# Trade Data Analysis 2.0

## Working paper for Resilience Inquiry

February 2024

Jaimie Legge and Ben Temple

NEW ZEALAND
PRODUCTIVITY COMMISSION
Te Kōmihana Whai Hua o Aotearoa

**The New Zealand Productivity Commission**

Te Kōmihana Whai Hua o Aotearoa[1]

The Commission – an independent Crown entity – completes in-depth inquiry reports on topics selected by the Government, carries out productivity-related research and promotes understanding of productivity issues. The Commission aims to provide insightful, well-informed and accessible advice that leads to the best possible improvement in the wellbeing of New Zealanders. The New Zealand Productivity Commission Act 2010 guides and binds the Commission.

**How to cite this document**: New Zealand Productivity Commission (2024) Trade Data Analysis 2.0.

**Date**: February 2024

## *Disclaimer*

The contents of this report must not be construed as legal advice. The Commission does not accept any responsibility or liability for an action taken as a result of reading, or reliance placed because of having read any part, or all, of the information in this report. The Commission does not accept any responsibility or liability for any error, inadequacy, deficiency, flaw in or omission from this report.



[1] The Commission that pursues abundance for New Zealand

# Contents

## List of Tables



## List of Figures

# Introduction

This paper sets out the Productivity Commission's approach to analysing trade data for its Economic Resilience Inquiry.

While trade liberalisation and technological innovations in transportation, logistics, and communications technology have made it easier and cheaper to source goods and services internationally, these advances have also enabled supply chains to become longer and more complex, forming networks across many firms and economies. Long and complex supply chains can bring many possible points of failure, but they can also be adaptive and resilient. Foreign supply disruptions have larger adverse effects where both geographic and industry concentration is high (Schwellnus et al., 2023).

There are not sufficient data to properly identify or map these complex networks. However, there are data on the concentration of traded intermediate products as well as industries' use of those products. The Commission wanted to create a dataset that linked highly concentrated products with industries that can be shared with industry experts to help identify communities that might be exposed to persistent supply chain disruption.

Besides constituting a practical analytical tool that might allow firms and communities to identify and therefore proactively manage their own vulnerabilities, this dataset could help identify gaps in our information on supply chains across multiple firms and industries. Better information would help prioritise and coordinate resilience-enhancing investments and to guide reporting on supply chain risks in critical sectors under the Indo-Pacific Economic Framework for Prosperity (IPEF).

The approaches and indicative findings presented in this paper are a first step to what could form a more regular and systematic process of collaborating with industry experts to generate data-driven insights from trade data.

The trade data analysis in this paper is based on the approach undertaken by public agencies in Australia, the EU, Germany or Canada (Australian Productivity Commission, 2021; European Commission, 2021; German Council of Economic Experts, 2022; Jiang, 2021). In particular, we rely on the Australian Productivity Commission's (APC) specification as a starting point for determining supply chain vulnerabilities through a series of market concentration filters. However, due to the wider focus of this inquiry on economic resilience, the analysis has been expanded to explore the exposure of industries to supply chain vulnerabilities.

By focusing on industries, we can use other data sources to explore the potential impact of disruption on output and employment outcomes, at both a national and regional level, and therefore the likely impact on communities. The industries we look at include services firms. Services trade data is collected differently from goods, and it is not possible to analyse traded services in the same way as traded products.

This paper is structured in two parts. The first part replicates and extends the APC's market concentration filters and applies them to NZ's trade data to identify vulnerable import and export products. This part also includes a discussion of the suitability of this approach for measuring vulnerability for the specific purposes of this inquiry and the limitations of using this approach to identify vulnerable services.

The second part uses Stats NZ's Input-Output tables to look at industry exposure to trade. Two alternative approaches were tested to map the vulnerable products identified in part one to specific industries. Industries were ranked by their potential vulnerability by overall import and export shares.

The steps taken to indicate how different regions may be exposed to the specific vulnerable imports and exports examined in the first part of the paper are described in Part Two with exposure heat maps. 2018 worker-jobs data for different regions were linked to government administrative, census and survey data using distributional analysis of Stats NZ's Longitudinal Business Database and Integrated Data Infrastructure (IDI). This process was followed for related work for the Inquiry (Riggs, forthcoming) to distribute the impacts of economic shocks to particular industry and employment exposures based on the characteristics for each worker-job profile: age, qualification, ethnicity, and region.[2]

## Fit with other trade analysis and modelling work

The analysis in this paper focuses on *direct* trade exposures, based on customs data of bilateral market transactions. The Commission's Inquiry report contained analysis replicating a recent study of United States supply chain resilience (Baldwin et al., 2022, 2023), exploring hidden (or indirect) supply chain exposure, where a trading partner sells a New Zealand product on to a second destination, which New Zealand may or may not have a direct trade relationship with.[3]

Looking at existing hidden exposures suggested a greater level of reliance on China, based on data for the 2018 year. While food-sector exposure is relatively low (10%) as most manufactured goods used as intermediate inputs in food production are sourced domestically, agricultural sectors are more exposed. Direct plus indirect exposure to imports of (49%), indicating high dependence on imported fertiliser and machinery. China was the top source of imports for 18 of the 19 industries studied.

The Commission also commissioned Motu to run a static CGE (Computer Generalised Equilibrium) model to identify the potential production sector and labour market impacts of a representative set of supply chain disruptions. These output and employment results were then applied by the Commission to estimate more detailed industrial, regional, and demographic impacts (Riggs, forthcoming). This analysis is similar to the Distributional Impacts Microsimulation for Employment (DIM-E), which was developed by the New Zealand Climate Change Commission to analyse policies to reduce greenhouse gas emissions (Riggs & Mitchell, 2021).

The main advantage of CGE models is that they allow us to see how all sectors of the economy would adjust to a supply chain shock by capturing substitution between production inputs and outputs. In other words, they can capture the likely responses of different sectors of the economy to different price changes.

[2] Access to the data used in this study was provided by Stats NZ under conditions designed to give effect to the security and confidentiality provisions of the Statistics Act 1975. The results presented in this study are the work of the authors, not Stats NZ or individual data suppliers. These results are not official statistics. They have been created for research purposes from the Integrated Data Infrastructure (IDI) and Longitudinal Business Database (LBD) which are carefully managed by Stats NZ. For more information about the IDI and LBD please visit https://www.stats.govt.nz/integrated-data/. The results are based in part on tax data supplied by Inland Revenue to Stats NZ under the Tax Administration Act 1994 for statistical purposes. Any discussion of data limitations or weaknesses is in the context of using the IDI for statistical purposes and is not related to the data's ability to support Inland Revenue's core operational requirements.

[3] The details and full results of this analysis are provided in Supplementary Information to the Final Inquiry Report

The trade data analysis in this paper provides descriptive statistics about the imports and exports likely to be affected by a supply chain shock and the industries that are most exposed. Aside from enabling the more detailed analysis of particular industries, markets, or supply chains, this information could be used to inform how the underlying parameters of a CGE model could be specified, to guide the analysis of other potential supply chain disruptions.

## Previous versions

The analysis in this paper is a first step in what could be a collaborative process involving trade officials and industry experts to identify vulnerabilities. This analysis follows the initial part of the APC (2021) framework, which could be extended by consultation with industry experts to examine choices about defining essential and critical goods. This version (2.0) updates the preliminary findings used to inform the Issues paper for the Inquiry (version 1.1).

The main changes include time series analysis to observe whether the vulnerable products identified in 2019 were also vulnerable in preceding years. Stats NZ and BACI data are readily available for 4 years from 2017 through to 2020. Earlier data would require concordance between different versions of HS codes, which has not been undertaken. The role of industry experts to help interpret the filtering results, plus the need to look at multiple periods, should not be understated. Analysing vulnerability across 2017-2019, rather than 2019 alone, removed one of the vulnerable products that the Meat Industry Association of New Zealand identified as being an outlier in their submission on the Issues paper. The high concentration of frozen meat cuts (excl lamb) to China in 2019 was likely due to African swine fever that decimated domestic pork production.

This version also explores the importance of these products and supply chains to particular industries and communities, using a range of data concordance techniques as well as employment statistics from the IDI.

Links to the data files and R analytical code used to produce the results in this paper will be available on the Commission's website, which are provided at the end of this paper.

Main changes from version 1.0:

- Import products worth less than $100,000 re-included in model.

