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Subject The potential local and regional impacts of COVID-19 in New Zealand with a focus on tourism

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Note: Given the recent global events, we have refocused our paper on the potential economic effects of COVID-19 on New Zealand tourism instead of looking at an increase in tourism and foreign students.

1.1 Abstract

Due to the on-going global COVID-19 pandemic, there is a growing concern regarding its potential impacts on economies. With restrictions on entry and movements imposed by most countries, the tourism industry is particularly at risk. In New Zealand, where tourism contributes 5.8 percent to the national GDP and represents 20 percent of national exports, businesses in the tourism industry are already starting to see the effects of the latest travel restrictions imposed by the government.

We present a CGE modelling application with a disaggregated tourism sector in our database to explore the potential impacts of COVID-19 on tourism for the local, regional and national New Zealand economies.

In this paper, we focus on New Zealand's major urban areas and tourist destinations in New Zealand, and we use a multi-regional bottom-up computable general equilibrium (CGE) model based on the original TERM model (Wittwer 2012, 2017). TERM-NZ is calibrated using Statistics NZ's 2013 Input-Output tables and updated with the latest National Accounts data available. The model database has been extended so that it contains information on 149 industries, 149 commodities and 88 districts. This includes 68 territorial authorities across New Zealand plus, within Auckland, 20 local community boards. It includes a tourism sector that can distinguish between domestic tourism, foreign tourism and foreign students.

We also provide an overview of the methodology we used to prepare the TERM-NZ database, focusing on tourism industries and regional detail. We use a 54-sector, 10-region aggregation of the model to simulate the effects of the ongoing COVID-19 pandemic. To this extent, we model three scenarios, each representing a different level of alert defined by the New Zealand government and associated with different degrees of foreign and domestic travel restrictions, including a travel ban, borders closures and confinement.

Key words: computable general equilibrium, tourism, New Zealand, COVID-19, pandemic.

1.2 Introduction

The outbreak of COVID-19, which started in China in December 2019, has since spread to the rest of the world and was recognised as a pandemic on 11 March 2020. COVID-19 has brought major disruptions in the global economy as many countries have closed their borders to foreign visitors and adopted measures of social distancing and confinement.

Due to its geographic isolation, New Zealand has been able to watch as the situation evolved in China, Italy, Spain, France and the USA. As a consequence, the country rapidly implemented strict measures to limit and contain the spread. New Zealand's lockdown was imposed on 25 March 2020 when the country had only 262 cases.

As of April 8, New Zealand's confirmed and probable cases reached 1,160. Similarly to other countries, New Zealand closed its borders to foreign travellers and declared a 4-week confinement period with all business premises closed except for essential services such as medical, pharmaceutical and food supply.

The duration of the New Zealand's business restrictions under COVID alert levels is uncertain and will mostly depend on how fast the country can flatten the curve.[1] If the lockdown succeeds, social distancing measures will be eased, and non-essential businesses will be able to re-open. However, borders are likely to remain closed or entry to the country severely curtailed for the next few months. Given the importance of the tourism sector for the New Zealand economy, COVID-19 is expected to have significant negative impacts for the economy.

To date, no publicly available study has looked at the economic impacts of COVID-19 on New Zealand and its tourism sector using a CGE modelling framework. Through the work presented here, we provide an attempt to fill the gap by focusing on measuring the impacts of COVID-19 on tourism and the wider economy, at both the regional and national levels. Using our regional bottom-up CGE model, TERM-NZ, which allows for a disaggregated tourism sector, we model three different scenarios to better understand the potential economic impacts of COVID-19 on foreign and domestic tourism in New Zealand.

The paper is structured as follows. We first conduct a literature review to explore what has been done in terms of CGE modelling regarding tourism and pandemics and we present a snapshot of the New Zealand tourism sector. We then outline the model, scenarios and input data used for our modelling application. In the subsequent sections, we present and discuss results, as well as the conclusions drawn for industry stakeholders and policy-makers.

1.3 Literature review

Measuring the contribution of tourism to a national economy is a difficult exercise as, on the demand-side, tourism represents the sum of tourist expenditure on a wide range of products. From the supply-side, tourism can be viewed as a collection of productive activities that are mostly used by tourists. As such, tourism is not identified as a single industry in national accounts (United Nations, 2010).

A significant amount of research work has been done over the last few decades to fill the gap and better estimate the economy-wide effects of tourism.

Until recently, tourism analysis was heavily relying on Input-Output (I-O) analysis. Archer (1977) and Fletcher (1989) provide examples of and discuss some of these studies. However, I-O models suffer several shortcomings. For example, they assume that all wages and prices remain constant, regardless of the levels of production and demand. Hence, they consider that economic resources such as land, labour and capital are infinitely available, are never idle or can be reallocated without adjustment costs. They also do not consider any crowding out effects (Dwyer et al, 2004). As such, I-O models can lead to misleading results, including in tourism analysis, as they do not take into account the effects of tourism on factor prices, incomes or income distribution.

In contrast, CGE models are not only driven by prices that respond to changes in supply and demand, they also account for resource constraints and flow-on effects. Contrary to I-O analysis, CGE models capture the complex and multidirectional flows between tourism, other sectors in the economy and foreign producers and consumers.

Given their versatility, CGE models have recently appeared as a relevant and important tool for tourism policy analysis (Dwyer, 2015), and as such, are now increasingly used for tourism economic analysis and policy implications. CGE analysis of tourism has been facilitated with the introduction of tourism satellite accounts (TSAs) in the mid-1990s,[2] which have enabled tourism to be identified as an economic

[1] I.e. reduce the number of new cases.

[2] Canada was one of the first to adopt a tourism satellite account and published results in 1994, followed by other countries such as France, New Zealand, Mexico, Norway, Singapore, Sweden and the USA (United Nations, 2010).

driver for GDP, employment, investment, and consumption. See Dwyer et al. (2006) for an illustration and discussion on the differences, similitudes and complementarities between TSAs and CGE application.

In the last fifteen years or so, applications of CGE modelling in tourism has included evaluation of the economic contribution of the tourism sector (Dwyer et al., 2003), economic impact evaluations of government policies (Blake and Sinclair, 2003) changes in inbound tourism (Dwyer et al., 2003, Dixon et al., 2019) and changes in the number of foreign students (Dixon et al., 2019).

Several studies that use CGE modelling have also looked at the impacts of a special event or crisis, including disease pandemic. For example, Dixon et al. (2001), Giesecke et al. (2012 and 2015), Nassios and Giesecke (2018), all looked at the tourism and economy-wide effects of the 9/11 terrorism attack in Australia. Other studies, such as Moss et al. (2016) explore the impacts of a possible Ebola outbreak in the Asia-Pacific.

Dwyer et al. (2006) use a CGE model of the Australian economy to show that the effects of SARS on the Australian tourism industry were less severe than what was perceived by stakeholders of the tourism industry. Authors show that the economic impact of a crisis on an economy is contingent on whether cancelled or delayed outbound travel are substituted by savings, domestic tourism, or for the purchases of other goods and services. The results indicate that substitution effects must be considered in estimating the impact of some adverse situation on the economic contribution of tourism to a destination.

Keogh-Brown et al. (2010) and Smith et al. (2011) use a CGE model to measure the potential economic impact of a global infectious disease pandemic on the United Kingdom, France, Belgium and the Netherlands. In both papers, authors conclude that the impact of a pandemic influenza is less significant than disease mitigation policies, such as school closures and increased absenteeism of healthy workers.

Verikios et al. (2015) assess the global effects of two influenza pandemics with a global CGE model and show that the economic impacts are more significant in the case of a pandemic characterised by high infectiousness and low virulence, rather than a pandemic with low infection rate and high virulence.

More recently and topical, Wittwer (2020) used a multi-regional, dynamic CGE model of Australia, TERM-WINE, to provides an assessment of the economic impacts induced by bushfires and COVID-19 in the country, with a particular focus on the grape and wine sectors.

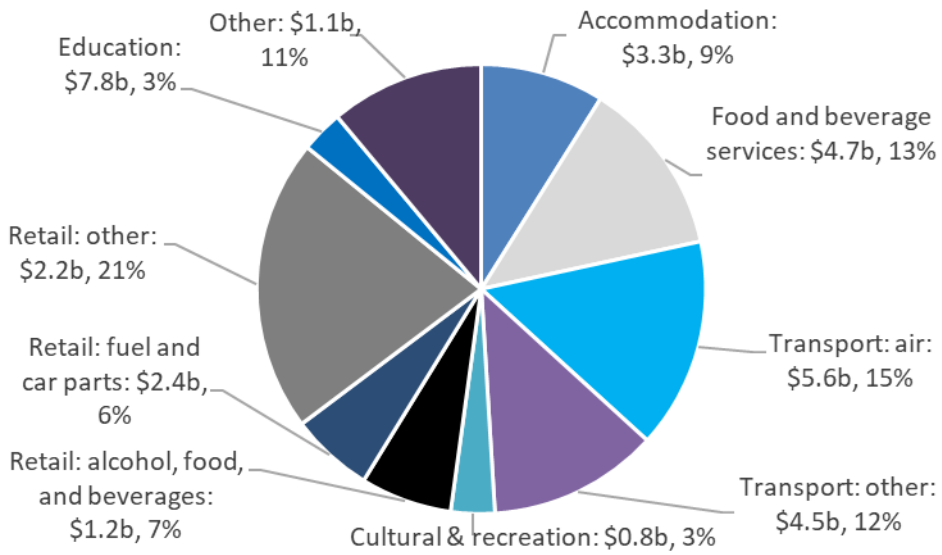
As far as we know, no publicly available study has been done that looks at the economic impacts of a disease pandemic on tourism and the wider economy in New Zealand within a CGE modelling framework. We provide an attempt to fill the gap by focusing on measuring the impacts of COVID-19 on regional tourism in New Zealand.

