashes.

2.1.2 Warkworth to Wellsford

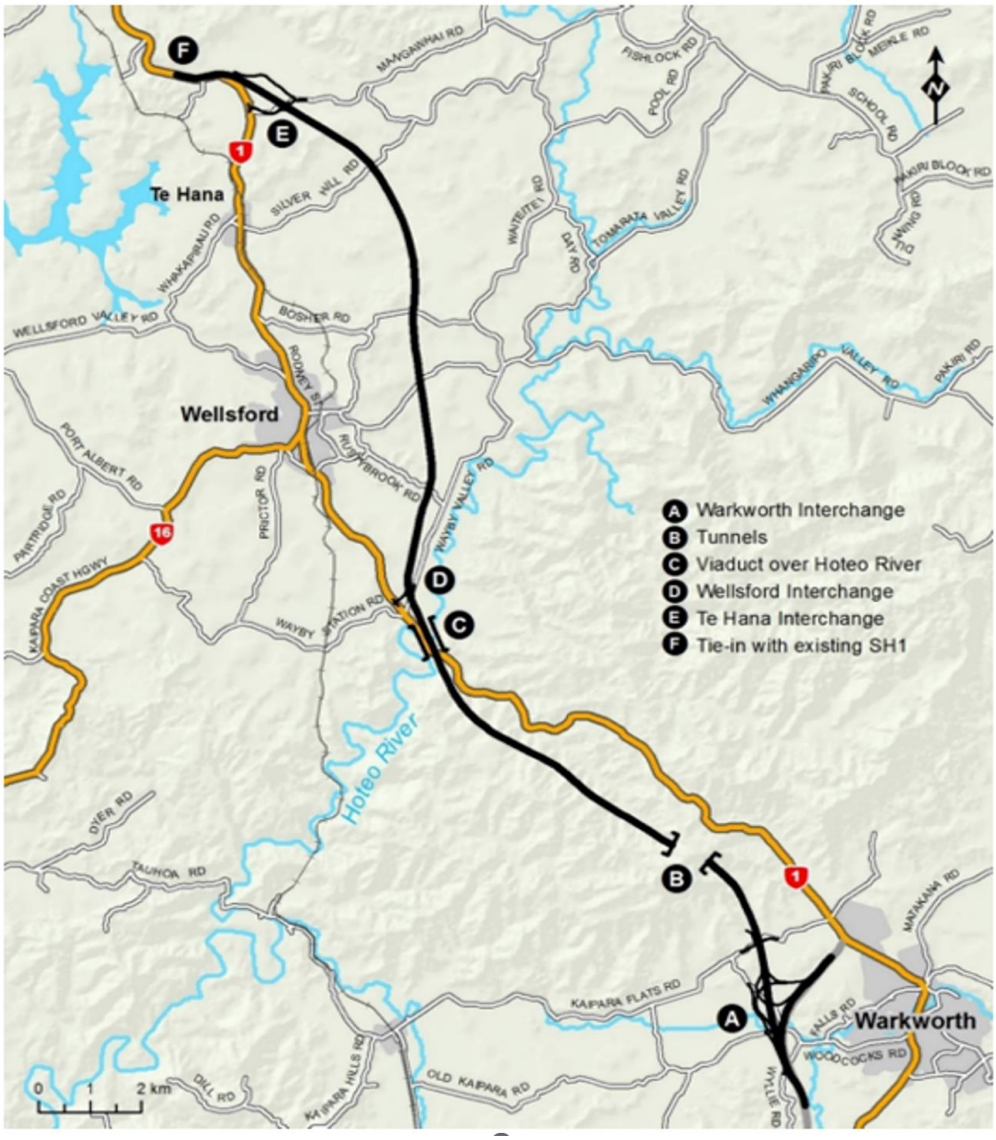
The proposed Warkworth to Wellsford (W2W) project is the second stage of the broader Ara Tūhono – Pūhoi to Wellsford project. The first stage – Pūhoi to Warkworth motorway has just started operating in June 2023.

The proposed project is a new offline four-lane state highway of approximately 26 km in length. It starts at the interface with the Pūhoi to Warkworth motorway and passes to the west of the existing SH1 near the Dome until it reaches the Hōteo River where it will head eastwards and passes to the east of Wellsford and Te Hana, bypassing both Wellsford and Te Hana townships. Three interchanges – Warkworth, Wellsford and Te Hana, and twin bore tunnels, and a viaduct will also be built as a part of the project. It is estimated that the project could cost about $2.1 billion to construct.[8]

Figure 3 shows the indicative route for the proposed W2W highway.

[8] NZIER's estimate in 2020 prices using Stats NZ's CPI based on the range of estimated construction cost (in 2017 prices) given in NZTA's detailed business case for the W2W project.

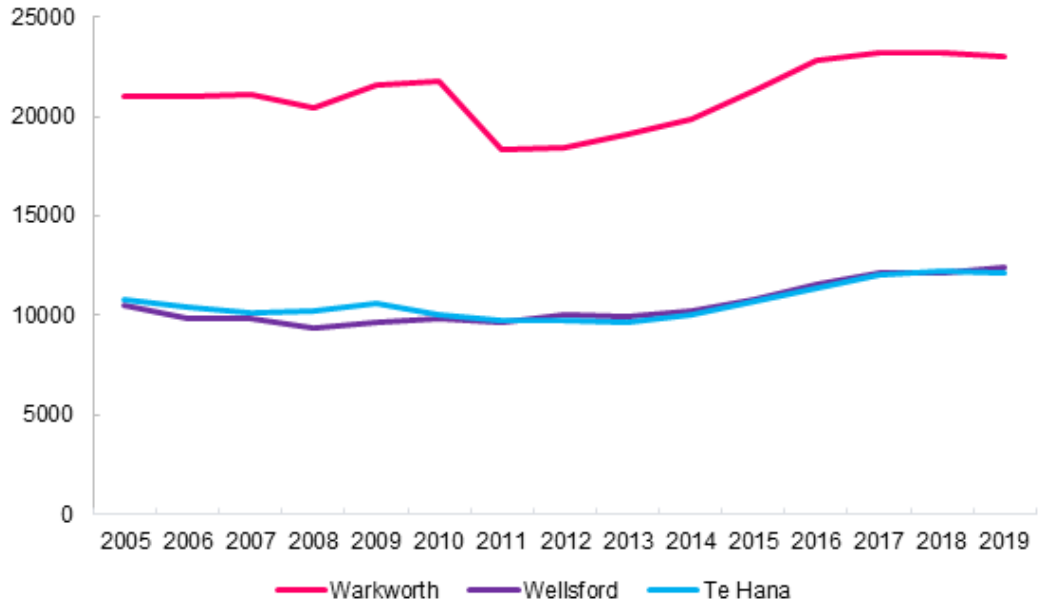
Figure 3 Proposed Warkworth to Wellsford highway



Source: Waka Kotahi NZ Transport Agency (2020)

Currently, the section between Warkworth and Te Hana on the existing SH1 is about 24 km long. The SH1 corridor between Pūhoi and Wellsford has an ONRC of national high-volume route and a national route between Wellsford and Whangārei (Waka Kotahi NZ Transport Agency 2019b). This section of SH1 is the main transport link that connects the regional economies of Northland and Auckland. Over the year 2019, an average daily flow through Warkworth via SH1 was almost 23,000 vehicles per day, more than 12,000 vehicles per day through Wellsford and Te Hana (see Figure 4). About 10–11 percent of the traffic is heavy vehicles carrying freight.