Main changes from version 1.1:

- Re-exports removed.

# Part One: Trade exposure

This part replicates Australian Productivity Commission (APC) work with NZ's trade data to identify NZ's traded products that might be vulnerable to supply chain disruption. The approach has been modified to reflect NZ's trade situation and data constraints. This section also contains a discussion of the suitability of the APC approach for measuring vulnerability for the purposes of our inquiry, and the limitations of using their approach to identify vulnerable services.

## Filtering trade data for concentration

The APC developed a series of filters to apply to Australian trade data to identify imported and exported products (and services) that are vulnerable to supply chain disruption. Exports are considered important for exploring vulnerability to supply chain disruption, as they can form essential parts of other countries' supply chains. The income earned from exports also contributes to a country's GDP and its ability to deliver on society's wellbeing aspirations.

The filters are primarily based on **market concentration**, with the rationale that products (and services) that are imported from or exported to only a few countries or concentrated markets are likely to be more vulnerable to supply chain disruptions. While long and complex supply chains can be adaptive and resilient, they can also bring many possible points of failure. Foreign supply disruptions have larger adverse effects where both geographic and industry concentration is high due to there being limited alternative sources of supply. Depending on the significance of a disruption, impacts on imports or exports can flow through firms to industries and communities, and may lead to consequences for the national economy (Schwellnus et al., 2023).

The two main types of market concentration this paper looks at are:

a) Economy-specific concentration, where a nation sources almost all of its imports from or sends most of its exports of a specific product to a small number of markets, and
b) Global concentration, arising from relatively small number of economies exporting a given product.

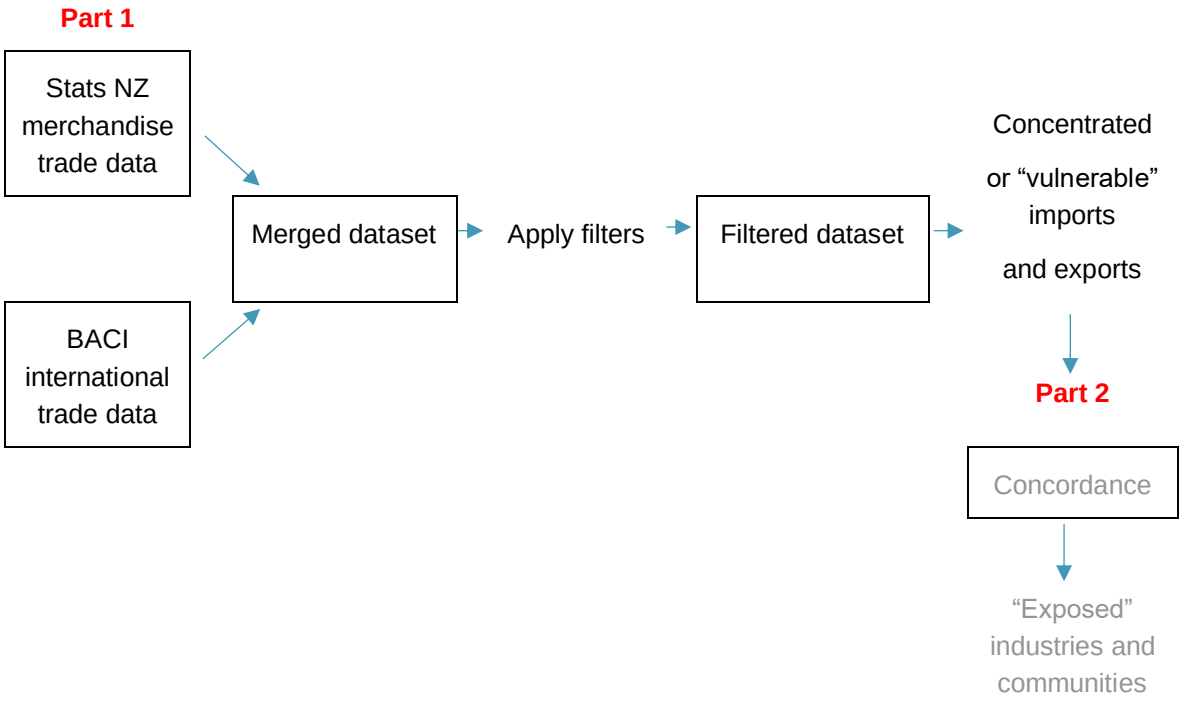
These correspond to the APC's first two filters. In addition to market concentration, the APC approach filters according to the **type of good** (intermediate, capital, consumption). Consumption goods are not considered to be as vulnerable from an economic perspective, so are removed from analysis. However, the Commission's Resilience Inquiry is also focused on *persistent* disruption and economic *wellbeing.* Consumption goods may in fact contribute to the persistence of an economic shock for some communities and, depending on the consumption good, may also affect economic wellbeing. For this reason, we were more cautious, removing only "pure" consumption goods, rather than consumption-intermediate and consumption-capital goods.

Finally, the APC approach filters out products that are not **vulnerable across time**. Due to data constraints, our approach focused on vulnerable goods across the three years from 2017–2019. More data cleaning would be required to extend this analysis.

We added a filter based on a similar Canadian study (Jiang, 2021), which removed imported goods that we export more of. This filter picks up **domestic substitutability**, as these products are not likely to be as vulnerable if we have the ability to switch from global to domestic production as required.

Figure 1 outlines the steps taken with the data analysis.

**Figure 1: Data linkage and filtering process**




Analysis and findings for imports and exports are presented separately in this report.

## *Trade data sources*

Stats NZ's merchandise trade data[4] provides detailed monthly information on the value and volume of physical goods that are imported into and exported from New Zealand. The physical goods are recorded using a 10-digit code, based on the international Harmonised System Code (HSC).[5]

[4] https://www.stats.govt.nz/large-datasets/csv-files-for-download/overseas-merchandise-trade-datasets

[5] The first six digits (HSC-6) represent the internationally comparable code published by the World Customs Organisation, followed by two additional digits (HSC-8) representing country-specific product categories, and then a two-digit NZ statistical code (HSC-10). The first two-digits represent the most aggregated product groupings (HSC-2), based on the chapters from the international code, while the first four digits represent headings, while the six-digits represent the sub-headings. In this report, we refer to data based on the HSC-2, HSC-6 and HSC-10. For the analysis underlying this report, while HSC-6 data was used to link NZ data with international trade data, more detailed product code data was retained for interpretation purposes.

International trade data was required to gauge the New Zealand share of global trade and how concentrated that trade is. Data was sourced from the BACI dataset developed by CEPII, a French centre for research on the world economy.[6]

Analysis focused on data from 2019, the year before the Covid-19 pandemic. This provided a benchmark to compare trade flows before and after a massive supply shock to the New Zealand economy and aligned with the most recent Input-Output tables produced by Stats NZ, discussed in Part 2. Analysis of 2020 and 2021 data could provide an initial assessment of whether the measurement approach successfully identified products that were disrupted by the Covid-19 pandemic.

Less detailed analysis was undertaken with 2017 and 2018 data, with results compared with 2019. Analysis of earlier years would require concordance with earlier Harmonised System codes, which was not undertaken.

The two final datasets for imports and exports (produced following the approach outlined in Figure 1) are available in the supplementary information file[7] and can be used to explore specific traded products.

# Import products

## Import dataset

The results in this section have been generated from the merged Stats NZ-BACI import dataset to provide a picture of New Zealand's total import trade and a basis for comparison with the filtered dataset, discussed in the next section.

The original Stats NZ dataset for 2019 had a total import CIF ("cost, insurance, freight") value of $64 billion NZD. The merged dataset with BACI has a total value of $60.8 billion NZD. There are 132,378 matched observations (country:HSC-10 product pairings) and 938 unmatched Stats NZ observations, meaning $3.4 billion NZD of trade could not be matched. Unmatched observations consist of oils, lubricants, and confidential trade items.

The main changes to create the import dataset were:

- 2349 observations were removed where New Zealand is recorded as the country of origin, representing a value of $187 million or 0.29% of the total value of imports. These are likely to be re-imports (where the same imported goods come back into New Zealand either due to New Zealand adding some small amount of added value or shipping logistics) or returned exports.
- Country names were changed to BACI spellings, which includes Taiwan as "Other Asia, Not Elsewhere Specified".