1.4 Snapshot of the tourism sector in New Zealand

New Zealand tourism is a $41 billion industry (from Statistics NZ's TSA). Tourism expenditure contributed to $16.2 billion of direct value-added, which represents a 5.8 percent of direct contribution to GDP. It accounted for 20 percent of New Zealand total exports in the year to March 2019, with international visitors spending $17 billion. Domestically, New Zealanders spend $24 billion annually in places outside their residence (40 km radius from home). Tourism also benefits the New Zealand government, providing 3.8 billion in value added tax (GST).

Figure 1 shows that retail trade significantly benefits from tourism, with tourists spending $12 billion annually on alcohol, food, fuel and other retail products. This is followed by transport ($10 billion), food and beverage services ($4.7 billion) and accommodation services ($3.3 billion). Both air transport and accommodation are highly dependent on tourism with over 90 percent of all spending in these industries coming from tourists compared to only 43 percent for the food and beverage services industry.

Figure 1 Share of tourism expenditure by product in New Zealand



Source: Statistics NZ, Tourism Satellite Account (2019)

Over 220,000 people are directly employed in the New Zealand tourism industry (8.4 percent of all employment), with an additional 160,000 people indirectly employed through industries supplying the tourism industry (6.0 percent of all employment).

Statistics NZ's TSA is New Zealand's official source of tourism statistics. However, these numbers are not timely, as provisional numbers are released for the previous year. The Ministry of Business, Innovation and Economic Development (MBIE) also produces a range of tourism statistics. These numbers represent estimates rather than official statistics. However, they are reasonably robust, timelier and include more detailed breakdowns. This is especially relevant given that MBIE's data can be broken down by region.

Twenty-nine percent of all tourist expenditure occurs in Auckland, which is New Zealand's largest city and hosts New Zealand's largest airport. Auckland Airport welcomes 71 percent of all visitor arrivals in New Zealand. The next largest tourism markets are:

- Queenstown-Lakes (10 percent)
- Christchurch City (9 percent)
- Wellington City (7 percent)
- Hamilton City (3 percent)
- Tauranga City (3 percent)
- Rotorua District (3 percent)
- Dunedin City (3 percent).

International tourists spend more in Auckland and Queenstown-Lakes than domestic tourists. Auckland makes up 38 percent of the international tourism market but only 23 percent of the domestic market. Queenstown-Lakes is 16 percent of the international market but only 6 percent of the local tourist market. Domestic tourists spend more than international tourists in Wellington City, Hamilton City, Tauranga City and Dunedin City.

Based on MBIE's regional tourism estimates described above, we choose to focus on the following districts (territorial authorities):

- Auckland City
- Queenstown-Lakes district
- Christchurch City
- Wellington City
- Hamilton City
- Tauranga City
- Rotorua district
- Dunedin City
- Rest of North Island (20% of tourist expenditure)
- Rest of South Island (13% of tourism expenditure).

1.5 The TERM-NZ model

For this paper, we use our bottom-up multi-regional CGE model, TERM-NZ. TERM-NZ stands for "The Enormous Regional Model" of the New Zealand economy. It is based on the original Australian multi-regional TERM model (Wittwer 2012, 2017).

1.5.1 Key feature of the model

Given the model's multi-regional bottom-up structure, New Zealand regions/districts are each modelled as an independent CGE model which means that New Zealand regions/districts are linked via interregional trade, interregional movements of labour and capital.

The model is based on neoclassical foundation in which supply and demand are determined for each commodity produced at the regional/district level based on profit maximisation by producers and utility maximisation by households in the region/district.

The model also assumes mobility of labour and competitive markets within each region/district. At the regional/district level, each industry chooses labour, capital and land so as to maximise its profits while functioning in a competitive market.

A regional representative household purchases an assortment of goods and services based on their individual preference, relative prices and their available income. Investment is divided amongst regional industries in such way that it maximises rates of returns to investors (households, firms). Each regional industry uses industry-specific capital in a cost-minimising fashion.

Within each region, there is a local and central government. Local government within each region follows a central fiscal framework. Behaviours of foreign tourists are expressed by export demand curves for goods and services from each region and by supply curves for international imports to each region.

Other key assumptions within the model include:

- Production inputs are intermediate inputs (domestic and imported) and primary factors (labour, land and capital).
- The demand for primary factors and the choice between imported and domestic commodities are determined by Constant Elasticity of Substitution (CES) production nests. This means an increase in the price of one input shifts sourcing towards another input.

- Intermediate goods, primary factors and other costs are combined using a Leontief production function. This means the proportion of production inputs is held constant for all levels of output.
- The production mix of each industry is dependent on the relative prices of each commodity. The proportion of output exported or consumed domestically is also dependent on relative prices.

1.5.2 The TERM-NZ database

TERM-NZ is originally based on Statistics NZ 's 2013 Input-Output tables which contain information on 106 industries and 201 commodities. The model database is benchmarked to the latest annual national accounts data (GDP expenditure and income side components) once year.

We have recently worked on extending our original database. The new TERM-NZ database contains information on 88 districts, which represent New Zealand's 67 territorial authorities and 21 local boards in Auckland. The model also contains information on 149 industries producing a similar number of commodities. This development work includes the addition of five new tourism industries, which are directly relevant to this paper.

TERM-NZ model is usually run with an aggregated version of the database to speed-up the computational process and because it is not technically possible to run such a large database with its full dimensions.

A description of the aggregated industries can be found in Table 6 in Appendix C. Figure 8, Figure 9 and Figure 10 in Appendix D show maps of the New Zealand districts and Auckland local boards.

We provide below an overview of the methodology we applied to add tourism industries and (sub)-regional details. Figure 7 in Appendix A provides an overview of the different steps undertaken to extend our TERM-NZ and add sector and district-level detail.

1.5.3 Introduction of new tourism industries

In the original TERM-NZ database, tourism[3] is not identified as a separate industry or product but rather is nested in the expenditure of households and industries on products such as accommodation, food and beverages or transport.

We follow the approach of Wittwer (2017) to extend the TERM-NZ database with the addition of five new tourism industries. This is done by combining all the economic activities linked to tourism (characteristic and related tourism activities). These new tourism industries are:

- Domestic holiday, which represents tourist expenditure made by New Zealanders, undertaken domestically, either locally or inter-regionally. We used visitor expenditure by New Zealanders, including all corresponding taxes and margins.
- Foreign holiday (imported New Zealand tourism) represents tourism-related expenditure made by New Zealanders travelling abroad. We used international expenditure of New Zealanders travelling abroad.
- Export tourism (foreign tourism) covers tourism expenditure by foreign visitors in New Zealand, not travelling for education purposes. We used expenditure by foreign travellers in New Zealand other than foreign students studying in the country.
- Export student (foreign student) represents the expenditure by foreign students in New Zealand. We used expenditure by foreign students in New Zealand. This expenditure includes all corresponding taxes and margins.
- International flights cover the use of imported and domestically-produced air transport by New Zealanders travelling abroad.

[3] In its definition, tourism includes usual travellers who are holidaying, visiting friends and relatives, on business or travelling for educational purposes.

Unlike all the other industries in the database, the new tourism industries do not use labour and capital directly. Instead, tourism industries purchase goods and services (e.g. accommodation, food and beverage, transport) and sale them to foreign and domestic visitors. As such, these tourism industries can be seen as combining goods and services produced by a variety of industries, so that all tourism expenditure is grouped within these five tourism industries.

We construct data for the costs and sales of the new tourism industries by disaggregating the existing TERM-NZ database using information from the Statistics NZ's TSA and MBIE's regional tourism estimates.

We provide further detail on steps undertaken to develop these new industries in Appendix A.1 of this paper.

1.5.4 Bottom-up regional modelling

Our methodology to extend the database at the regional/district level is based on Wittwer and Horridge (2010) and follows a bottom-up approach. In such an approach, each region/district is modelled as a separate economy, linked by trade of goods and services, common but imperfectly mobile factor markets, a common central government and exchange rate. The use of a bottom-up framework allows to estimate variations in both quantities and prices, at the regional/district levels.

The TERM-NZ database is based on national input-output tables which has been split so that it now contains information for 88 districts (68 territorial authorities and 20 local boards in the Auckland region). These districts can easily be aggregated into regions.[4]

Similarly to the original TERM model (Wittwer 2012, 2017), we usually run TERM-NZ with an aggregated version of the database to speed-up the model computation and because it would not be technically possible to run the model with such a large database. TERM-NZ allows us to estimate the impacts of territorial authorities or local boards (sub-regions), such as Queenstown-Lakes and Central Otago in the Otago region, or Rotorua and Tauranga in the Bay of Plenty.

Two maps highlighting the different regions, territorial authorities and Auckland local boards can be found in Figure 8 and Figure 10, both in Appendix D.

Appendix A.2 provides further detail on the methodology used to add (sub-) regional detail in our database.

1.6 Illustrative simulations on the tourism sector in New Zealand

We examine the effects of COVID-19 on two major categories of tourism expenditure:

- foreign visitors to New-Zealand (excluding foreign students)
- domestic travellers.

1.6.1 Scenario design based on NZIER tourism forecasts

Each quarter NZIER publishes its *Quarterly Predictions*[5] for members, which provides 5-yearly macroeconomic forecasts for the New Zealand economy. For the June quarter 2020 forecasting round, NZIER has forecasted the New Zealand tourism expenditure to capture the effects of COVID-19.