Figure 4 Annual average daily traffic on the W2W corridor 2005–2019



Source: Waka Kotahi NZ Transport Agency (2023b)

Previous transport assessments presented by NZTA suggest that traffic volumes on SH1 between Warkworth and Te Hana by 2046 could almost be double the volume on this route from 2016 levels, and the growth is expected to be more pronounced for evening peak (Waka Kotahi NZ Transport Agency 2019a).

There are a number of key concerns with the existing SH1 corridor between Warkworth and Te Hana highlighted in NZTA's assessments for the W2W investment. These include:

- Inefficient journeys: the average travel speed (<80 km/h) on the current SH1 route underperforms many other routes of the same ONRC (Waka Kotahi NZ Transport Agency 2019a; 2019b), and the variability in travel time per trip on the route has been considerable, especially during evening peak hours. With the predicted increase in travel volumes, travel time on the existing SH1 route is expected to increase further.
- Poor route resilience: between 2013 and 2018, there was about one full closure on the existing SH1 route every seven months, with a total of 29 hours of closures and an average delay of over 3 hours per closure. This section of SH1 is vulnerable to severe natural events such as major slips and flooding. While detour routes are available during closures, they represent a significant increase in travel time, and many cannot carry heavy vehicles.
- High number of crashes resulting in deaths and serious injuries: the Warkworth to Te Hana SH1 corridor is constrained by undulating landforms with restricted sightlines and steep grades in some locations, contributing to a high risk of injury crashes on the route. Between 2015 and 2019, there were 29 crashes resulting in 8 deaths and 36 serious injuries (Waka Kotahi NZ Transport Agency 2023a).

With the new W2W highway in operation, it is expected that:

- 90 percent of the traffic volumes on the existing SH1 will divert to use the new W2W highway. Travel time per trip on both the existing SH1 and the new highway will

reduce by around 10 to 16 percent[9] (depending on the time period travelled and direction) relative to without the W2W in place.

- There will be 175 fewer hours of full closures over a 30-year period compared to without the project.
- With a higher standard of design than the existing SH1 route, the total number of crashes (on SH1 and the new route combined) will reduce by over 10 percent.

2.2 Existing economic impact analysis on similar state highway investments

When the seven RoNS were proposed, NZTA investigated the potential total economic benefits, including those benefits captured by the conventional CBA approach (travel time savings, accident reductions, vehicle operating cost savings etc.) and regional and national wider economic benefits (SAHA 2010). The conventional CBA of the RoNS proposal indicated that the overall RoNS portfolio generates a net present value (NPV) of economic benefits of over $4.5 billion over the years up to 2055. Assessment of the wider economic benefits suggests the potential for further benefits to accrue to the economy from the productivity improvement generated by the direct impacts of the RoNS.[10] While there is no major difference in the overall economic outcome between a 10-year delivery timeframe and a longer timeframe, the economic benefits can be realised sooner if the investments can commence sooner.

A more recent study by Principal Economics (2022) applied CGE modelling to quantify the cost to society of delaying infrastructure investment, using the Waikato Expressway as a case study. Their results suggest that the foregone economic benefit could be as large as $334 million each year the expressway operation was delayed.

9 NZIER's updated calculation based on updated travel time information on Google Maps

10 The wider economic impact assessment on the seven RoNS was undertaken by Richard Paling Consulting (2009) and Infometrics (2010).

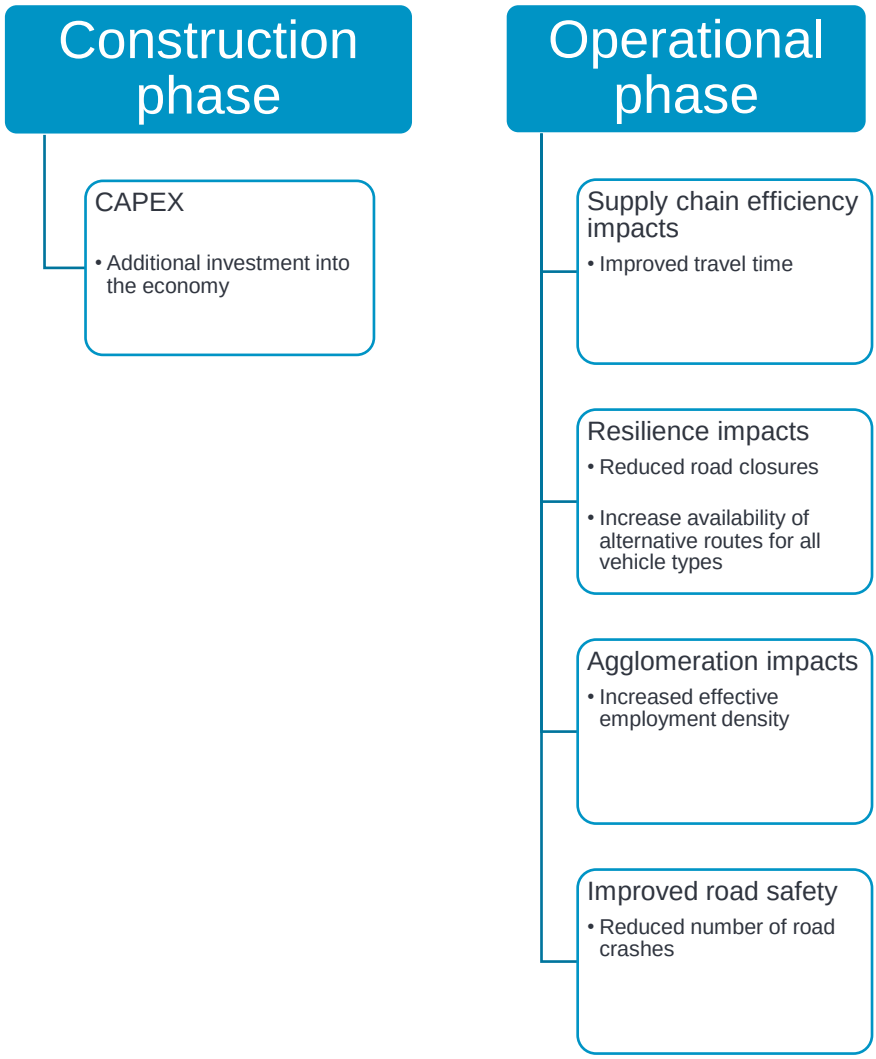
3 Methodology

We assessed the economic impact over two distinct phases of the investments – construction phase and operational phase. Figure 5 illustrates the direct impacts included in our assessment.

In the construction phase, the direct costs of building the proposed routes is regarded as a capital investment into the economy.

The four direct impacts we identified for the operational phase are in line with the drivers for long-term improvements on the C2P and W2W corridors as described in NZTA's previous business cases and transport assessments.