In 2019, New Zealand imported 11041 HSC-10 level products from 216 countries. By comparison, in 2017 New Zealand imported 11361 HSC10 level products, from 212 countries, with a total import CIF

[6] http://www.cepii.fr/CEPII/en/bdd_modele/bdd_modele_item.asp?id=37

[7] Refer to the "MAIN" data sheet in each file: Trade data analysis 2.0_export results.xlsx and Trade data analysis 2.0_import resutls.xlsx

value of $54 billion. New Zealand imported 11109 HSC-10 level products from 214 countries in 2018, with a total import CIF value of $60 billion.

**Figure 2: Ten most concentrated markets for *all* imports 2017 – 2019**

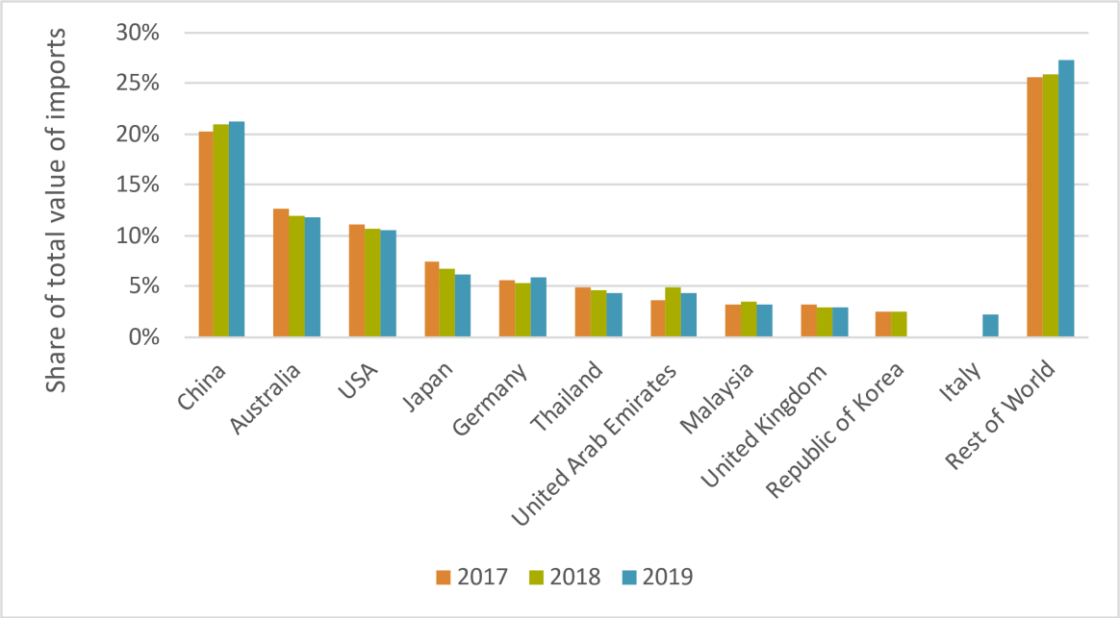
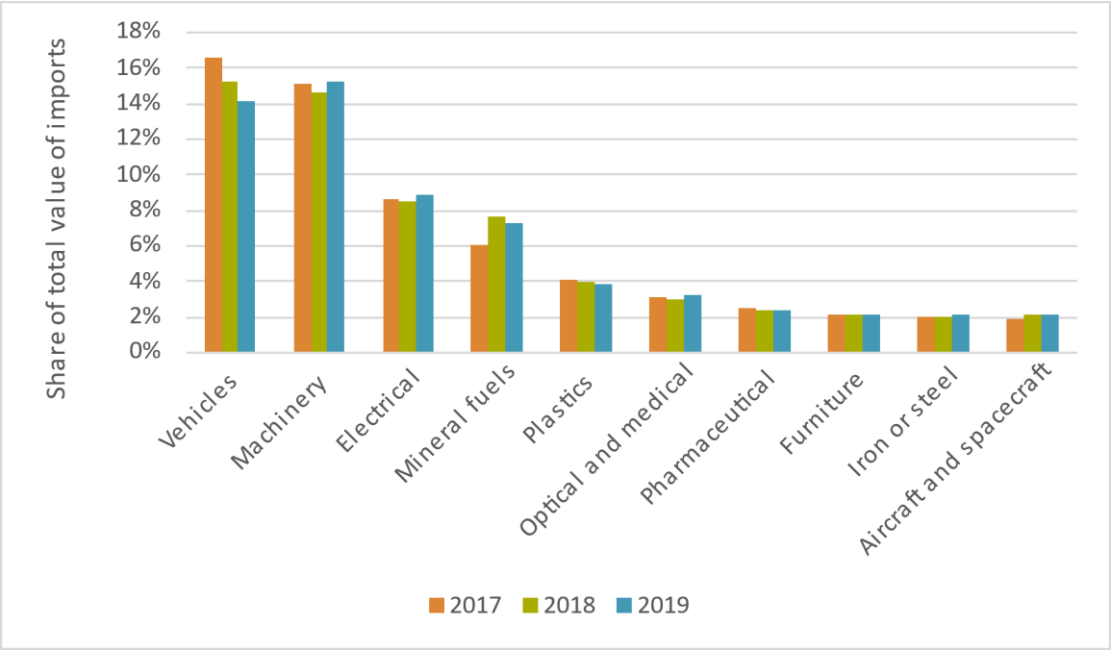



Figure 2 shows China as New Zealand's largest source of total imports, followed by Australia, the USA and Japan. The ranking of the most concentrated countries has been fairly consistent over the period from 2017 to 2019 (except that Italy, rather than Korea was in the top 10 for 2019).

Imports from China make up 21% of New Zealand's total imports in 2019, up from 20% in 2017. New Zealand also imports more HSC-10 products from China than any other country (8177 in 2019, down from 8320 in 2017).

Figure 3 shows the top ten (of 96) HSC-2 level products New Zealand imported in 2017–2019. The remaining 86 HSC-2 level products New Zealand imported each make up 2% or less of the value of New Zealand's total imports.

**Figure 3: Top HSC-2 categories for *all* imports 2017–2019**




## Import filters

The following filters were applied to the import dataset to identify potentially vulnerable imported products:

- Filter one (concentrated import sources) identifies products that have a limited number of existing import sources, or specifically where the main (country) supplier provides more than 80% of the HSC-10 product category that New Zealand imports. Imports sourced from only a few countries are more likely to be exposed to individual supply constraints, transportation disruptions, production bottlenecks and/or unforeseen policy changes (border closures, export restrictions, natural disasters etc.).

- Filter two (concentrated global markets) identifies products from limited alternative global suppliers, where New Zealand may face challenges sourcing following a major disruption. Following the APC method, this is assumed to be when the Herfindahl–Hirschman Index (HHI) of a supplier for an imported product to New Zealand is in the top quartile (greater than 1670 in 2019), and when the supplier of a product to New Zealand also accounts for at least 50 per cent of global exports of that product.[8]

[8] The HHI is a measure of market concentration using the square of the sum of county shares of individual HSC-10 product imports. Values range between 0 and 10000 – values above 2500 signal high market concentration. New Zealand's top quartile value of 1670 (in 2019) is considerably lower than the value of 3100 used by the APC, suggesting that New Zealand imports fewer products from countries with a high market share in the supply of those products. While this may be the case, as Australia's economy is structurally different and trades in more categories than New Zealand, there are two aspects of our data analysis that might also explain the difference: (1) the APC used more comprehensive and granular UN Comtrade data rather than BACI (HSC-8, rather than HSC-6) which generates higher average HHIs; and (2) we calculate the HHI for products that are imported to New Zealand. While we think this is consistent with the APC's approach, our method of calculation may differ. Filter two combines the APC's second and third filters (Australian Productivity Commission, 2021).

- Filter three (limited domestic capacity) removes products that New Zealand could produce locally. The potential capability to produce a product was assumed to occur where the export value is higher than the import value for the same HSC-10 product.[9]

- Filter four (not consumption) removes pure consumption products, based on the UN's Broad Economic Categories (BEC).[10] While these items may be less essential to the production of goods in of the economy, their loss would have important wellbeing implications.