[4] The 16 regions of New Zealand are defined according to Statistics NZ, http://archive.stats.govt.nz/browse_for_stats/Maps_and_geography/Geographic-areas.aspx

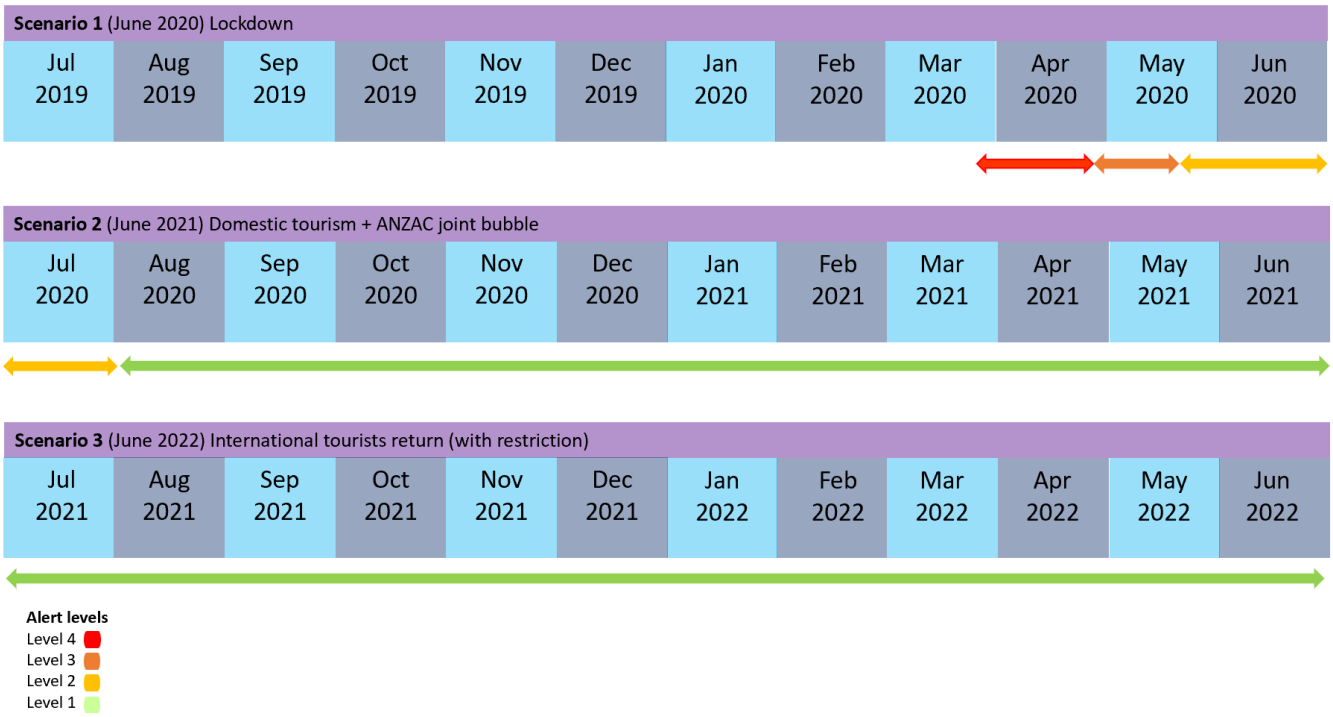
[5] NZIER's quarterly predictions are calculated using a multi-sector macro-economic model of the New Zealand economy. Complimentary data analysis is also employed to make professional judgements when macro-economic conditions have changed from trend.

NZIER used the following assumptions for its forecasts:

- International and domestic tourism falls close to zero during the month of Alert Level 4 (lockdown), due to travel restrictions[6].
- Domestic travel restrictions and isolation measures continue for an additional two weeks, where New Zealand has moved to Alert Level 3.
- New Zealand moves to Alert Level 2 on 15 May, in a phased approach which will unfold over four to six weeks, and to Alert Level 1 by July 2020. We expect domestic tourism to resume and grow quickly due to pent-up demand for recreation activities and New Zealanders substituting local holidays over foreign holidays. We forecast domestic tourism will peak in December 2020 for the holiday period.
- At the start of June 2020, New Zealand moves to Alert Level 1. More foreign tourists from more countries are allowed in the country with self-confinement.
- Australia and New Zealand both have COVID-19 under control and have a joint border control at the start of August 2020. This allows for an open border policy between both countries. As a result, some domestic tourism is substituted to the newly opened Australian market and Australian tourist expenditure improves.

Figure 2 presents a visual illustration of the timing we are considering regarding New Zealand international and domestic travel restrictions. Our scenarios are based on the assumptions illustrated in this figure. Results of NZIER tourism forecasts can be seen in Figure 3.

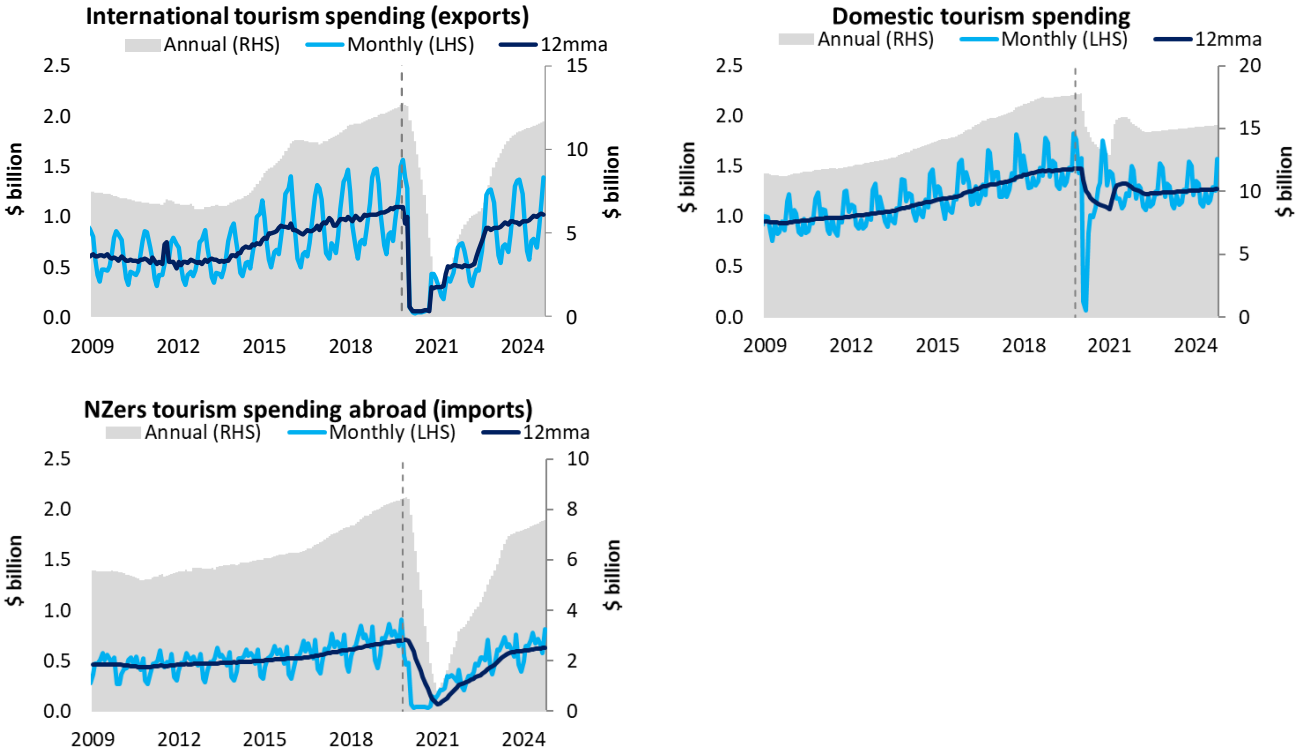
Figure 2 Potential timing of lifting New Zealand international and domestic travel restrictions



Source: NZIER (forthcoming)

[6] Our assumption takes into account the fact that since the country has closed its borders, a number of foreigners are still in New Zealand, on extended holidays or on temporary work visas, and continue to contribute in tourist expenditure.

Figure 3 NZIER's monthly tourism forecasts and 12 monthly moving average (12mma)



Source: NZIER, derived from Statistics NZ's balance of payments and MBIE tourism estimates

To date, New Zealand government strategy is to eliminate COVID-19 from the country, rather than a herd immunity approach. As such, the country is likely to adopt very restrictive measures on inbound and outbound international travel, thus, to avoid the risk of imported cases which would put the country at risk of an increased spread.

We design three scenarios to explore the potential impacts of COVID-19 on the New-Zealand economy. These scenarios are based on the set of measures imposed by the New Zealand government for the different alert levels (1 to 4).[7] We mostly focus on restrictions applied to the entry and movements of people, as well as on labour and capital temporarily rendered idle due to the isolation and social distancing measures.

In all our simulations, we use the static version of TERM-NZ, so that we compare the economy before and after COVID-19 looking at the impacts of different social and travel restriction measures ('shock'). There is no time dimension in the static model, so we do not look at how the economy adjusts to a new equilibrium. The 'shock' applied disturbs the equilibrium in the economy, and the model calculates changes in demand, supply and prices of inputs (like labour and capital) then reallocates them across sectors according to where they get greatest returns, establishing a new equilibrium after a policy has been implemented.

Given the immediate enforcement of a lockdown, travel ban and closure of New Zealand's borders, and given the short timeframe the different Alert Levels will play out, we assume an immediate effect on the tourism industries and the New Zealand economy. Therefore, we apply a short-term closure for our three scenarios.

For each scenario, we report results as percentage deviation from the 2019 base case. In other words, we measure it as the percentage difference between the state of the New Zealand economy pre-COVID

[7] https://covid19.govt.nz/alert-system/covid-19-alert-system/

(counterfactual) and the situation with COVID-19 outbreak pandemic and its associated travel restrictions and isolation measures.

Scenario 1 – Lockdown and travel ban - Year ended June 2020

We consider the situation of New Zealand during the five-week period that extended from 25 March to 26 April of this year, and some relaxation of restrictions under Alert Level 3 in the subsequent two weeks. Under the lockdown, borders are closed to foreign visitors (inbound travel) and New Zealanders are not allowed to travel abroad (outbound travel) and within the country (domestic travel). We also assume overall export education decreases by 20% under the lockdown period based on figures from Immigration New Zealand.

The lockdown measures are also likely to impact the labour market as firms in non-essential manufacturing and services industries have been forced to shut temporarily. Based on NZIER's *Quarterly Predictions* June 2020 forecasts, we assume a 7% decrease in the average labour demand for 2020.

Additionally, we take into consideration the fact that part of the capital stock in manufacturing, services and construction sectors cannot be used under the lockdown. We also assume a change in households' tastes away from consumer goods and services (retail, hotels and restaurants, transport, childcare, sports and recreation activities, etc.) to reflect the measures imposed by the lockdown.