Figure 5 We include impacts in construction phase and operational phase



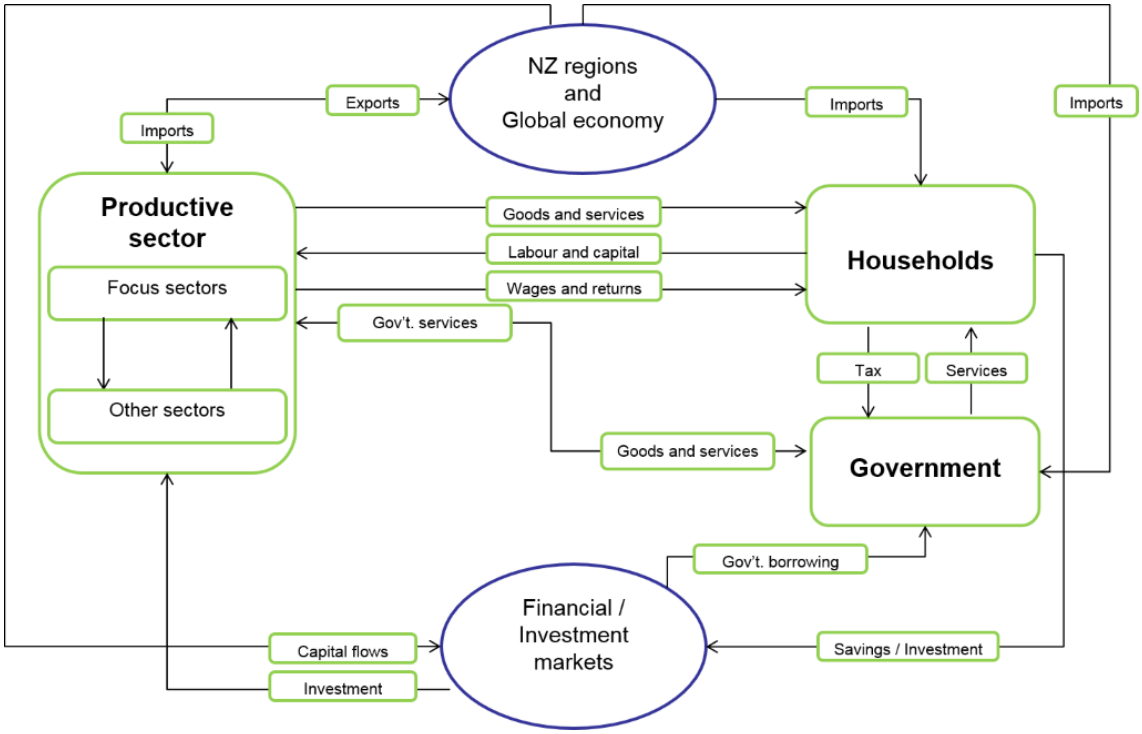
Source: NZIER

3.1 Computable general equilibrium modelling

As described in section 2.2, existing economic impact studies on similar state highway investments in New Zealand suggest the potential for indirect benefits to the supporting sectors and wider economy from gains generated from the direct impacts of the investments.

We use our regional TERM CGE model to estimate the wider economic impacts of the C2P and W2W investments. The model captures the interactions between households, industries and government in the New Zealand economy. It incorporates the complex and multidirectional relationships between the various parts of each regional economy and how they interact with the rest of New Zealand and the world (Figure 6 below).

Figure 6 NZIER's regional TERM CGE framework



Source: NZIER

We estimate the wider economic benefits of the investment by applying 'shocks' (i.e. changes to parts of the economy) as an input into our CGE model and comparing the results of the economy with and without the investment. The shocks we apply to our CGE model for the assessment of each investment are:

- Capital investment per annum over the construction phase.
- Annual change in productivity relative to the baseline (i.e. productivity shocks) from the identified direct impacts over the investment's operational phase.

3.1.1 Approach for quantifying productivity shocks in the operational phase

Modelling the investment's operational phase requires estimating the size of the productivity gains arising from each direct impact. We draw on approaches applied in relevant studies and guidelines to inform us on how direct benefits to supply chain efficiency, resilience, agglomeration and road safety can translate into productivity gains.

In NZIER's (2017) previous work on road decongestion in Auckland, direct benefits to supply chain efficiency were measured as travel time savings and vehicle operating costs for freight, trades and postal industries. Travel time savings by heavy and light commercial vehicles will lead to an increase in the combined productivity of labour and capital of those industries as they can produce goods and services with fewer resources. Using Stats NZ's Input-Output tables, the direct travel time savings benefits were translated into a percentage reduction in wages paid and return on capital as a productivity gain due to labour and capital input savings. Savings in vehicle operating costs were applied as an intermediate productivity shock to the freight, trades and postal industries. This is because reduced travel time for those industries lowers the cost for them to operate vehicles – including costs of fuel, maintenance and depreciation, which are considered as savings in intermediate inputs by those industries (Wallis and Lupton 2013).

The agglomeration impact has been widely recognised in appraisals for transport investments (SAHA 2010). A more efficient transport network enables better connectivity between people, businesses and regions so that the density of activity increases in the surrounding regional economies, leading to increased productivity. The latest edition of NZTA's MBCM (Waka Kotahi NZ Transport Agency 2023c)[11] details the general approach for quantifying agglomeration impacts on productivity from transport investments. It builds on the existing work by Maŕe and Graham (2009), which estimates agglomeration elasticities for New Zealand industries based on the relationship between effective employment density[12] and each industry's productivity.

The relevance of improving network resilience has been increasingly emphasised in recent years as a key objective for transport and infrastructure investments. Building on the concepts of resilience defined in a 2017 NZTA Research report (Money et al. 2017), McWha and Tooth (2020) identified a suite of techniques and methods to use to incorporate resilience benefits into transport investment appraisals. The authors define resilience benefits as avoided costs of disruption, and one way for approaching measuring these is to use estimates of additional travel time and vehicle operating costs (VOC) associated with diverting to alternative routes, waiting and/or deferring trips given the estimated frequency of disruptions. Drawing on the approach applied in NZIER's previous work on Auckland road decongestion, this method of measuring resilience benefits can be translated into savings in labour and capital input, as well as savings in intermediate input consumption.

We estimate road safety benefits outside CGE modelling

The research by Schiff et al. (2017) looked at a number of case studies of ex-post evaluation of transport improvement projects in New Zealand and overseas. In those case studies which put a focus on road safety impacts, they used econometric methods, but only to the extent of direct benefits associated with a reduction in road crashes. The valuation method

11 This supersedes the previous Economic Evaluation Manuals.

12 The practical use of effective employment density is to understand the available employment in a neighbourhood within a given travel time. It is calculated as $EDiS = \sum EjS\ AGCij\ S\ j$, where: ED is effective density, E is employment and AGC is the average generalised cost of travel per trip.

of road safety benefits included in NZTA's MBCM incorporates costs related to a number of crash-related consequences (Clough 2023).[13] However, the public's preference, in terms of willingness to pay to avoid a crash-related injury, represents the largest component in their valuation, while the lost output from absenteeism as a result of a crash injury represents the smallest part. Also, there is limited evidence to suggest that a reduction in road accidents can be accounted for by a gain in productivity.

Given existing work on the relationship between the reduced number or causality of crashes and productivity is scarce, we estimate road safety benefits over each investment's construction phase outside of our CGE model. We follow the general approach documented in NZTA's (2023c) MBCM and its Crash Cost Savings Worksheet, which incorporates crash factors from *Crash estimation compendium* (Waka Kotahi NZ Transport Agency 2016). We use the latest NZTA's valuation of social cost per crash, which uses the measure of households' willingness to pay for reducing deaths and injuries from road crashes. The values of those social costs are recently updated by Denne et al. (2023).