## Findings from filtered import dataset

**Table 1: Potentially vulnerable New Zealand import products 2017-2019**

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| Number of **unique HSC-10 level** products imported to NZ | 11361 | 11109 | 11041 |
| Total import value (NZD billions) | $53.9 | $60.0 | $60.8 |
| **Filter one:** Products from concentrated import sources<br>(Main supplier >80% of imports) | 3802<br>$8.0 | 3776<br>$8.4 | 3744<br>$9.0 |
| **Filter two: F**ew global suppliers<br>•HHI > top ¼ AND<br>•Highest market share >50% | 775<br>$3.1 | 793<br>$3.1 | 808<br>$4.0 |
| **Filter three: Excluding** domestic capacity to substitute | 739<br>$3.1 | 757<br>$3.1 | 776<br>$3.9 |
| **Filter four:** Excluding pure consumption | 407<br>$2.2 | 426<br>$2.1 | 429<br>$3.0 |
| **Proportion of imported products** | 3.58% | 3.83% | 3.88% |
| **Number products in any 3 years** | 811 | | |
| **Number products in any 2 years** | 332 | | |
| **Number products in all 3 years** | 119 (2019 value = $1.4 billion) | | |
| **Number products also vulnerable in 2020** | 28 | | |

[9] This proxy measure is based on the measure used by Global Affairs Canada in their study of vulnerable imports. See Jiang (2021)

[10] https://unstats.un.org/unsd/classifications/Econ#Correspondences

Table 1 presents results of filtering the merged Stats NZ-BACI imports datasets from 2017–2019. Filtering identified 119 imported products from 17 countries between 2017—2019, representing 2% of the number of discrete 11041 HSC-10 level product categories imported in 2019.

The 119 products were worth $1.4 billion in 2019, of the $61 billion total imports in 2019 that could be matched with international trade data. In other words, 2% of the value of New Zealand's imported products were potentially "vulnerable" to persistent supply chain shocks based on this methodology and using the filter thresholds described above.

Table 1 shows that while the results of the filtering process are broadly comparable between 2017-2019, the proportion of vulnerable products to unique HSC-10 products increased.

There is variation in the specific products that were vulnerable in any given year. A total of 811 products were vulnerable in at least one of the years, almost twice the total of any given year, compared to less than a third of any given year (119) being vulnerable across all three years. The following findings are presented in terms of the products that are vulnerable in all three years.

**Table 2: Top ten concentrated markets for vulnerable imports 2017–2019 (2019 values)**

| | Country of origin | Share of total value of vulnerable HSC10 products (%) | Vulnerable HSC10 categories | Total value of vulnerable products (NZD) |
|---|---|---|---|---|
| 1 | China | 71.4% | 73 | $1003M |
| 2 | Argentina | 12.3% | 1 | $172M |
| 3 | Australia | 4.8% | 4 | $67M |
| 4 | Malaysia | 2.0% | 1 | $28M |
| 5 | Indonesia | 1.8% | 2 | $26M |
| 6 | USA | 1.8% | 11 | $25M |
| 7 | Japan | 1.8% | 2 | $25M |
| 8 | France | 1.4% | 2 | $19M |
| 9 | Germany | 1.3% | 3 | $19M |
| 10 | Canada | 0.7% | 18 | $12M |
| | Rest of World | 0.8% | 2 | $9M |
| | *Total value of vulnerable import trade* | | *$1.4B (of a total $60.8 billion in 2019)* | |
| | *Total countries with vulnerable import trade* | | *17 (of a total 216 countries)* | |
| | *Total vulnerable imported HSC10 categories* | | *119 (of a total 11041 discrete product categories)* | |

There are 17 countries New Zealand imports vulnerable products from, of a total of 216. Table 2 shows the top 10 countries accounting for more than 99% of the total value of vulnerable products.

China accounted for 71.4% by value across the three years 2017-2019, compared with only 41.7% in 2019. This compares with imports from China making up 21% of New Zealand's total goods imports in 2019. Of the total 119 vulnerable HSC-10 level products identified, China supplied the majority (73, or 61%).

Table 3 shows that China supplied five of New Zealand's top ten vulnerable imported products (by 2019 value) between 2017-2019.

**Table 3: Top ten vulnerable HSC-10 imported products 2017–2019 (2019 values)**

| | HSC2 | HSC10 category | Origin | Value of vulnerable HSC10 category | Value of total HSC10 category | % of total HSC10 category | % of total vuln. trade |
|---|---|---|---|---|---|---|---|
| 1 | 84 | Data processing machines | China | $741M | $795M | 93 | 53 |
| 2 | 23 | Oil-cake and residues | Argentina | $172M | $174M | 99 | 12 |
| 3 | 85 | Monitors for data processing machines | China | $68M | $78M | 88 | 5 |
| 4 | 48 | Paper and paperboard | Australia | $61M | $62M | 100 | 4 |
| 5 | 85 | Electrical machinery | China | $33M | $37M | 89 | 2 |
| 6 | 15 | Vegetable oils | Malaysia | $28M | $30M | 96 | 2 |
| 7 | 44 | Wood (kwila) | Indonesia | $25M | $25M | 99 | 2 |
| 8 | 94 | Furniture | China | $23M | $27M | 84 | 2 |
| 9 | 84 | Gas water heaters | Japan | $23M | $24M | 95 | 2 |
| 10 | 85 | Microwave ovens | China | $20M | $23M | 88 | 1 |
| | | *Total vulnerable import trade (including all countries)* | | | | | *$1.4B* |

Table 4 shows the top ten vulnerable products in each year, which are reasonably consistent across time. These import categories are not necessarily captured in the 119 filtered dataset for 2017-2019 shown in Table 3, which shows vulnerable products in *all* three years.

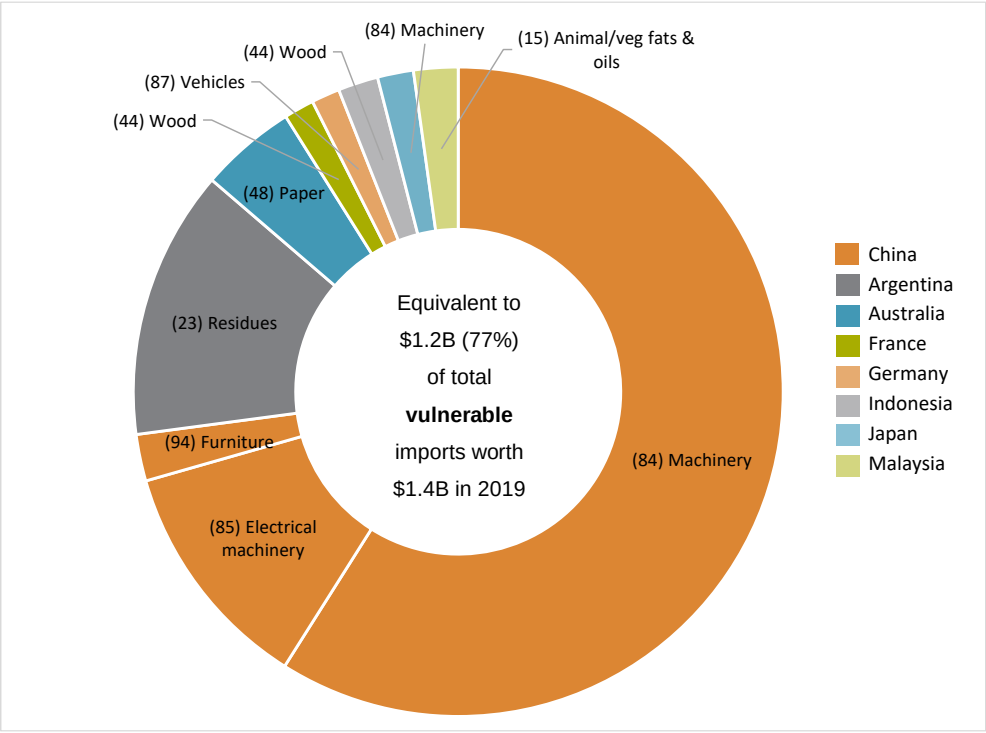
Breaking the data down by HSC-2 categories[11] reveals more detail within the dataset. Figure 4 shows New Zealand's top ten vulnerable imports by country and HSC-2 category, worth $1.7B (77% of New Zealand's vulnerable imports). China's share of this remains significant at $1.3B.

[11] Refer Footnote 5 above.