Finally, recent export figures released by NZ Statistics shows that, during the lockdown period, there was an increase in export demand (mostly from China) for dairy, fruit, meat and seafood products and a decrease in forestry and non-food manufactured goods. We take these changes in export demand into consideration in our simulations.

Scenario 2 – Only domestic tourism is allowed again (under conditions) - Year ended June 2021

In this scenario, New Zealand returns to Alert Level 2 (15 May) then to Alert Level 1 in August 2020. We assume that most of the measures for Alert Level 2 will be implemented in a staged approach over a few weeks, with most measures becoming less restrictive over time.[8]

Under Alert Level 2, borders stay closed to foreign visitors, but international students with a student visa can travel back to the country. New Zealanders are allowed to travel domestically, and more economic activities can resume (restaurants, bars, etc.). Additionally, we assume households' tastes partly move back to consumer goods and services as more retail, sports and recreation activities can resume under Alert Level 2.

We also assume a slight increase of labour demand as some workers on zero-hour contracts can go back to work and capital is put back to use with the reopening of most non-essential manufacturing and services industries. Capital stays mostly immobilised in air transport as Air New Zealand maintain a reduced number of domestic flights.[9]

Scenario 3 – Both foreign and domestic tourism are allowed again (under conditions) - Year ended June 2022

In this scenario, we consider that New Zealand has fully transitioned to Alert Level 1 (early August 2020)[10] and will stay at that level until June 2022.[11] Borders are open to foreign travellers and students under certain conditions (mandatory self-isolation for a two-week period and access restricted to certain countries). These conditions also apply to New Zealanders who travel abroad and come back in

8 As Level 2 measures are becoming less restrictive over time, there is a possibility of NZ moving into Level 1 during this period. Our forecasts and assumptions take this possibility into account.

9 https://www.airnewzealand.co.nz/covid19-airnz-updates#flight-changes

10 As Level 1 measures are becoming less restrictive over time, there is a possibility of NZ moving into a "Level 0" (close to pre-COVID-19 life) during this period. Our forecasts and assumptions take this possibility into account.

11 As Level 1 measures are becoming less restrictive over time, there is a possibility of NZ moving into a "Level 0" (close to pre-COVID-19 life) during this period. Our forecasts and assumptions take this possibility into account.

the country. Domestic tourism is allowed, and most economic activities have returned to normal, with the exception of air transport[12].

Our shocks have been annualized based on the number of weeks we assumed New Zealand stays under each alert level. Each scenario can have multiple alert levels within them.

Table 1 presents our assumptions for domestic and international tourism (outbound and inbound) under the three different scenarios.

Table 1 Tourism and foreign students' forecasts under different scenario assumptions[13]

Annual percentage change. Note: each scenario is compared with 2019 baseline

Scenario	Period[14]	International	Domestic	NZers spending abroad	Foreign students
Scenario 1	2020	-94%	-27%	-94%	-20%
Scenario 2	2021	-58%	-10%	-65%	-10%
Scenario 3	2022	-30%	-11%	-40%	+2%

Source: Derived from NZIER tourism forecasts for *Quarterly Predictions*

1.6.2 Simulation results

In this section, we present and discuss results from our simulations to show the potential impacts of COVID-19 on the local, regional and national New Zealand economies. Results of the simulation help us to understand the importance of the tourism industry in New Zealand and to identify the potential risks to a strong downturn of activities mostly dedicated to tourism.

Results are subject to change as we revise our simulations with latest forecasts on the expect impacts of COVID-19 on tourism data.

Macroeconomic impacts of restriction measures from COVID-19 in New Zealand

Table 2 shows the national impacts of COVID-19 on main economic variables. Real GDP decreases by between 7.1% ($21.2 billion) and 2.2% ($6.8 billion) as New Zealand transitions through the different alert levels. For all three scenarios, real GDP loss is dominated by labour and capital temporarily not used because of the lockdown measures and restrictions imposed on international and domestic travel.

We estimate the decrease in real household consumption to be between 13.1% (Scenario 1) and 3.2% (Scenario 3). Real household consumption falls by more than the decline in GDP due to a deterioration in the terms of trade from weaker global demand. Export prices are falling more than import prices. Hence, exports are becoming cheaper while imports become relatively more expensive. This leads to a decline in household purchasing power and hence, in consumption.

Due to the significant drop in employment and utilised capital, there is no offsetting switch in sales to exports. At the national level, export volumes fall by between 10.8% (Scenario 1) and 5.6% (Scenario 3).

[12] Air New Zealand has permanently reduced its fleet on domestic and international flights. https://www.airnewzealand.co.nz/covid19-airnz-updates#flight-changes

[13] We use a monthly comparison with the same month last year instead of annual data. This is because if we used annual data the sharp decline in domestic tourism will be hidden in the pre-COVID-19 peak and the recovery, once New Zealand moves to Alert Level 2 or 1.

[14] Dates were chosen to see the impact as travel bans and alert level restrictions were implemented.

Table 2 Headline economic impacts

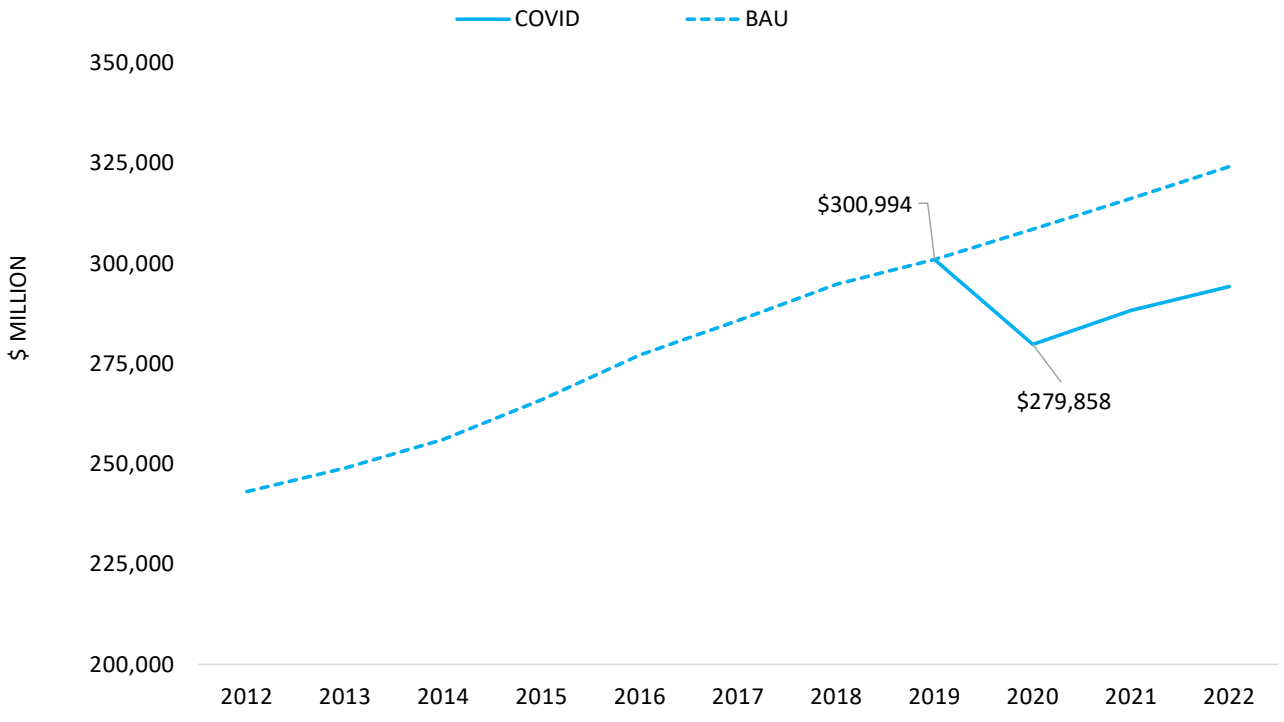
Changes compared to 2019 baseline, in $ million and in percent, in real terms

Scenarios		GDP	Household consumption	Exports	Imports	National output
Scenario 1	% change	-7.1%	-13.1%	-10.8%	-11.6%	-8.9%
	Level ($m)	-21,136	-22,032	-9,096	9,616	-50,348
Scenario 2	% change	-4.3%	-7.5%	-7.3%	-7.3%	-5.5%
	Level ($m)	-12,704	-12,824	-6,145	6,003	-31,388
Scenario 3	% change	-2.2%	-3.2%	-5.6%	-4.1%	-3.3%
	Level ($m)	-6,759	-5,588	-4,710	3,388	-18,772

Source: Results from authors' simulations

Figure 4 gives an overview of the recovery trajectory of the national real GDP. It shows that New Zealand's GDP has fallen back to a similar level to 2016. In other words, COVID-19 has removed three years of GDP growth. We expect that it will take at least an additional four years until New Zealand's GDP returns to its pre-COVID level (2019).

Figure 4 New Zealand's real GDP recovery path



Source: Results from authors' simulations

Regional effects

Table 3 presents the impacts of COVID-19 on regional real GDP for different Alert Levels. Regions for which tourism activities account for a larger share of the regional economy are the most affected by COVID-19. This is the case for Queenstown-Lakes, Rotorua and Auckland. For all three scenarios, real GDP loss (in percentage terms) is the highest for Queenstown-Lakes which is highly tourism dependent and therefore, substantially affected from a downturn in international and domestic tourism. Real GDP losses for Hamilton City and Greater Wellington are not as significant as these economies are not as reliant on tourism.