3.1.2 Shocks included in the operational phase for our CGE modelling

Figure 7 below depicts our CGE modelling process for each investment's operational phase. For each of the direct impacts, we applied productivity shocks to the most relevant sectors and to regions which are most proximate to the investments:

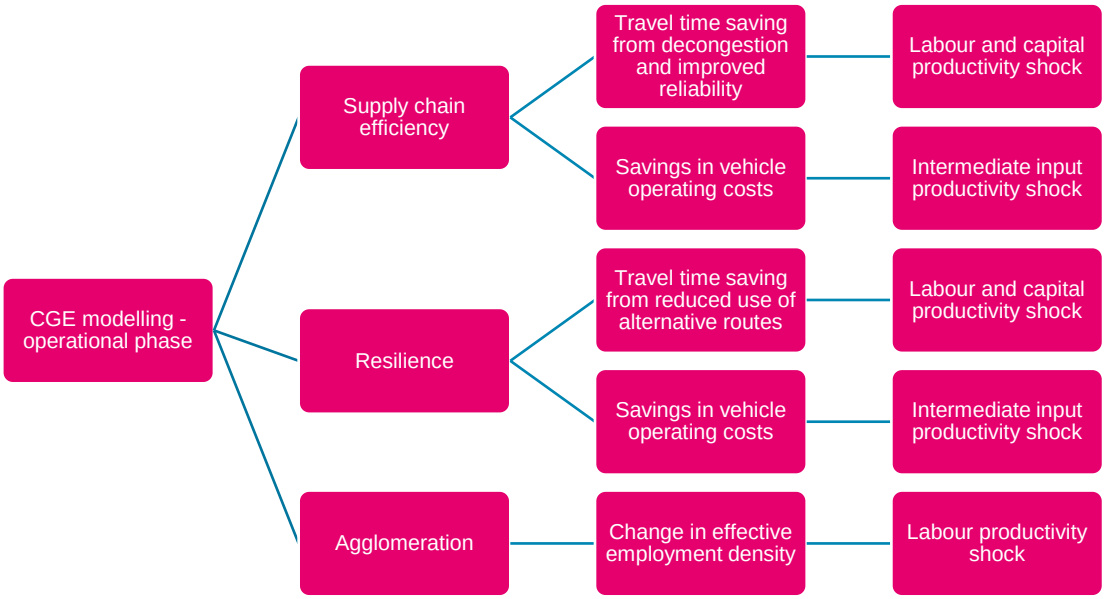
- Supply chain efficiency and resilience impacts – productivity shocks to road freight, construction services,[14] and postal and courier pick-up and delivery services[15] industries
- Agglomeration impact – productivity shocks to manufacturing, services, and wholesale and trade.

[13] The MBCM's valuation approach of crash cost includes: a) accident attendance and clean-up costs; b) hospitalisation and other medical costs; c) lost output from casualty absenteeism; d) public preference to avoid injury.

[14] Categorised as other construction in our CGE modelling.

[15] Categorised as other transport in our CGE modelling.

Figure 7 Productivity shocks into NZIER CGE model for the operational phase



Source: NZIER

3.2 Data and inputs

A wide range of inputs were required to inform the productivity shocks for CGE modelling of each investment's operational phase, including:

- Forecast traffic volume by vehicle type and time of the day
- Forecast travel time
- Forecast additional travel time during full road closures by vehicle type
- Forecast employment for regions near the C2P and W2W corridors
- Change in average cost of work-related travel
- Forecast number of crashes.

Detailed outputs from transport and growth scenario modelling are often used to inform most of the required inputs listed above. However, given the lack of access to transport and growth modelling data, we drew on information mostly from the following sources to inform our assumptions and calculations:

- NZTA's previous detailed business cases and transport assessments for the two investments
- NZTA's state highway traffic and traffic volumes
- Fleet statistics
- Economic impact studies on similar state highway investments in New Zealand
- Google Maps
- Stats NZ's business demography statistics and population projections.

Table 23 in Appendix A provides full details of the data and inputs and calculations we have undertaken in estimating direct impacts and size of productivity shocks to model the operational phase.

4 Results

This section presents our estimates of the economic impact of each investment scenario based on a comparison of the economy with and without (i.e. the baseline) each of the investments. We estimate the impacts over the construction and operational phases of each investment.

4.1 Cambridge to Piarere (C2P)

The estimated CAPEX of the Cambridge to Piarere Expressway is $635 million,[16] the construction of which we assume to take place over five years.

4.1.1 Wider economic impacts in the construction phase

Over the construction phase of the new expressway, additional capital investment will be injected into the regional economies of Waikato and the Bay of Plenty which are connected by the C2P corridor.

Table 2 presents our CGE model estimates of the economic gains from the investment. Our estimates indicate an additional growth of $9.6 million in New Zealand's annual GDP over the construction phase. Over the five-year construction lifecycle, at a discount rate of 5 percent, we estimate this amount to be an increase in GDP of $41 million.

The construction and services industries in Waikato and the Bay of Plenty will experience most of the positive impacts in the construction phase. Our CGE model captures resource constraints in an economy. This means that when significant infrastructure construction occurs in Waikato and the Bay of Plenty, it will take up resources from the other regions in New Zealand. While this will result in less economic activity, the net impact on the overall New Zealand economy over the construction period is positive relative to the absence of the investment.

Table 2 Impact on real GDP – construction phase

Change relative to baseline, ($ million)

Region	Annual growth	5-year NPV[17]
Waikato	$8.7	$37.9
Bay of Plenty	$7.2	$31.2
New Zealand	$9.6	$41.4

Source: NZIER

4.1.2 Supply chain efficiency

Based on the historic trends in average daily traffic on the C2P corridor and predicted traffic growth presented by NZTA's transport assessment on the corridor (Waka Kotahi NZ

[16] All costs and benefits are estimated at the pre-COVID baseline of 2020 prices for consistency in assessing the real impact of the investments.

[17] The discount rate applied throughout this research is 5.0% per annum derived from The Treasury's rate for roading and transport projects: https://www.treasury.govt.nz/information-and-services/state-sector-leadership/guidance/reporting-financial/discount-rates.

Transport Agency 2021c), we estimate that average daily traffic flows from all three directions of travel (north of Cambridge, Tauranga and south of Piarere) will increase by 62 percent by the year 2052.

We overlaid our traffic volume forecasts with NZTA's state highway traffic data on the C2P corridor (2023b) and the Ministry of Transport's annual fleet statistics (2022) to decompose the forecasts into heavy and light commercial vehicles (see Table 3 below).

Table 3 Forecast total daily traffic by vehicle type on the C2P corridor[18]

Forecast annual average daily traffic, vehicles per day

Vehicle type	2022	2052
Heavy	5,630	9,121
Light commercial	6,341	13,950
All vehicle types	42,958	69,548

Source: NZIER

Using information from NZTA's business case for the C2P investment on travel time saved per trip (Waka Kotahi NZ Transport Agency 2021b) and live travel time information from Google Maps, we calculated the travel time savings for heavy and light commercial vehicles. We estimate that, by 2052, the operation of the new expressway will enable an annual travel time savings of over 178,000 hours for heavy vehicles and over 193,000 hours for light commercial vehicles compared to the baseline. This will result in an annual time savings benefit of $14 million for heavy vehicles and $15 million for light commercial vehicles. The associated savings in vehicle operating costs will be just under $1 million for each vehicle type. These were estimated based on the findings in the Wallis and Lupton (2013) study that vehicle operating cost savings are about 6 percent of travel time savings.