**Table 4: Top ten vulnerable HSC-10 imported products 2017-2019**

| 2017 | 2018 | 2019 |
|---|---|---|
| Automatic data processing machines | Automatic data processing machines | Automatic data processing machines |
| Aeroplanes and other aircraft | Fertilizers (diammonium phosphate) | Aeroplanes and other aircraft |
| Fertilizers (diammonium phosphate) | Oil-cake and soya-bean residues | Aluminium oxide |
| Oil-cake and soya-bean residues | Brewing or distilling waste | Oil-cake and soya-bean residues |
| Monitors for automatic data processing machines | Tankers (not refrigerated) | Brewing or distilling waste |
| Kraft paper and paperboard | Monitors for data processing machines | Monitors for data processing machines |
| Wooden frame seats | Kraft paper and paperboard | Kraft paper and paperboard |
| Electrical machinery | Wood (Thuja plicata) | Wood (Thuja plicata) |
| Vegetable oils | Cranes | Wooden frame seats |
| Tanks and other armoured fighting vehicles | Vegetable oils | Cane sugar |
| **407** total product categories | **426** total product categories | **429** total product categories |

**Figure 4: Top ten HSC-2 vulnerable imports by country 2017–2019 (2019 values)**



# Export products

## Export dataset

The original 2019 Stats NZ dataset had a total export "free on board" (FOB)[12] value of $59.9b (*including* re-exports). The merged dataset (*excluding* re-exports) has 63,942 observations (country:HSC-10 product pairings), with a total value of $56.2 billion NZD. There are 578 unmatched observations – a mix of meat, dairy, lubricants and confidential items – meaning almost $1.6 billion of trade could not be matched.

The main changes to create the export dataset were:

- 14,687 observations were removed from the original 2019 Stats NZ dataset where the recorded FOB value was $0, representing a value of $2 billion or 3.46% of the total value of exports. These goods are re-exports, either produced by another country and shipped via New Zealand, or produced in New Zealand but processed by an internal port. Removing these observations avoids double-counting – otherwise New Zealand is credited with producing goods that were actually imported from elsewhere.
- Country names were changed to BACI spellings, which includes Taiwan as "Other Asia, Not Elsewhere Specified".

The following results have been generated from the merged export dataset to provide an overview of New Zealand's total export trade and as basis for comparison with the filtered dataset, discussed in the next section.

Figure 5 shows China as New Zealand's most concentrated export market between 2017-2019, followed by Australia, the USA, Japan and Korea. The share of exports to China increased over this period, relative to other countries.

Figure 6 shows the top ten (out of 96) HSC-2 level products New Zealand exported between 2017–2019, accounting for 75% of total exports. Dairy and animal produce (dairy produce, birds' eggs, natural hone, and edible products of animal origin) alone make up more than a quarter of total exports over this period (29%), followed by Meat at 14% and Wood at 9%. All the other categories each make up 5% or less.

In 2019, New Zealand exported 8525 HSC-10 level products to 206 countries. By comparison, in 2018, New Zealand imported 8787 HSC-10 level products, from 207 countries, with a total export FOB value of $53.6 billion. In 2017 New Zealand exported 8951 HSC10 level products, to 203 countries, with a total export FOB value of $50.3 billion.

[12] "Free on Board" refers to the value or price of the products being exported at the New Zealand border, including all costs incurred in the distribution up to this point.

**Figure 5: Top ten concentrated markets for *all* New Zealand exports 2017–2019**

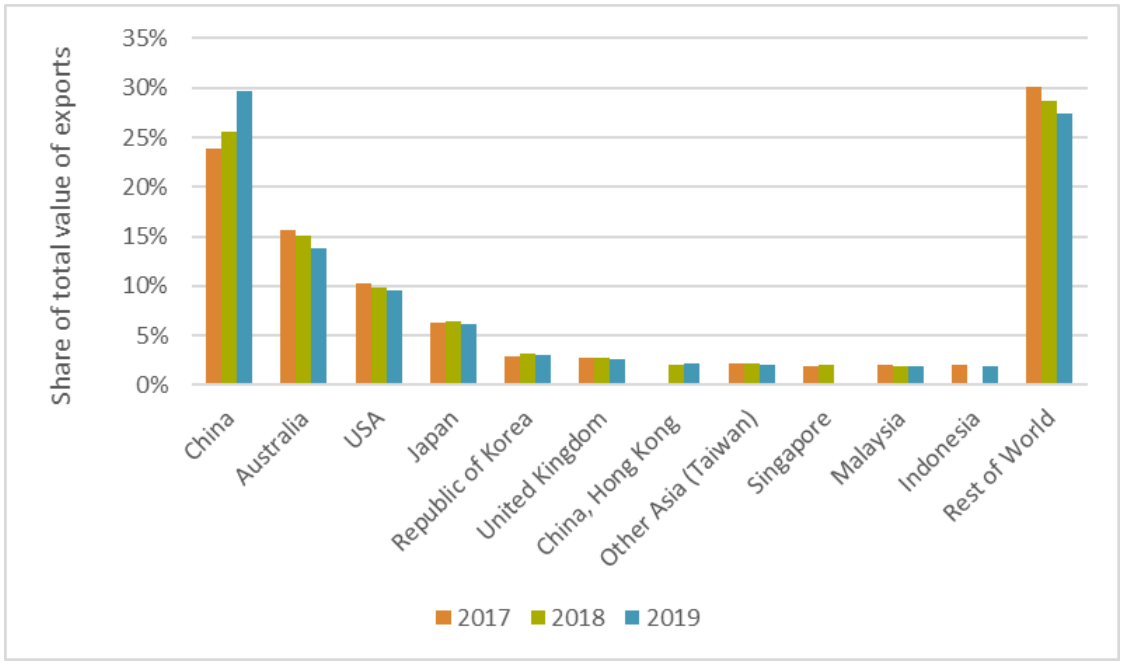
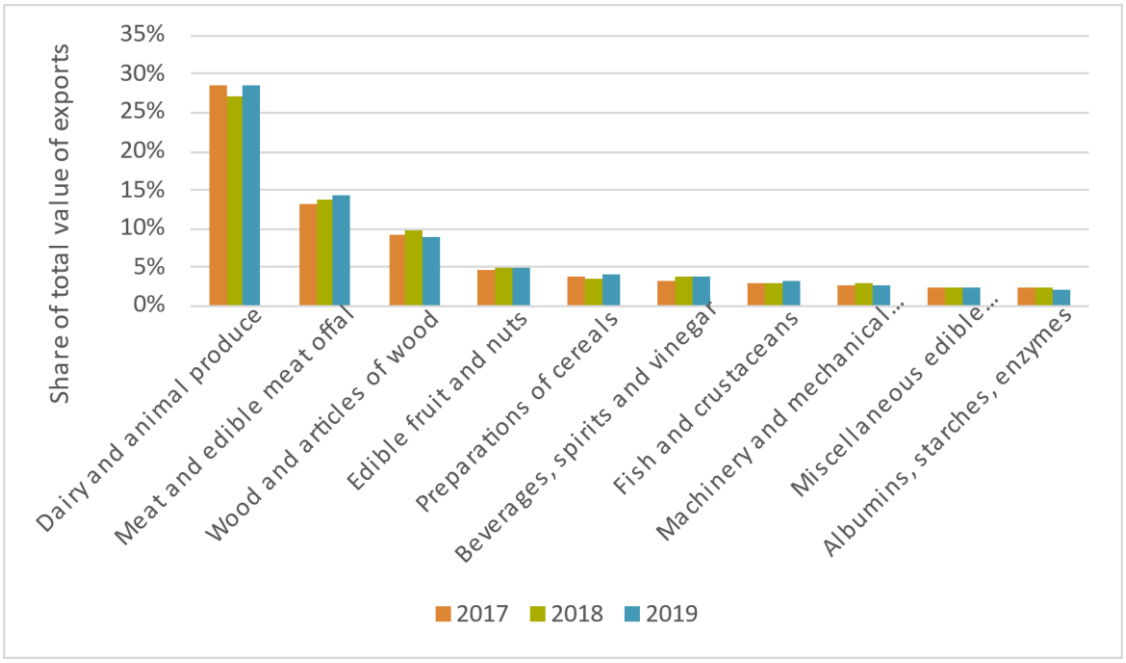



**Figure 6: Top ten HSC-2 categories for *all* exports 2017–2019**



## Export filters

The following filters were applied to the export dataset:

- Filter one (concentrated exports) identifies concentrated New Zealand exports by assessing whether a single destination accounts for more than 80% of total exports of that product. As with imports, concentrated exports may be more exposed to disruption caused by transportation issues, export restrictions or natural disasters etc.