Table 3 Impacts on regional GDP

Annual changes compared to 2019 baseline, in percentage and in $ million in real terms (2019 prices)

Region (TLA)	Scenario 1 (Lockdown)		Scenario 2 (Alert Level 2)		Scenario 3 (Alert Level 1)	
	in %	in $ million	in %	in $ million	in %	in $ million
Auckland	-7.7%	-8,066.1	-4.6%	-4,895.4	-2.5%	-2,672.5
Greater Wellington*	-6.9%	-2,157.3	-4.1%	-1,290.2	-2.1%	-677.7
Christchurch City	-7.8%	-2,100.9	-4.7%	-1,276.3	-2.6%	-706.8
Queenstown-Lakes	-16.7%	-509.7	-10.8%	-343.5	-6.6%	-217.4
Hamilton City	-6.6%	-725.6	-3.8%	-419.1	-1.8%	-200.5
Tauranga	-7.1%	-531.5	-4.3%	-318.9	-2.3%	-175.1
Rotorua	-8.8%	-307.7	-5.5%	-196.4	-3.2%	-117.0
Dunedin	-7.5%	-462.0	-4.5%	-282.7	-2.4%	-153.0
Rest of North Island	-6.2%	-4,089.3	-3.6%	-2,351.5	-1.7%	-1,150.1
Rest of South Island	-6.2%	-2,186.3	-3.7%	-1,330.1	-1.9%	-689.2
National	**-7.1%**	**-21,136.5**	**-4.3%**	**-12,704.3**	**-2.2%**	**-6,759.3**

Notes:

1 * Greater Wellington includes Wellington, Lower Hutt, Upper Hutt and Porirua.

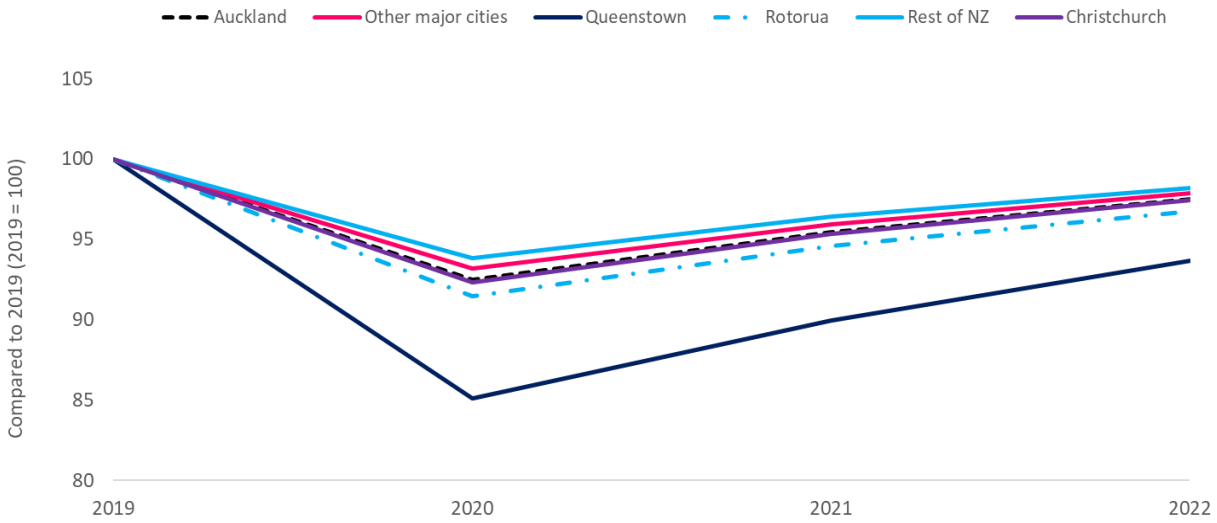
2 Prior to the COVID-19 outbreak, the New Zealand economy had been expected to grow by around 2% between 2020 and 2022. This highlights how significant the estimated reduction in key macroeconomic metrics are when we compare with the counterfactual, in which the economy would have *grown* in the absence of the COVID-19 pandemic.

Source: Results from authors' simulations

Figure 5 shows the recovery path of different regions, in terms of real GDP. Under Scenario 1 (lockdown in 2020), Queenstown-Lakes' real GDP falls to 85% of its 2019 level. Under Scenario 2 (2021) and Scenario 3 (2022), Queenstown-Lakes' real GDP is slowly recovering but is still at 90% and 94%, respectively, of its 2019 level. Rotorua is the second most affected region from COVID-19 in terms of real GDP, with a drop to 92%, 95% and 97% under Scenarios 1, 2 and 3, respectively.

Figure 5 Regional real GDP recovery path under the different scenarios

Annual changes from 2019 baseline, in percentage



Source: Results from authors' simulations

Regional household spending – our proxy for 'economic welfare' – in dollar value (Table 4) is expected to decrease the most in Auckland, Greater Wellington and Christchurch under each scenario. This is because household spending is higher in regions that are more populated and wealthier. Therefore, even a small percentage decrease will have a larger monetary impact than less populated and less wealthy regions.

The decrease in regional household spending share is the most significant in regions whose economy is more reliant on tourism activities, such as Queenstown-Lakes, Auckland, Christchurch, and Rotorua.

Table 4 Impacts on regional real household spending

Annual changes compared to 2019 baseline, in percentage and in $ million in real terms (2019 prices)

Region (TLA)	Scenario 1 (Lockdown)		Scenario 2 (Alert Level 2)		Scenario 3 (Alert Level 1)	
	in %	in $ million	in %	in $ million	in %	in $ million
Auckland	-14.0%	-8,018.7	-8.2%	-4,739.5	-3.7%	-2,150.3
Greater Wellington*	-12.5%	-1,977.5	-7.2%	-1,160.2	-3.1%	-507.1
Christchurch City	-13.7%	-2,140.0	-8.0%	-1,263.2	-3.5%	-565.0
Queenstown-Lakes	-28.2%	-537.2	-18.4%	-361.4	-10.7%	-213.0
Hamilton City	-12.5%	-806.8	-7.1%	-466.3	-3.1%	-202.7
Tauranga	-12.8%	-536.9	-7.4%	-313.6	-3.3%	-140.2
Rotorua	-13.5%	-275.8	-7.8%	-161.3	-3.4%	-71.3
Dunedin	-13.1%	-457.9	-7.7%	-273.3	-3.5%	-123.7
Rest of North Island	-11.9%	-4,730.7	-6.6%	-2,649.0	-2.6%	-1,049.5
Rest of South Island	-11.9%	-2,550.2	-6.6%	-1,436.7	-2.6%	-565.6
National	**-13.1%**	**-22,031.8**	**-7.5%**	**-12,824.5**	**-3.2%**	**-5,588.5**

Note: * Greater Wellington includes Wellington, Lower Hutt, Upper Hutt and Porirua.

Source: Results from authors' simulations

Impacts on sector activities

Figure 6 presents the changes in aggregated industries, compared with the 2019 baseline under each scenario.

The tourism sector (domestic and foreign tourism) is the most affected by COVID-19 and restriction measures. It is also the sector that is likely to take longer to recover compared with other sectors.

With COVID-19, international tourism output falls to 27% of its 2019 level, and slowly recovers over time to reach 59% of its 2019 level in 2022 (Scenario 3). Domestic tourism output falls to 49% of its 2019 level in 2020 (Scenario 1) and reaches 78% of its 2019 base in 2022 (Scenario 3). Domestic tourism is expected to recover relatively quickly, with public campaigns playing a role in restoring regional demand. The impact on international tourism may last much longer given that border restrictions are expected to last until 2022.

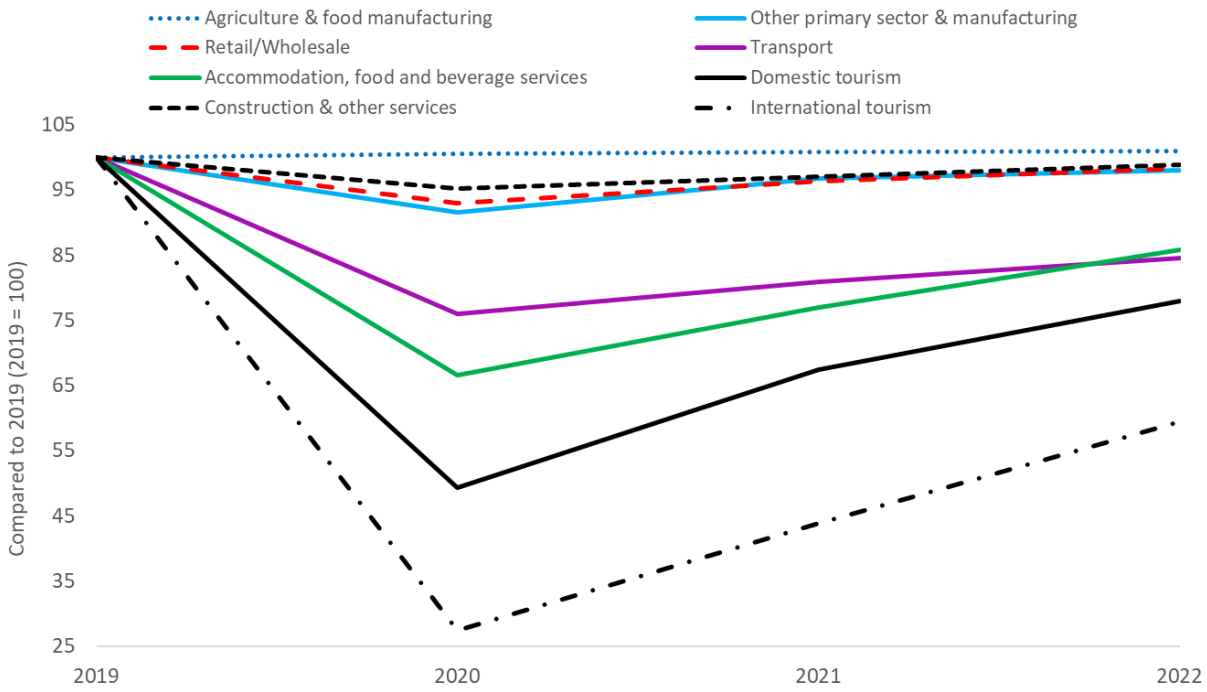
Industries that support the tourism sector, such as accommodation, food and beverage services and transport (mostly air transport) industries, are also significantly hit by the isolation measures and travel ban, with output for each of these industries dropping to 66% and 76%, respectively, of their 2019 base.

Output decrease less sharply in industries that are not directly reliant on the tourism sector (e.g. other primary sector and manufacturing, construction and other services). The output decrease in these industries is due to the decrease in labour and capital immobilised following the implementation of restriction measures. There are also some substitution effects at play: with the decrease in expenditure towards visitor economic activity, households might allocate a larger portion of their budgets to other industries such as health and education (included in construction and other services).