Table 4 Impact from travel time savings for heavy and light commercial vehicles

Estimated annual impact by the year 2052

Vehicle type	Travel time savings (hours)	Time savings benefit ($ million)	VOC savings benefit ($ million)
Heavy	178,817	$13.9	$0.8
Light commercial	193,801	$15.0	$0.9

Source: NZIER

Table 5 presents the economic impact of improved supply chain efficiency after we applied the shocks to labour and capital productivity and intermediate input to the relevant industries (refer to Section 3.1.2) in our CGE model. Our results indicate that New Zealand's annual GDP will grow by $352 million due to supply chain efficiency gains relative to the economy without the investment. These gains will be heavily concentrated in the Waikato and Bay of Plenty regions, which are closest to the C2P corridor.

[18] This includes directions from and to north of Cambridge, south of Piarere and Tauranga.

Over 20 years, these economic benefits from the supply chain efficiency impacts, for the New Zealand economy amount to an increase in GDP of $4.4 billion.

Table 5 Supply chain efficiency impact on real GDP – C2P Expressway

Change relative to baseline, ($ million)

Region	Annual growth	20-year NPV
Waikato	$216.3	$2,695
Bay of Plenty	$229.6	$2,861
New Zealand	$351.8	$4,384

Source: NZIER

4.1.3 Resilience

From Google Maps, we identified the various alternative routes available when there are full closures on the C2P section of SH1 and their estimated travel time and distances. Using the information on the frequency of road closures and availability of viable options of alternative routes for heavy vehicles, we calculated the number of trips by heavy vehicles and light commercial vehicles that could be affected by SH1 closures if the C2P investment did not take place and the additional travel time during closures.

One of the outcomes, as described in NZTA's business case for the C2P (Waka Kotahi NZ Transport Agency 2021b), is that the investment will ensure that all users of SH1 will be able to use the new expressway as an alternative route during unplanned events. Based on this information, we calculated the additional travel time savings during closure events and the associated direct benefits due to better resilience on the C2P corridor (see Table 6 below).

Table 6 Impact of improved resilience for heavy and light commercial vehicles

Estimated annual impact by the year 2052

Vehicle type	Additional time savings (hours)	Time savings benefit ($million)	VOC savings benefit ($ million)
Heavy	94,693	$7.1	$0.4
Light commercial	4,282	$0.2	$0.01

Source: NZIER

Following the general approach, we estimated the productivity gains from improved resilience and applied these productivity shocks to industries considered most affected (road freight, construction services, postal and courier pick-up and delivery services). Our CGE modelling then captures the flow-on impact of these productivity gains across the economy.

As shown in Table 7, our CGE results for resilience impact shocks indicate a more modest benefit relative to the gains from improved supply chain efficiency, with an increase in New Zealand's annual GDP of $49 million.

Table 7 Resilience impact on real GDP – the C2P Expressway

Change relative to baseline, ($ million)

Region	Annual growth	20-year NPV
Waikato	$36.9	$460.2
Bay of Plenty	$25.4	$316.2
New Zealand	$48.9	$609.1

Source: NZIER

4.1.4 Agglomeration

A better roading system contributes to economic agglomeration in the local regions, resulting in cost savings and increased productivity. Such effects can be measured using the change in effective employment density, which captures how access to employment opportunities in a local area increases as the average cost of travel within a given distance for work-related purposes reduces. We calculated these effects at a regional level.

Without available estimates of additional employment growth attributable to the C2P investment, we drew on a previous economic impact assessment on RoNS (Richard Paling Consulting 2009) similar to the C2P investment to quantify the size of the investment's total employment impact.[19] This was then overlaid with Stats NZ's (2022a) business demography statistics to estimate the impact at the industry and regional levels.

Following the guideline in NZTA's MBCM (Waka Kotahi NZ Transport Agency 2023c) for quantifying agglomeration impacts, we estimate that, by 2052, the increase in effective employment density as a result of the C2P expressway operation is 9.4 percent.

Table 8 Annual agglomeration impact by the year 2052 – the C2P Expressway

Change relative to baseline

Region	Annual change
Total employment	0.2%
Effective employment density	9.4%

Source: NZIER

We input the agglomeration productivity gains as calculated from agglomeration elasticities presented in Maré and Graham (2009) into our CGE model, and we estimate that the Waikato economy will grow by $82 million annually and the Bay of Plenty economy will grow by $57 million annually as a result of agglomeration arising from the investment. For both regions, the manufacturing sector will experience much stronger growth.

[19] We drew on previous estimates of the employment impact of the Waikato Expressway and Tauranga Eastern Corridor to calculate the percentage increase in employment over a 10-year period.

Table 9 Agglomeration impact on real GDP – the C2P Expressway

Change relative to baseline, ($ million)

Region	Annual growth	20-year NPV
Waikato	$82.1	$1,023
Bay of Plenty	$57.3	$714.2
New Zealand	$86.0	$1,072

Source: NZIER

4.1.5 Safety

Benefits from improved road safety are estimated outside of our CGE model. We followed the approach described in NZTA's Manual and used NZTA's (2022) crash cost savings worksheet. The approach is based on site-specific trends in roading. Table 10 summarises the number of crashes by severity on the C2P corridor between 2015 and 2019 extracted from NZTA's Crash Analysis System (CAS) data.

Table 10 Road crashes by severity on the C2P corridor between 2015 and 2019

Crash severity	Number of crashes
Fatal	4
Serious injury	20
Minor injury	28
Non-injury	78
Total	**130**

Source: Waka Kotahi NZ Transport Agency (2023a)

The C2P investment's objective in terms of road safety is to reduce the number of high-severity crashes (i.e. those that lead to deaths and serious injuries) by 70 percent. Inputting this information into the crash cost savings worksheet and adjusting for non-reported crashes as guided by NZTA's manual, we have estimated the road safety benefits shown in Table 11.

Our estimates indicate that by having the C2P Expressway in operation, annual costs associated with road crashes will reduce by $7.1 million per annum. At a discount rate of 5 percent, over 20 years, this equates to $88.5 million. This is the road safety benefit to the New Zealand economy as a whole. It is also important to note that the estimates represent the direct savings in costs to households from the reduced occurrence of crashes on the C2P corridor due to the C2P investment being in place. Some of the flow-on effects from improved safety are already captured through the investment's resilience impact, given fewer crashes means fewer incidents resulting in road closures on the C2P corridor.

Table 11 Benefits from improved safety – the C2P Expressway

Change relative to baseline, ($ million)

Impact	Annual benefit	20-year NPV
Savings in road crashes	$7.1	$88.5

Source: NZIER

4.2 Warkworth to Wellsford (W2W)

The estimated CAPEX of the Warkworth to Wellsford is $2.1 billion, the construction of which we assume to take place over five years.

4.2.1 Wider economic impacts in the construction phase

Over the construction phase of the new highway, capital investment will be injected into the regional economies of Auckland and Northland, which are connected by the W2W corridor.

Table 12 presents our CGE model estimates of the economic gains from the investment scenario compared to if no investment is made. Our estimates indicate additional growth of $19.5 million in New Zealand's annual GDP during the construction phase. Over the five-year construction lifecycle, at a discount rate of 5 percent, this amounts to $84 million.

Similar to the C2P investment, gains over the construction phase are concentrated in the services and construction sectors. At the regional level, while gains to Auckland are greater in dollar value, the Northland economy will see greater economic gains as a proportion of its regional GDP. The construction does mean a redistribution of resources and hence economic activity from the rest of the country to Auckland and Northland.