- Filter two (concentrated global markets) identifies exports with few alternative destination markets to redirect exports. For the purposes of initial analysis, this was assumed to be when the HHI is in the top quartile ***and*** the biggest importer accounted for more than 50% of global imports.[13]

## Findings from filtered export dataset

**Table 5: Potentially Vulnerable New Zealand Exported Products 2017-2019**

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| Number of **unique HSC-10 level** products exported to NZ | 8951 | 8787 | 8525 |
| Total export value (NZD billions) | $50.3 | $53.4 | $56.2 |
| **Filter one:** Products to concentrated destinations<br>(Main supplier >80% of exports) | 4160<br>$5.3 | 4004<br>$5.7 | 3929<br>$8.6 |
| **Filter two: F**ew global buyers<br>•HHI > top ¼ **and**<br>•Highest market share >50% | 277<br>$1.3 | 251<br>$0.7 | 234<br>$0.7 |
| **Proportion of imported products** | 3.09% | 2.86% | 2.76% |
| **Number products in any 3 years** | 593 | | |
| **Number products in any 2 years** | 146 | | |
| **Number products in all 3 years** | 23 (2019 value = $0.1 billion) | | |
| **Number products also vulnerable in 2020** | 15 | | |

[13] Filter two combines the APC's original second and third filters (Australian Productivity Commission, 2021).

Table 5 presents the results of filtering the export dataset. New Zealand exported 8525 products to 206 countries in 2019, 3929 (46%) of which were to concentrated individual markets, 746 (9%) to concentrated global markets, and 234 (3%) to the largest global market.

Filtering identified 23 products exported to seven countries between 2017—2019, representing 0.3% of the 8525 HSC-10 level products New Zealand exported in 2019. The 23 products were worth $114 million in 2019, of the total $56.2 billion exports that could be matched with international trade data. In other words, 0.3% of the value of New Zealand's exported products could be considered "vulnerable" to persistent supply chain shocks based on this methodology and using the filter thresholds described above.

Table 6 shows Australia as the largest export market for these vulnerable products, closely followed by Japan and China. While China is New Zealand's main export market, purchasing 30% of unfiltered exports ($16.6 billion of a total $56.2 billion), China directly imports only 18% of New Zealand's vulnerable products ($114 million).

**Table 6: Most concentrated markets for vulnerable exports 2017–2019 (2019 values)**

| | Destination country | Share of total value of vulnerable HSC10 products (%) | Vulnerable HSC10 categories | Total value of vulnerable products (NZD) |
|---|---|---|---|---|
| 1 | Australia | 34.5% | 12 | $39M |
| 2 | Japan | 32.7% | 1 | $37M |
| 3 | China | 18.4% | 2 | $21M |
| 4 | USA | 14.3% | 5 | $16M |
| 5 | Singapore | 0.0% | 1 | $0M |
| 6 | Samoa | 0.0% | 1 | $0M |
| 7 | Niue | 0.0% | 1 | $0M |
| | *Total vulnerable trade* | | *$0.1B (of a total $56.2 billion in 2019)* | |
| | *Total countries with vulnerable export trade* | | *7 (of a total 216 countries)* | |
| | *Total HSC10 vulnerable categories exported* | | *25 (of 8525 discrete product categories)* | |

Table 7 shows the breakdown of New Zealand's top ten vulnerable HSC-10 category exports between 2017–2019 (by their 2019 value) compared with the proportion of the total value of this category that New Zealand exports. Non-coniferous wood for fuel to Japan accounted for a third of the value of vulnerable exports, followed by unprocessed wool to China (17%) and printed plastic packaging to Australia (11%).

Finally, Figure 7 below shows New Zealand's top ten vulnerable exports by country and HSC-2 category, which are worth $111 million or 98% of New Zealand's vulnerable imports. Australia's share was $38 million (34%), Japan's $37 million (33%), and China's $21 million (18%).

**Table 7: Top ten vulnerable HSC-10 exported products 2017–2019 (2019 values)**

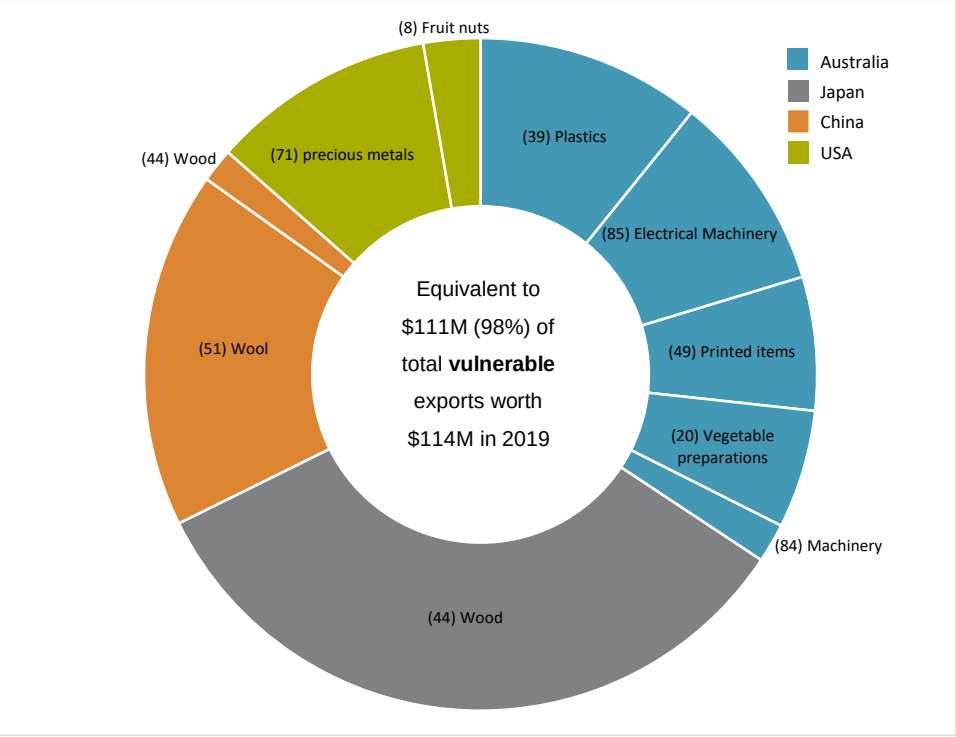
| | HSC2 | HSC10 category | Destination | Value of vulnerable HSC10 category | % of total HSC10 category | % of total vuln. Trade |
|---|---|---|---|---|---|---|
| 1 | 44 | Wood for fuel (non-coniferous) | Japan | $37M | 99.9 | 33 |
| 2 | 51 | Wool (not carded or combed) | China | $19M | 97.6 | 17 |
| 3 | 39 | Plastic packaging (printed) | Australia | $12M | 97.7 | 11 |
| 4 | 71 | Waste of precious metals | USA | $12M | 100.0 | 11 |
| 5 | 85 | Fire alarm systems | Australia | $11M | 94.2 | 9 |
| 6 | 49 | Calendars | Australia | $7M | 98.4 | 6 |
| 7 | 20 | Nuts and edible plants, not fruit | Australia | $6M | 95.6 | 6 |
| 8 | 8 | Dried apples | USA | $3M | 93.7 | 3 |
| 9 | 84 | Parts for hydraulic powered engines | Australia | $2M | 91.2 | 2 |
| 10 | 44 | Wood (Populus spp.) | China | $2M | 99.9 | 2 |
| | | *Total vulnerable export trade (including all countries)* | | | | *$114M* |

Table 8 compares the top ten vulnerable HSC-10 products in each year from 2017–2019. The only common products across the three years are Wood rough (coniferous) and Wood for fuel (non-coniferous), suggesting significantly more variability in New Zealand's exports than imports.