With a weakening demand for tourism, the exchange rate goes down. This leads to a demand increase for other export commodities such as dairy, meat and fruit products, which in turns leads to a slight increase in output for agriculture and food manufacturing products relative to the 2019 baseline.

Figure 6 Sector impacts under the different scenarios at the national level[15]

Annual changes from 2019 baseline, in percentage



Source: Results from authors' simulations

[15] For simplification purposes, we have combined industries that have a similar recovery path such as: agriculture and food manufacturing, construction and other services, other primary sector and manufacturing industries.

1.7 Discussion on assumptions and policy implications

At the national level, restriction measures and the travel ban due to COVID-19 led to substantial real GDP loss (between $21 billion and $6.8 billion between Scenario 1 and Scenario 3, respectively). For all three scenarios, the fall in real GDP is dominated by labour and capital temporarily not used because of the social and travel restriction measures imposed in the country. The decrease in domestic and foreign tourism is also expected to have a significant impact on regional economies, especially those for which tourism activities represent a larger share of the regional economy, such as Queenstown-Lakes, Christchurch, Auckland and Rotorua.

Domestic tourism has the potential to partially mitigate the negative impacts of COVID-19 on foreign tourism in New Zealand. Further research is needed to estimate the extent to which expenditure in both inter-region/district and intra-region/district tourism represent a substitution from foreign travellers' expenses foregone.

There is considerable uncertainty about the severity of the potential economic impacts of COVID-19. We attempted to explore some of these uncertainties through the design of modelling scenarios. The magnitude of these impacts is highly dependent on the assumptions made regarding the duration of travel ban and restriction measures and their likely effects on labour, capital, or household demand for consumer goods and services. Most of our assumptions are derived from NZIER's *Quarterly Predictions*. We are mindful that our assumptions are based on data that were available at the moment we wrote this paper and that the situation is evolving rapidly. This means that assumptions made at the time this paper was written might need to be updated as more timely information comes to hand.

We use the static version of our regional CGE model, TERM-NZ, which looks at 'before' (i.e pre COVID-19) and 'after' (with different COVID-19 alert levels). We therefore do not explicitly model the timing of the different restriction measures imposed by the New Zealand government under the different alert levels. There is no time dimension in the static model, so we do not look at how the economy adjusts to a new equilibrium over time16. We also do not take into consideration the economic growth that would have happened without COVID-19. Prior to the COVID-19 outbreak, the New Zealand economy had been expected to grow by around 2% between 2020 and 2022. This highlights how significant the estimated reduction in key macroeconomic metrics are when we compare with the counterfactual, in which the economy would have *grown* in the absence of the COVID-19 pandemic.

Additionally, and given the information available at the time this paper was written, we have not explicitly modelled labour productivity loss resulting from social distancing measures in essential industries as its importance is still uncertain. However, labour productivity loss has been taken into account in NZIER's labour forecasts, hence in our assumptions as well.

We also assume no fiscal response by government outside wage subsidies, which are implicitly taken into account in NZIER's labour forecasts. Therefore, public consumption follows the decrease in household consumption (in nominal terms). While the New Zealand government has recently announced a substantial COVID-19 Economic Response Package, we decided to not explicitly model any fiscal response in order to showcase the base against which fiscal policies can be assessed.

At time of writing (15 May 2020), the cost of the COVID-19 Economic Response Package has been increased from an initial $12 billion to $20 billion. Given the welfare loss modelled in this study, this fiscal response could be a bit more ambitious.

[16] These fluctuations may have significant impacts in their own right and could be captured in future research by using our more sophisticated, dynamic CGE model.

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Appendix A Extending the TERM-NZ database – methodology

A.1 Adding tourism industries

In the classic TERM-NZ database, tourism[17] is not identified as a separate industry or products but rather is nested in the expenditure of households and industries on products such as accommodation, food and beverages or transport.

Following the approach of Wittwer (2017) which is detailed in Dixon (2019), we extended the TERM database with the addition of five new tourism industries. This has been done by combining together all the economic activities linked to tourism. These new tourism industries are:

- Domestic holiday, which represents tourist expenditure made by New Zealanders, undertaken domestically, either locally or inter-regionally. We used visitor expenditure by New Zealanders, including all corresponding taxes and margins.
- Foreign holiday (imported New Zealand tourism) represents tourism related expenditure made by New Zealanders travelling abroad. We used international expenditure of New Zealanders travelling abroad.
- Export tourism (foreign tourism) covers tourism expenditure by foreign visitors in New Zealand, not travelling for education purposes. We used expenditure by foreign travellers in New Zealand other than foreign students studying in the country.
- Export student (foreign student) represents the expenditure by foreign students in New Zealand. We used expenditure by foreign students in New Zealand. This expenditure includes all corresponding taxes and margins.
- International flights cover the use of imported and domestically-produced air transport by New Zealanders travelling abroad

Unlike all the other industries in the database, the new tourism industries do not use labour and capital directly. Instead, tourism industries purchase goods and services (e.g. accommodation, food and beverage, transport) and sell them to foreign and domestic visitors. As such, these tourism industries can be seen as combining goods and services produced by a variety of industries, so that all tourism expenditure are grouped within these five tourism industries.

We build cost and sale structures for each of the new tourism industries by disaggregating the existing TERM-NZ database using the TSA from Statistics NZ and the Monthly Regional Tourism estimates from MBIE.

Table 5 in Appendix B presents a summary of the data requirements for extending the TERM-NZ database, at the sector and district levels.

Domestic tourism

This section describes the steps done to build the domestic tourism industry in the TERM-NZ database.

Statistics NZ' TSA provides data on the value of total domestic consumption on the seven tourism-characteristic products[18] and the two tourism-related products[19] purchased by New Zealand households, businesses and governments at purchaser (market)'s prices.

[17] In its definition, tourism includes usual travellers who are holidaying, visiting friends and relatives, on business or travelling for educational purposes.

[18] Statistics NZ classifies tourism-characteristic product a product whose at least 25 percent of its production is purchased by tourist and for which the level of consumption would decrease significantly in the absence of tourists.

[19] Statistics NZ defines a tourism-related product as a product that is purchased up to 25 percent of its production by tourists. However, 'Retail sales – clothing and footwear', which exceeds the 25 percent of production threshold, is categorised as a tourism-related retail commodity, because the activity undertaken specifically relates to retail.

Using this information and concordance between TSA's tourism products and commodities in the TERM database, we derive domestic tourism ratios, defined at the national level as follows:

$$D(c) = \frac{NZer\ tourist\ domestic\ spending\ (c)}{Total\ expenditure(c)} \quad \textit{with c defined as commodity} \qquad (1)$$

With information for the numerator taken from Statistics NZ's TSA and data for the denominator taken from the TERM database and defined as the total expenditure from household and industry on tourism commodity at purchasers' prices.

Because of data inconsistencies, the ratio can be higher than one. When this happens, we manually set its value to one.

We assign this domestic tourism ratio across all regions of destination, household, industries and associated sales taxes and margins to the TERM database. This allows us to pull out expenditure on tourism-related products made by New Zealanders travelling domestically. This expenditure is then placed into the cost structure of domestic tourism industry. For each affected industry other than domestic tourism industry, total cost is lower than total sales because of costs associated with domestic travel being removed. Conversely, total costs for domestic tourism industry exceeds total sales and consumption expenditure is lower than its initial level due to the costs of domestic travel being removed.

Foreign holiday (New Zealanders travelling abroad)

This section describes the steps done to build the foreign holiday industry in the TERM database.

The TSA from Statistics NZ provide data on the market price value of total external consumption on tourism-characteristic and tourism-related products by New Zealand households, businesses and governments.

We use concordance between tourism products described in Statistics NZ's TSA and commodities that are in the TERM-NZ database to estimate the foreign holiday ratios, defined at the national level as follows:

$$FH(c) = \frac{NZer\ tourist\ spending\ overseas\ (c)}{Import\ expenditure\ (c)} \quad \textit{with c defined as commodity} \qquad (2)$$

Where data for the numerator is from Statistics NZ's TSA and data for the denominator is the sum of household and industry use of a commodity at purchasers' prices from the TERM database. Because of data inconsistencies, the ratio can be higher than one. When this happens, we manually set its value to one.

We assign this ratio across all regions of destination, household, industries and associated sales taxes and margins to the TERM database. This allows us to pull out expenditure on tourism-related products made by New Zealanders travelling abroad. Once these tourism-related values are taken out from the industry costs matrices, the sum of costs is less than the sum of sales for each affected industry. Similarly, the value of consumption expenditure is below its initial level after we removed overseas travel costs.

International air transport

The international air transport industry represents the use of imported and domestically-produced air transport by New Zealanders travelling abroad.

In the TERM-NZ database, air transport is used indirectly as a margin for freight and directly for passenger transport. Here we are only interested in passenger transport demand. As such, we isolate the expenditure of New Zealanders travelling overseas, including air transport, from the existing flows

of imported goods and corresponding taxes and margins. Given that New Zealanders who travel overseas might also purchase domestic air flights, we account for this domestic spending as follows:

- We first make an informed guess of the Air New Zealand revenue share generated by fares bought by New Zealanders travelling abroad and apply this share to the existing value of domestic air transport in the database.[20] This gives us a dollar value which we allocate toward fares paid by New Zealanders travelling abroad.
- We maintain the same allocation to industry and household users and regions as the initial allocation of imported air transport expenditure.
- Expenditure on domestic flights are added into the margin matrices (for passenger transport not for freight) in the database. This expenditure represents the use of domestically-produced air transport in the purchase of imported New Zealand tourism (outbound New Zealand tourism).
- As a final step, we ensure that the total purchasers' value of air transport associated with outbound New Zealand tourism corresponds to what is reported in the TSA (Statistics NZ). To do so, we decrease the basic value of imported air transport which was initially taken out from the basic value of industry spending on domestic or imported commodities and from the basic value of regional household expenditure, and associated taxes and margins.