Table 12 Impact on real GDP in the construction phase

Change relative to baseline, ($ million)

Region	Annual growth rate	5-year NPV
Northland	$4.3	$18.5
Auckland	$25.3	$109.4
New Zealand	$19.5	$84.4

Source: NZIER

4.2.2 Supply chain efficiency

Based on the historic trends in average daily traffic on SH1 between Warkworth and Te Hana, we estimated that the average total daily traffic flows going through Wellsford and Te Hana will exceed 70,000 by the year 2052. This traffic growth rate is in line with the rate indicated in NZTA's previous business case and transport assessment for the W2W investment (Waka Kotahi NZ Transport Agency 2019a; 2019b). Table 13 below shows our forecast average daily traffic decomposed into heavy and light commercial vehicles.

Table 13 Forecast total daily traffic by vehicle type on the W2W corridor[20]

Forecast annual average daily traffic, vehicles per day

Vehicle type	2022	2052
Heavy	2,709	7,239
Light commercial	4,145	15,076
All vehicle types	27,110	72,540

Source: NZIER

Informed by live travel information on Google Maps and NZTA's forecast of travel time for the baseline and with the investment in place (Waka Kotahi NZ Transport Agency 2019a), we estimate that, by 2052, the new highway on the W2W corridor will reduce travel time by over 114,000 hours and over 275,121 hours per annum for heavy and light commercial vehicles, respectively, relative to if the W2W investment did not go ahead. This is attributable to the decongestion of the existing SH1 route and the new highway's better design.

Table 14 Impact of travel time savings for heavy and light commercial vehicles

Estimated annual impact by the year 2052

Vehicle type	Travel time savings (hours)	Time savings benefit ($ million)	VOC savings benefit ($ million)
Heavy	114,397	8.9	$0.5
Light commercial	275,121	$16.4	$1.0

Source: NZIER

Table 15 summarises the wider economic impact of improved supply chain efficiency due to the time savings benefit and vehicle operating cost savings to road freight, construction services and postal industries. Our results show an increase in New Zealand's annual GDP of $399 million as a result of these supply chain efficiency gains arising from the investment. These economic gains will be concentrated mostly in Northland and Auckland, which are connected by the corridor.

With a discount rate of 5 percent per annum, we estimate these supply chain efficiency gains will amount to an increase in New Zealand GDP of $5.0 billion over 20 years.

[20] This includes directions from and to Wellsford and Te Hana.

Table 15 Supply chain efficiency impact on real GDP – the W2W highway

Change relative to baseline, ($ million)

Region	Annual growth	20-year NPV
Northland	$166.8	$2,079
Auckland	$360.0	$4,486
New Zealand	$399.3	$4,976

Source: NZIER

4.2.3 Resilience

We identified a number of alternative routes on the current W2W corridor, with additional travel time ranging from 20 minutes to up to an hour. For heavy vehicles, the availability of viable options in times of SH1 closures is very limited, so they mostly tend to wait or defer their journeys when the route is closed.

Between 2013 and 2018, there was about a full closure on the existing SH1 route every seven months, with a total of 29 hours of closure and an average delay of over 3 hours per closure. One of the triggers for investing in the new W2W highway is if the total number of closure hours per annum were to increase by 30 percent, but the investment is expected to result in 175 fewer closure hours over 30 years (Waka Kotahi NZ Transport Agency 2019b). Based on this information, we calculated the additional time savings for heavy and light commercial vehicles as a result of reduced closure hours arising from the investment. Our estimates are shown in Table 16 below.

Table 16 Impact of improved resilience for heavy and light commercial vehicles

Estimated annual impact by the year 2052

Vehicle type	Additional time savings (hours)	Time savings benefit ($million)	VOC savings benefit ($ million)
Heavy	4,506	$0.3	$0.02
Light commercial	2,665	$0.2	$0.01

Source: NZIER

Applying the productivity gains as a result of additional time savings and vehicle operating cost savings to the relevant sectors, we estimate an increase in annual GDP of $2.6 million as a result of improved resilience arising from the investment (see Table 17).

Table 17 Resilience impact on real GDP – the W2W highway

Change relative to baseline, ($ million)

Region	Annual growth	20-year NPV
Northland	$1.5	$18.6
Auckland	$2.1	$26.0
New Zealand	$2.6	$31.9

Source: NZIER

4.2.4 Agglomeration

The W2W investment enables a better connection between Northland and Auckland, which increases the accessibility of business and employment in these two regions and helps lift productivity.

In the absence of available estimates of the additional employment growth that would be generated by the operation of the new W2W highway, we drew on previous economic impact assessments on a similar state highway project[21] to quantify the size of the investment's total employment impact to Northland and Auckland.

Following the guideline in NZTA's MBCM (Waka Kotahi NZ Transport Agency 2023c) for quantifying agglomeration impacts, we estimate that, by 2052, the increase in effective employment density as a result of the W2W investment is 14.8 percent (see Table 18).

Table 18 Annual agglomeration impact by the year 2052 – the W2W highway

Change relative to baseline

Region	Annual change
Total employment	0.1%
Effective employment density	14.8%

Source: NZIER

Applying the same method we used for estimating the C2P investment's agglomeration benefits, our CGE model results suggest that the agglomeration effects of the W2W highway are significant to both Northland and Auckland relative to the size of their economies. We estimate that Northland will experience additional growth in its annual GDP of $28 million and Auckland will experience an additional growth of $119 million in its annual GDP (see Table 19). For Northland, these agglomeration benefits are concentrated in the manufacturing and tourism sectors, whereas for Auckland, the gains are concentrated in the manufacturing and services sectors.

[21] We drew on previous estimates of the employment impact of the Pūhoi-Warkworth project by Richard Paling Consulting (2009) to calculate the percentage increase in employment over a 10-year period.

Table 19 Agglomeration impact on real GDP – the W2W highway

Change relative to baseline, ($ million)

Region	Annual growth	20-year NPV
Northland	$28.4	$353.9
Auckland	$119.2	$1,485
New Zealand	$95.3	$1,188

Source: NZIER

4.2.5 Safety

Table 20 summarises the number of crashes by severity on the W2W corridor between 2015 and 2019.

Table 20 Road crashes by severity on the W2W corridor between 2015 and 2019

Crash severity	Number of crashes
Fatal	8
Serious injury	21
Minor injury	57
Non-injury	163
Total	**249**

Source: Waka Kotahi NZ Transport Agency (2023a)

NZTA's previous transport assessment for the W2W investment forecasts an overall 10 percent reduction in crash causality on the corridor (Waka Kotahi NZ Transport Agency 2019a). This is driven by the significant diversion of traffic from the existing SH1 route onto the new highway and the highway's better route design.

Applying the same method we used in our estimation of road safety benefits for the C2P investment, we estimate an annual road safety benefit of $5 million for New Zealand as a whole. This amounts to a benefit of $62 million over a 20-year operational period (see Table 21 below).

Our estimate of road safety benefit represents the direct savings in costs to households from the reduced occurrence of crashes relative to if the W2W highway was not built.

Table 21 Benefits from improved safety – the W2W highway

Change relative to baseline, ($ million)

Impact	Annual benefit	20-year NPV
Savings in road crashes	$5.0	$62.2

Source: NZIER

5 Conclusion

Our assessment of the wider economic impacts of the C2P and W2W shows each investment will contribute significant economic gains for the regions connected by the transport corridors and the New Zealand economy. While the economic returns from the capital investment in terms of additional GDP growth during their construction are moderate, there are long-lasting benefits to the wider economy once the investments become operational.

After the completion of the project construction, our CGE model results show the C2P and W2W investments will increase New Zealand's annual GDP by $487 million and $497 million, respectively, with most of the benefits flowing to regions connected by the corridors. Each investment will deliver economic gains of over $6 billion over the first 20 years of their operation. This is a much greater return compared to the initial capital expenditure during their construction.