**Table 8: Top ten vulnerable HSC-10 exports 2017—2019**

| 2017 | 2018 | 2019 |
|---|---|---|
| Methyl alcohol | Live lobsters | Frozen meat cuts (excl lamb) |
| Unwrought silver | Wood rough (coniferous) | Wood rough (coniferous: fir, spruce) |
| Lamb skins | Wood for fuel (non-coniferous) | Wood for fuel (non-coniferous) |
| Wood rough | Fresh blueberries | Wood rough (non-coniferous) |
| Fresh blueberries | Jewellery of precious metal (excl. silver and jade) | Jewellery of precious metal (excl. silver and jade) |
| Wood for fuel (non-coniferous) | Wood for fuel (pinus radiata) | Wood for fuel (pinus radiata) |
| Wood rough (coniferous) | Wool (not carded or combed) | Wool (not carded or combed) |
| Beetroot prep. | Electrical transformers | Wood rough (coniferous) |
| Waste paper or paperboard | Plastic packaging (printed) | Gas space heaters |
| Waste batteries | Dead lobsters | Machines, particle accelerators |
| **277** total product categories | **251** total product categories | **234** total product categories |

**Figure 7: Top ten HSC-2 vulnerable exports by country 2017–2019 (2019 values)**



# Trade in services

This section sets out available data sources on trade in services, what we already know about trade in services, and work that could be undertaken to improve our understanding of what trade in services is more vulnerable to disruption (from an economic and wellbeing perspective).

Because there are no country-specific tariffs or taxes on service trade flows, there is no equivalent data source to goods that provides details of specific New Zealand services trade. Services tend to flow 'invisibly' across borders and can involve the flow of people.

The World Trade Organisation's General Agreement on Trade in Services (GATS) sets out four internationally recognised modes of supply:

1. Direct cross border (interact from distance/electronically) – in 2011, this made up 86% of New Zealand commercial services exports (data from ITSS, but not public).
2. Consumption abroad (eg New Zealand exports of education services) – 3%.
3. Commercial presence (eg New Zealand imports of financial services from Australian banks) – no data.
4. Movement of labour (presence of natural persons) – 12%.[14]

Replicating the analysis of traded goods, would require information about the service provided, the country from or who the service was provided to and comparable overseas data. Given services data limitations, this section presents some (less detailed) information that could be used to identify and potentially measure traded services that are could be vulnerable to persistent disruption.

Depending on the measure of vulnerability, it may be possible to identify:

- Economy-specific services concentration (filter 1), but not global concentration (filter 2).
- Traded services that are essentially labour (GATS modes 2 & 4).
- Trade costs using a gravity model (Gervais & Jensen, 2019).

## Services data sources

There are three interrelated sources that inform our understanding about trade in services:

1. The International Trade in Services and Royalties Survey (ITSS) is a quarterly survey undertaken by Stats NZ that provides revenue, expenditure and country information on 39 'product' categories. Totals are available on infoshare, but not detailed categories, countries, or GATS mode 3.[15] Some country level data is available on downloadable tables via Stats NZ's information releases, however complete data would need to be requested or accessed in IDI.[16]
2. Stats NZ's National Account Input-Output (IO) tables have aggregate data on imports and exports, including services.[17] However, these primarily relate to domestic production and "services" refer to specific IO products and industries, which may or may not be traded. It's not clear how the IO services products relate (if at all) to the 39 categories in the ITSS. Data

[14] Lisa Meehan, NZ Productivity Commission, "New Zealand's international trade in services: A background note", 2014/1.
[15] https://infoshare.stats.govt.nz/ > Economic Indicators > Balance of Payments > BPM6 current account services (March year)
[16] https://www.stats.govt.nz/insights?filters=Goods%20and%20services%20trade%20by%20country%2CInformation%20releases
[17] https://www.stats.govt.nz/information-releases/national-accounts-input-output-tables-year-ended-march-2020

used for the IO tables is collated from a number of sources, including the Annual Enterprise Survey and Business Operations Survey. While it is possible to calculate the import share of a domestically produced "service", it is not clear from the IO tables themselves if the import component is a service or a good. It is, however, possible to work out services embedded in exported goods, using the import coefficients provided in the IO tables.

3. The OECD's TiVA (Trade in Value Added) dataset provides statistics (rather than raw data) on the value that is added by different countries and industries in producing goods and services for trade.

## Services trade composition

In 2019, services made up 30% of total New Zealand exports ($26 billion services of a total $86 billion) and 26% of total imports ($22 billion of a total $83 billion).[18] According to TiVA, services accounted for 57% of the value-added of New Zealand's gross exports in 2018, just above the OECD average of 55.7%.[19]

Table 9 shows that Australia was New Zealand's main source of services imports and main destination for services exports.

**Table 9: Top ten source and destination countries for services (and goods) in 2019**

| IMPORTS | | | | EXPORTS | | | |
|---|---|---|---|---|---|---|---|
| Services | | Goods | | Services | | Goods | |
| Australia | $6.0B | China | $12.5B | Australia | $5.3B | China | $16.7B |
| EU | $3.3B | EU | $11.5B | USA | $4.0B | Australia | $8.7B |
| USA | $3.3B | Australia | $7.1B | EU | $3.7B | USA | $5.6B |
| Singapore | $2.4B | USA | $6.1B | China | $3.4B | EU | $5.3B |
| China | $0.8B | Japan | $3.9B | Japan | $1.0B | Japan | $3.5B |
| Switzerland | $0.6B | Thailand | $2.6B | India | $1.0B | Korea | $1.7B |
| Fiji | $0.4B | UAE | $2.6B | Korea | $0.6B | Hong Kong | $1.3B |
| Hong Kong | $0.3B | Korea | $2.4B | Singapore | $0.5B | Taiwan | $1.2B |
| UAE | $0.3B | Malaysia | $1.9B | Hong Kong | $0.5B | Singapore | $1.1B |

Source: https://www.stats.govt.nz/information-releases/goods-and-services-trade-by-country-year-ended-december-2019/

[18] https://www.stats.govt.nz/information-releases/goods-and-services-trade-by-country-year-ended-september-2019/

[19] https://www.oecd.org/sti/ind/CN2021_NZL.pdf (Feb 2022)

While travel and transport are key for New Zealand's trade in services, commercial services are also important. Table 10 identifies four of New Zealand's top ten import and export products as services.

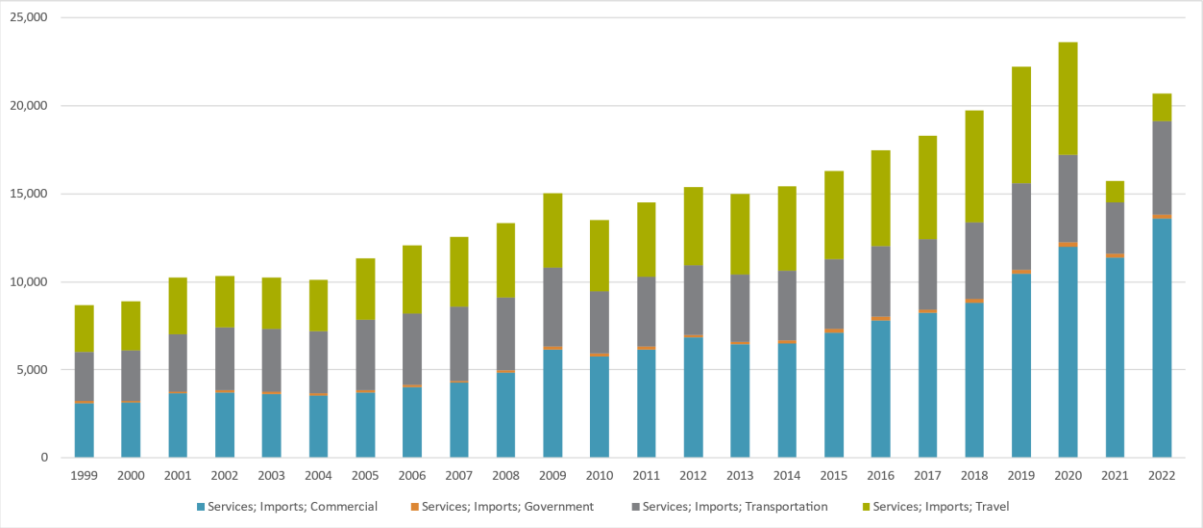
**Table 10: Top ten goods and services exports and imports in 2019**

| IMPORTS | | | | EXPORTS | | | |
|---|---|---|---|---|---|---|---|
| Good | Mechanical machinery and equipment | $9.0B | 10.8 | Good | Milk powder, butter, and cheese | $15.8B | 18.3 |
| Good | Vehicles, parts, and accessories | $8.1B | 9.7 | Service | Business and other personal travel | $11.6B | 13.4 |
| Good | Petroleum and products | $6.8B | 8.2 | Good | Meat and edible offal | $8.0B | 9.4 |
| Service | Business and other personal travel | $6.5B | 7.8 | Good | Logs, wood, and wood articles | $5.0B | 5.8 |
| Good | Electrical machinery and equipment | $5.3B | 6.3 | Service | Education travel services | $4.6B | 5.3 |
| Service | Other business services | $4.1B | 4.9 | Good | Fruit | $3.4B | 4 |
| Service | Air transport | $2.8B | 3.3 | Service | Air transport | $2.7B | 3.1 |
| Good | Textiles and textile articles | $2.7B | 3.3 | Service | Other business services | $2.4B | 2.8 |
| Good | Plastic and plastic articles | $2.2B | 2.7 | Good | Preparations of milk, cereals, flour, and starch | $2.3B | 2.7 |
| Service | Sea transport | $2.2B | 2.6 | Good | Mechanical machinery and equipment | $1.9B | 2.2 |