We ensure the database is balanced by adding sales of the domestic holiday industry into the cost matrices of industries and households. At this stage, regional users (household and industries) purchase small amounts on imported tourism products (e.g. accommodation and air transport) and their expenditure is now indirectly taken into account through spending on imported domestic tourism services.

Foreign tourism

This section describes the steps done to build the foreign tourism industry in the TERM-NZ database.

Statistics NZ's TSA provides information on the value of total domestic consumption on the seven tourism-characteristic products and the two tourism-related products purchased by foreign tourists at purchaser (market)'s prices.

Using this information and concordance between TSA's tourism products and commodities in the TERM-NZ database, we derive the following export tourism ratios, defined at the national level as follows:

Foreign tourism ratio by commodity = Foreign visitor domestic spending by commodity / Export expenditure by commodity

$$ET(c) = \frac{Foreign\ tourist\ domestic\ spending\ (c)}{Export\ expenditure\ (c)} \quad \textit{with c defined as commodity} \qquad (3)$$

With information for the numerator taken from Statistics NZ's TSA and data for the denominator taken from TERM database and defined as the value of exports at purchasers' prices for each tourism commodity.

Similarly to the other industry splits, the ratio is manually set to one if its value is greater than one.

We assign this foreign tourism ratio across all regions of destination to extract the contribution of foreign tourists to New Zealand exports by commodity (along with sales taxes and margins associated with exports by commodity).

[20] We looked at Air New Zealand's annual reports to inform our assumptions.

Foreign students

Spending by foreign visitors in New Zealand by commodity and region of expenditure generated in the previous step is split into spending by students and non-students based on the number of foreign students arriving in New Zealand.

It is unlikely that the Statistics NZ's I-O tables account for spending of foreign students as sales to exports after their first year of study. As such, we focus on the expenditure of new foreign student arrivals.

To do so, we consider that the tourism-related product "education" in Statistics NZ's TSA represents the expenditure made by foreign students on higher education services that are domestically-produced. We then estimate the value of foreign student expenditure for all the other commodities in TERM-NZ as the product of the number of first year foreign students and the per capita spending by commodity reported for a single person aged under 35 in the Household Expenditure Survey from Statistics NZ.

We then removed expenditure made by foreign tourists and students in New Zealand by commodity and by regions from the existing export values and associated sales taxes and margins. We insert these expenditure values into the cost structure of foreign tourism and foreign student industries. In the TERM-NZ database, we take into account imports of goods and services purchased by foreign tourists and students in New Zealand as re-exports. In other words, we consider that re-exports correspond to the own-use of imported tourism products and therefore, we estimate the value of tourism re-exports as the ratio of imports to total sales by commodity, at the national level.

At this stage, the total costs of foreign tourism and foreign student industries are lower or equal than the sum of sales. Export expenditure in each of these two industries is lower than its original level due to visitor exports being taken out.

We ensure the TERM-NZ database is balanced by taking out export sales (equal to the previous value of re-exports to foreign visitors) and adding them to domestic tourism industry to equal the cost of inputs that are domestically-produced and imported. This allows for export expenditure to return to its original level. In the extended TERM-NZ database, tourism-related industries such as accommodation have few direct exports and little inputs of imported own product. Exports of the foreign tourism industry are now produced by the newly created domestic tourism sectors.

A.2 Bottom-up regional modelling

Our methodology to extend the database at the regional/district level is based on Wittwer and Horridge (2010) and follows a bottom-up approach. In a bottom-up approach, each region/district is modelled as a separate economy, linked by trade of goods and services, common but imperfectly mobile factor markets, a common central government and exchange rate. The use of a bottom-up framework allows to estimate variations in both quantities and prices, at the regional/district levels.

TERM-NZ database is based on a master database which contains information for 88 districts (68 territorial authorities and 20 local boards in the Auckland region).[21] Similarly to the original TERM model (Wittwer 2012, 2017), we usually run TERM-NZ with an aggregated version of the database to speed-up the model computation and because it is not technically possible to run the model with such a large database in its full dimensions.

Wittwer and Horridge (2010) use Census data to represent regional database at a smaller regional level for Australia. We follow their methodology to introduce detail at the district level in our TERM-NZ database.

[21] The 16 regions of New Zealand are defined according to Statistics New Zealand, http://archive.stats.govt.nz/browse_for_stats/Maps_and_geography/Geographic-areas.aspx

We use regional employment data from Statistics NZ, by industry and for each district (i.e. territorial authority or local board in Auckland) to estimate the following industry and district-level shares:

- R001: Production/output shares
- R002: Investment shares (same as R001)
- R003: Household consumption shares
- R004: Export shares
- R005: Government shares

To estimate these shares at the regional and district level, we use available information on employment by disaggregated industry and available at the district level (territorial authority or local board) and we assume an identical technology or input cost structure for a given industry in all districts, following Wittwer and Horridge's methodology (2018).

A.2.1 District-level share of industry value added

The district shares of industry value added VA_i for industry i is aggregated from districts ta to the regional level r and from industry i to broad sectors s, so that the sum of district shares of industry value added equals to the regional level of sector value added $VA_{s,r}$.

$$\sum_{ta \in r} \sum_{i \in s} \left(R001_{i,ta}.VA_i\right) = VA_{s,r} \tag{4}$$

From the above equation, we may need to adjust district production shares in a given region if the sum of these shares over industries and districts is different from the national account data.

A.2.2 Household consumption shares at the district level

We define as $ROO3$ the share of household consumption by commodity and district. $R003$ is equal to the product of the district's share of regional population and the region's share of national broad commodity consumption, aggregated from the granular commodity level c to the broad sector level s:

$$R003_{c,r} = \left({POP_{ta}}/{POP_{r(ta)}}\right).\left({V3\_R_{s(c),r(ta)}}/{V3NAT_{s(c)}}\right) \tag{5}$$

A.2.3 Government consumption shares at the district level

As there is no sector breakdown in government spending in the national accounts (for the regional level), we simply define $R005$, the share of government expenditure by commodity and district, as follows:

$$R005_{cta} = \left({POP_{ta}}/{POP_{r(ta)}}\right).\left({V5\_R_{r(ta)}}/{V5NAT}\right) \tag{6}$$

For local commodities, we assume that household and government consumption shares are equal to the production shares (one commodity corresponds to one industry in the TERM-NZ database), such as:

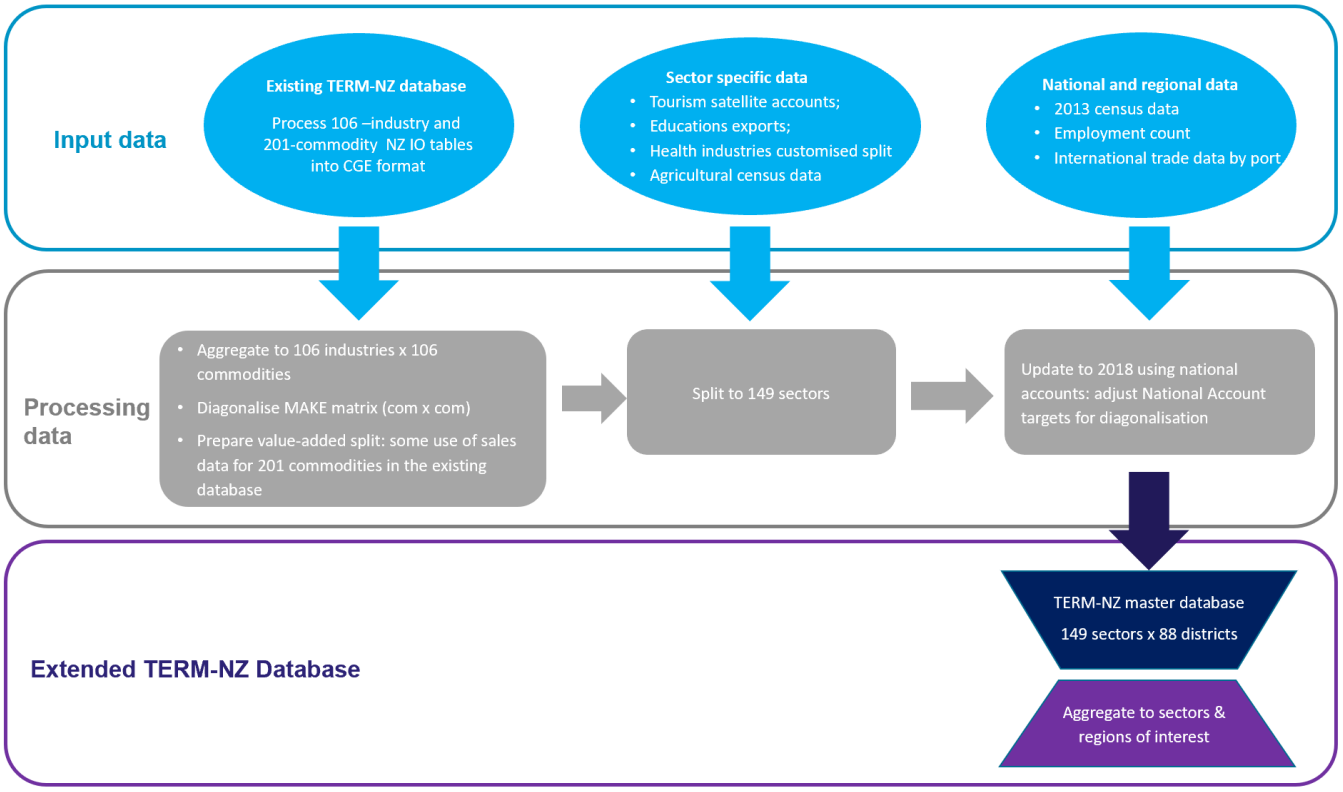
$$R005_{cta} = R001_{ita} \tag{7}$$

And

$$R003_{cta} = R001_{ita} \tag{8}$$

Figure 7 provides an overview of the different steps undertaken to extend our TERM-NZ and add sector and district-level detail.