Breaking down the estimated economic benefits by component, Table 22 shows that supply chain efficiency benefits represent over 70 percent of the total economic benefits, and agglomeration benefits comprise another 17 to 19 percent. The significance of supply chain efficiency and agglomeration impacts reflects the importance of enabling a more efficient roading system for freight, businesses and people. The cost savings from reduced travel time can help lift productivity significantly.

Table 22 Annual economic benefits once investments are operational

Annual change relative to baseline, $ million

Benefit component	Cambridge to Piarere		Warkworth to Wellsford	
	Annual growth	20-year NPV	Annual growth	20-year NPV
Supply chain efficiency	$351.8	$4,384	$399.2	$4,976
Resilience	$48.9	$609.1	$2.6	$31.9
Agglomeration	$86.0	$1,072	$95.3	$1,188
Total	**$486.7**	**$6,065.0**	**$497.1**	**$6,195.4**
Road safety[22]	$7.1	$88.5	$5.0	$62.2

Source: NZIER

Our results illustrate sizeable economic benefits could be forgone if either the C2P or W2W investment did not go ahead. While delaying the investment may not lead to a material change in economic benefits per se, it defers the timing of when those gains for the New Zealand economy are realised.

[22] Road safety benefits are not strictly additive to other values in Stats NZ's System of National Accounts. This is because the largest share of fatal and serious injuries is a non-market value derived from people's willingness to pay for improved safety. Reducing that portion of those accidents does not save any actual money per se for production in the New Zealand economy. This means some of the estimated safety value extends beyond what the New Zealand GDP measures.

Our estimates of wider economic benefits are conservative

Due to the lack of accessibility to detailed outputs from transport and growth scenario modelling and forecast employment impact of the C2P and W2W investments, most of our calculations for our CGE modelling inputs are informed by historic trends, forecasts and estimated impacts presented in previous business cases and transport assessments by NZTA and previous work on similar state highway investments, which are considered conservative. While the precision of our estimates could be improved with access to more detailed data, at this stage, we consider our results err on the conservative side.

Our traffic volumes and employment calculations are based on trends prior to the COVID-19 pandemic due to the pandemic's considerable short-term distortion on transport movement and economic activity between 2020 and 2021. Nonetheless, in the context of a transport infrastructure investment spanning several decades, we consider this a minor risk.

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Appendix A Details of data and inputs used for CGE modelling

Table 23 Data and inputs used for our analysis

Required input	Data/information used	Sources	Calculation by NZIER
Forecast traffic volume by vehicle type and time of the day	State highway traffic volumes – trends and growth	Waka Kotahi NZ Transport Agency (2023b; 2021a; 2021d; 2019a)	Forecast traffic volumes of heavy vehicles and light vehicles for baseline
	New Zealand fleet statistics	Ministry of Transport (2022)	Share of light commercial vehicles in light vehicle fleet
	Hourly traffic	Waka Kotahi NZ Transport Agency (2021a)	Traffic volume breakdown by AM peak, PM peak and other hours by vehicle type
	Percentage diverted onto the new route	Waka Kotahi NZ Transport Agency (2019a; 2019b)	Forecast traffic volume on SH1 and the new route by vehicle type in the operational phase
Forecast travel time	Current travel time on SH1 during AM peak, PM peak and other hours	• Google Maps • Ministry of Transport (2016) • Waka Kotahi NZ Transport Agency (2021b)	Current average speed for cars and heavy vehicles
	Predicted future travel time per trip or average travel speed under baseline	Waka Kotahi NZ Transport Agency (2019a; 2019b; 2021b)	Rate of increase in travel time per trip for cars and heavy vehicles under baseline
	Expected reduction in travel time/delay in the operation phase	Waka Kotahi NZ Transport Agency (2021b; 2019b; 2019a)	Average travel time and speed in the operational phase by vehicle type
Benefits from improved supply chain efficiency for road freight, trades and postal industries	Value of time for work travel	Waka Kotahi NZ Transport Agency (2023c)	Value of travel time savings for heavy and light commercial vehicles, adjusted to March 2020 prices
	Savings in vehicle operating costs from reduced travel time	Wallis and Lupton (2013)	Savings in vehicle operating costs of heavy and light commercial vehicles
Traffic affected during full SH1 closures by vehicle type	Frequency of full closures and average duration of closures – current and predicted	Waka Kotahi NZ Transport Agency (2021b; 2019a; 2019b)	Traffic affected during full closure hours by vehicle type – baseline and with the new route in operation
Additional travel time during closures	Distance and average travel time on alternative routes	• Google Maps • Waka Kotahi NZ Transport Agency (2021b; 2019b; 2019a)	Savings in additional travel time for heavy and light commercial vehicles during closures
	Choice of alternative routes	NZIER assumptions based on existing information	

Required input	Data/information used	Sources	Calculation by NZIER
Long-term employment projections by region and NZIER CGE economic sectors	Employment projections for Auckland and Waikato regions	Auckland Council (2017); Waikato Regional Council (2021)	Baseline employment projections by economic sector for Northland, Auckland, Waikato and Bay of Plenty
	Employee counts by region and industry	Stats NZ (2022a)	
	Subnational population projections	Stats NZ (2022b)	
	National labour force projections	Stats NZ (2021)	
Expected increase in employment in the operational phase	Estimated 10-year employment effects from RoNS	Richard Paling Consulting (2009)	Total 10-year employment impact as a percentage of the baseline projected employment
	NZIER assumptions drawing on estimated employment impact of similar RoNS projects	NZIER	
Change in effective employment density relative to the baseline	Proportion of light passenger vehicles used for work-related travel	Waka Kotahi NZ Transport Agency (2023c)	• Number of hours for work-related travel across all vehicle types • Weighted average cost per work-related trip
Productivity gains from agglomeration impacts by NZIER CGE economic sector	Average agglomeration elasticities by ANZSIC06 industry	Waka Kotahi NZ Transport Agency (2023c)	Weighted average agglomeration elasticities by economic sector
Number of crashes by severity	CAS (Crash Analysis System) data	Waka Kotahi NZ Transport Agency(2023a)	Costs associated with road crashes in the baseline and with the new route in operation
	Percentage reduction in crashes	Waka Kotahi NZ Transport Agency (2021b; 2019b; 2019a)	
	Crash cost savings worksheet	Waka Kotahi NZ Transport Agency (2023c)	

Source: NZIER

Appendix B Detailed CGE modelling results

This Appendix provides sector and regional results from our CGE model for wider economic impacts from each of the investment's construction and agglomeration impacts.