Figure 7 Process overview to extend the TERM-NZ database



Source: Authors, based on Wittwer (2012,2017)

Appendix B Information needed to extend the database

Table 5 Regional and sectoral information and sources

Data	Source	Latest data available
Product detail to extend sales detail of 206 commodities in the IO tables	National Accounts 2006 Commodity Classification (NA06CC) to Central Product Classification (CPC) classification	
Employment data	Statistics NZ	2019
Agricultural data	Statistics NZ	2018
Education data (exports)	Ministry of Education	2018
Employment data	BD Demographics, Statistics NZ	2018
International exports by ports (HS10)	Statistics NZ	2018
International imports by ports (HS10)	Statistics NZ	2018
National accounts	Statistics NZ	YE March 2018
Tourism satellite account (national level)	Statistics NZ	2018
Tourism satellite account (regional and TA levels)	Ministry of Business, Innovation and Employment	August 2019 (monthly data)
Concordances (product, industry and geographic details)	Statistics NZ	

Appendix C Aggregated industries in the TERM-NZ database

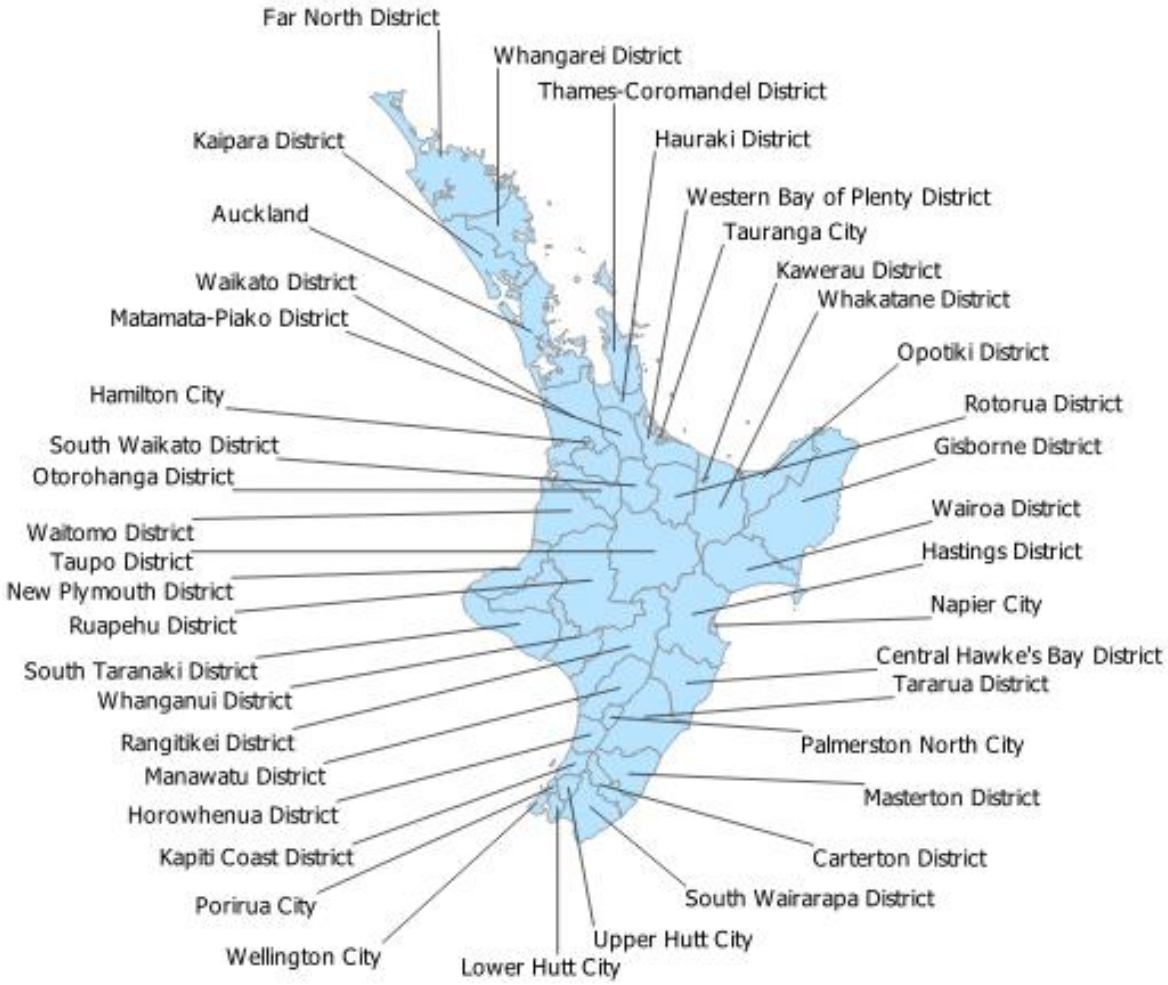
Table 6 CGE industries in the extended TERM-NZ database

No.	Short name	Description
1	Horticulture	Horticulture and fruit growing
2	SheepBeef	Sheep, beef cattle, and grain farming
3	DairyCattle	Dairy cattle farming
4	Poultry	Poultry, deer, and other livestock farming
5	Forestry	Forestry and logging
6	Fishing	Fishing and aquaculture
7	AgServ	Agriculture, forestry, and fishing support services
8	CoalOilGas	Coal mining, oil and gas extraction
9	MiningExplor	Mining and exploration
10	MeatManuf	Meat and meat product manufacturing
11	SeafoodProc	Seafood processing
12	DairyProduc	Dairy product manufacturing
13	FruitProc	Fruit, oil, cereal, and other food product manufacturing
14	BevTobMan	Beverage and tobacco product manufacturing
15	Textiles	Textile and leather manufacturing
16	Clothing	Clothing, knitted products, and footwear manufacturing
17	WoodMan	Wood product manufacturing
18	PulpPapMan	Pulp, paper, and converted paper product manufacturing
19	Printing	Printing & publishing
20	PetrolMan	Petroleum and coal product manufacturing
21	BChemMan	Basic chemical and basic polymer manufacturing
22	FertMan	Fertiliser and pesticide manufacturing
23	PharmMan	Pharmaceutical, cleaning, and other chemical manufacturing
24	RubberMan	Polymer product and rubber product manufacturing
25	MinMetalMan	Non-metallic mineral and metal manufacturing
26	TranEqpMan	Transport equipment manufacturing
27	ElecEqpMan	Electronic and electrical equipment manufacturing
28	MachMan	Machinery manufacturing
29	OthMan	Furniture and other manufacturing
30	ElecGenTrans	Electricity generation and transmission
31	GasWaterSupp	Gas and water supply
32	WasteSewag	Waste and sewage services
33	Construction	Residential, non-residential, heavy construction and construction services
34	Wholesale	Wholesale
35	Retail	Retail
36	AccomFoodBev	Accommodation, food and beverages services
37	RoadRailTran	Road and rail passenger transport

No.	Short name	Description
38	RoadRailFr	Road and rail freight
39	OthTransEqp	Other transport equipment and parts
40	AirTrans	Air and other passenger transport
41	AirFreight	Air freight
42	TransStorage	Transport support and storage services
43	MediaTeleCom	Publishing, Movies, Broadcasting, telecommunication services
44	FinanceInsur	Finance and insurance services
45	PropSrvDwell	Property services and owner-occupied dwelling
46	BusSrvc	Business services
47	LocalGovt	Local government administration services
48	CentGovt	Central government administration services
49	EducHosp	Education and health services
50	SportRec	Sport and recreation services, gambling activities
51	PersOther	Personal, community and other services
52	Holiday	Domestic holiday
53	FgnHoliday	Foreign holiday
54	ExpTourism	Export tourism
55	AirInt	Domestic and international air transport by New Zealanders travelling abroad
56	ExpEdu	Export of education (foreign students studying in NZ)

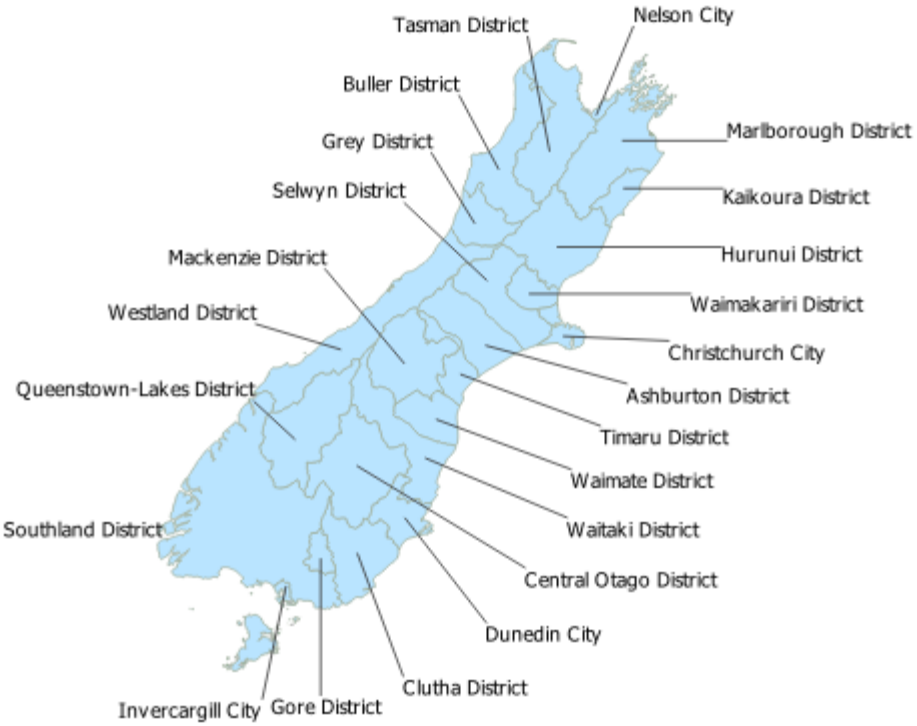
Appendix D Geographical detail in the TERM-NZ database

Figure 8 New Zealand districts represented in our database – North Island



Source: Statistics NZ

Figure 9 New Zealand districts represented in our database – South Island



Source: Statistics NZ

Figure 10 Auckland local boards represented in our database

Source: Statistics NZ