Table 24 Estimated annual increase in sector's nominal output during the C2P investment's construction phase – by region

Change relative to the baseline, $ million

Sectors in our model	Waikato	Bay of Plenty	New Zealand
Road freight	$0.3	$0.2	-$0.001
Other transport	$0.1	$0.2	$0.004
Civil construction	$20.0	$17.1	$32.7
Other construction	$5.6	$5.5	-$12.7
Manufacturing	-$1.0	-$0.9	-$0.8
Services	$9.0	$7.2	$0.8
Wholesale & trade	$2.3	$1.6	$0.4
Tourism	$0.5	$0.3	$0.9
Rest of the economy	-$0.4	-$0.5	$0.4
Total	**$36.2**	**$30.8**	**$21.6**

Source: NZIER

Table 25 Estimated annual increase in sector's nominal output from the C2P investment's agglomeration impact – by region

Change relative to the baseline, $ million

Sectors in our model	Waikato	Bay of Plenty	New Zealand
Road freight	$3.5	$2.2	$4.7
Other transport	$0.8	$1.7	$5.0
Civil construction	$1.7	$1.5	$1.3
Other construction	$4.3	$3.1	$4.4
Manufacturing	$67.2	$39.0	$59.2
Services	-$3.8	-$0.6	$0.8
Wholesale & trade	-$0.8	$0.4	$45.2
Tourism	$1.2	$1.6	$2.4
Rest of the economy	-$44.9	$17.6	$46.3
Total	**$118.8**	**$66.5**	**$170.2**

Source: NZIER

Table 26 Estimated annual increase in sector's nominal output during the W2W investment's construction phase – by region

Change relative to the baseline, $ million

Sectors in our model	Northland	Auckland	New Zealand
Road freight	$0.1	$0.5	-$0.1
Other transport	$0.1	$0.6	$0.1
Civil construction	$10.3	$63.1	$67.8
Other construction	$2.7	$4.2	-$28.0
Manufacturing	-$0.4	-$1.5	$0.3
Services	$4.4	$20.7	-$2.2
Wholesale & trade	$0.9	$5.0	-$0.04
Tourism	$0.3	$0.1	$1.0
Rest of the economy	-$0.1	$0.8	$2.7
Total	**$18.3**	**$93.5**	**$41.7**

Source: NZIER

Table 27 Estimated annual increase in sector's nominal output from the W2W investment's agglomeration impact – by region

Change relative to the baseline, $ million

Sectors in our model	Northland	Auckland	New Zealand
Road freight	$1.2	$16.5	$11.5
Other transport	$0.6	$24.7	$22.4
Civil construction	$0.6	$11.0	-$0.6
Other construction	$1.3	$36.9	$10.7
Manufacturing	$26.1	$326.6	$177.2
Services	$0.3	$103.2	$169.2
Wholesale & trade	-$2.0	$22.4	$6.5
Tourism	$2.2	$57.9	$64.4
Rest of the economy	$15.2	$95.6	$29.7
Total	**$45.7**	**$694.9**	**$491.0**

Source: NZIER

Appendix C Regional CGE model

We used our regional CGE model to undertake this assessment. CGE models are now our **preferred method for assessing economic impact of major regional investments** and are used extensively in New Zealand and internationally. As a recent commentary noted, "a well-designed [CGE] model that is used by skilled practitioners to shed light on issues the model was designed to illuminate can make a significant contribution to policy debates and decision making".[23]

Using actual economic data, CGE models estimate how the regional or national economy reacts to major projects or changes in policy, technology or other external factors. CGE models are useful whenever we wish to estimate the effect of changes in one part of the economy upon the rest of the economy.

CGE modelling is widely regarded as **more robust and provides more credible impact assessments** than input-output ('multiplier') methodologies.

CGE models are not only driven by prices that respond to changes in supply and demand, but they also account for resource constraints and flow-on effects. That is, in a CGE model, there are no "free lunches".

CGE models therefore produce **more conservative but more credible economic impacts** compared to multiplier methodologies.

NZIER no longer offers multiplier-based analysis of major projects to our clients. In our view, presenting the inevitably inflated figures that are produced by a multiplier study reflects poorly on NZIER. We are proud of our independence and reputation for delivering high quality, data-driven analysis. Multiplier studies no longer align with this reputation.

Another advantage of using our CGE models is that they are **understood and well respected in official circles**. The Ministry of Business, Innovation and Employment, Treasury, the Ministry of Foreign Affairs and Trade and the Ministry for Primary Industries have all commissioned NZIER to conduct policy analysis or sectoral impact studies using these models. Both MBIE and Treasury have highlighted the inherent flaws in using multiplier studies for serious economic analysis.[3]

Methodology and scenario development

NZIER's regional CGE model TERM-NZis a bottom-up model of the New Zealand economy.

TERM-NZ is based on a Stats NZ's Input-Output table that identifies the structure of the industries involved. TERM-NZ contains information on 206 industries, 206 commodities and 15 regions (88 subregions).

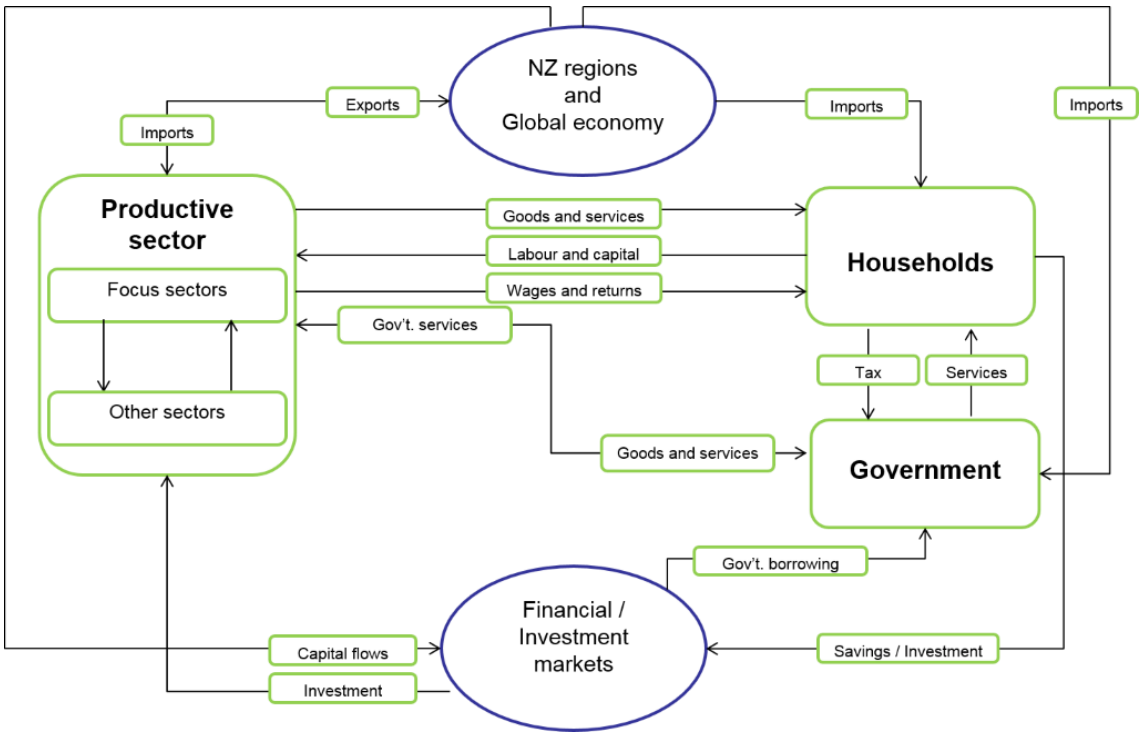
In the TERM-NZ model, each of the fifteen regions is modelled as its own economy, but all the regions are linked via inter-regional trade and flows of capital and labour. National results can be shown by the summation of the regional results.

TERM-NZ is the only bottom-up regional CGE model of the New Zealand economy. A visual representation of TERM-NZ is shown in Figure 8. It highlights how the model can capture

23 Denniss, R. 2012 The use and abuse of economic modelling in Australia, Australia Institute Technical Brief No. 12.

the complex and multidirectional relationships between the various parts of each regional economy and how they interact with the rest of New Zealand and the rest of the world.

Figure 8 CGE models show the whole economy



Source: NZIER