Source: https://www.stats.govt.nz/information-releases/goods-and-services-trade-by-country-year-ended-december-2019/

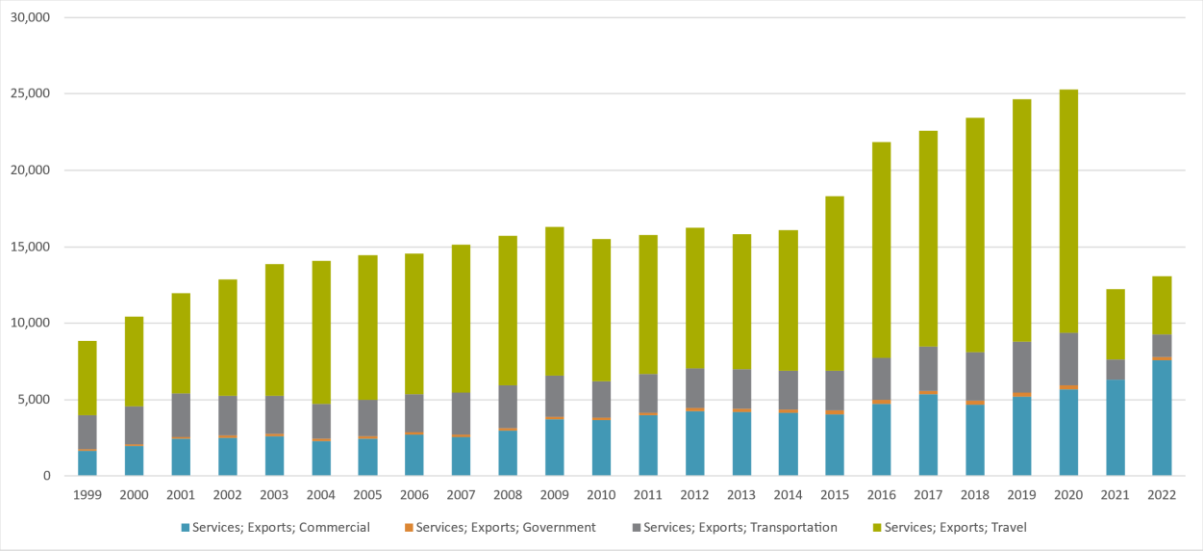
While there may be potential for further growth in traded services, the challenge for New Zealand is to see this growth in traded commercial services, rather than travel and transport. Figure 8 and Figure 9 below, show that while there has been growth in commercial services over the past 20 years, this has been more pronounced for imports than exports.

**Figure 8: Composition of New Zealand services imports 1999—2022**




Source: https://infoshare.stats.govt.nz/ > Economic Indicators > Balance of Payments > BPM6 current account services (Annual – Mar)

**Figure 9: Composition of New Zealand services exports 1999—2022**




(**Caution**: minor discrepancy in later years between total of these categories and total in BPM6 data)

Source: https://infoshare.stats.govt.nz/ > Economic Indicators > Balance of Payments > BPM6 current account services (Annual – Mar)

While the IO tables only tell us about New Zealand produced services, the import and export shares associated with these services may shed some light on vulnerabilities, particularly in terms of the kinds of commercial services New Zealand may be wanting to grow. In the year to March 2020,

services related to software licencing, insurance, cargo, and IT design and development had highest import share. Services related to cargo, software licencing, water and air transport, and film and television had highest export share.

As with trade in goods, trade in services was affected by the pandemic. According to Stats NZ, the services deficit was $5.4 billion in 2021 (December year), following a $1.0 billion surplus in 2020, and a $3.8 billion surplus in 2019.[20] This was primarily due to the impact on travel and transportation and the rising cost of freight.

## Previous Productivity Commission work on services

Commercial services appeared to be more resilient, at least in value terms, which can be seen in the Figures above. This included increased spending on streaming services and setting up for remote working; intellectual property exports increased by 28 percent, driven by the licensing of computer software.

The Commission's 2014 Inquiry into boosting services sector productivity concluded that, even though New Zealand's primary and goods producers could not function without an effective services sector, , subdued competition in some service industries reduces incentives to innovate and holds back wider productivity growth. The high costs of trading some services, combined with low population density and economies of scale in production, result in less choice and competition.

Interestingly, the Services Inquiry also found that government-mandated information disclosure can be a light-handed way to reduce search costs – if information is accessible and understandable and business compliance costs are minimised. Improving regulation (particularly occupational licensing and competition law), reducing search and switching costs, greater standardisation and flexibility of compliance with framework policies, and accelerating ICT adoption were all recommended as areas for the government to look at (NZPC, 2014).

Related and subsequent work found that not only is the traded sector more productive than the non-traded sector, traded services were growing faster than traded goods. Service exporting firms were larger, more productive and had higher foreign ownership than goods exporting firms. However, New Zealand's ratio of service trade to GDP was comparatively low compared to small advanced economies (although similar to OECD, unless we remove travel and transport).[21]

The main issue the Commission identified with commercial services was that most are via mode 1 – they are remote or electronic. Commercial services that involve the flow of people are valuable from a growth and productivity perspective.

There appears to be a proximity burden issue for modes 2-4. Since services are intangible, invisible and often produced and consumed at the same time, they are a flow and therefore cannot be stored. The proximity of the customer and seller is therefore more important than with goods trade. This proximity burden is why services are traditionally categorised as 'non-tradable'.

Modes 2-4 service require deep connections. Markets tend to be more concentrated then markets for goods (cf. filter 1 for goods trade data analysis) and trade liberalisation is more difficult, particularly for movement of labour and investment. New Zealand is less integrated into international markets than

[20] https://www.stats.govt.nz/news/international-trade-in-services-shows-5-4-billion-deficit-in-2021

[21] Meehan (2014) and Rajanayagam (2016).

other OECD countries; New Zealand's trade in services tends to be more with traditional trading partners (Australia, USA, EU) than Asia.

Distance makes it costly to establish and manage overseas networks and to effectively pool market intelligence. The limited scale and lack of geographic density provides a relatively weaker incentive to enter the New Zealand market, limiting import penetration and competition. This highlights the importance of lowering the fixed costs of investing in market information, marketing, networks and distribution chains, for example through improvements in regulatory settings and faster technology diffusion.

# Part Two: Industry exposure

This part of the paper looks at existing data sources to identify the industries that are most exposed to trade (*persistent supply chain*) disruptions, specifically to the vulnerable products identified in Part One.

Understanding which industries are exposed to trade shocks could help the government prioritise which sectors to collaborate with and share information about potential vulnerabilities or criticalities. Once identified, existing data about industries can be used to inform possible economic impacts of disruption on output and employment outcomes, based on key regional characteristics, value of output, number and size of firms, employment levels and earnings, and age and skill-level of workers. This information is important for assessing the likely impact a trade shock will have not just on the economy as a whole, but where this impact is likely to be felt most.

Currently, there is no detailed publicly available information on which firms import and export specific products, or make use of imported products in their production processes. Stats NZ publishes Input-Output tables every five years using data used to produce the National Accounts, showing the relationship between industries, the goods and services they produce, and who uses them.[22] The tables provide aggregate industry-product information, including information about both imports and exports, and about both goods *and* services.

We have used this information to assess the potential trade exposure of different industries to imports and exports generally, and with imports, the degree of industry exposure to the importation of specific (aggregate) product groups, independently of the analysis in Part One.

The latest version was produced for the March year ended 2020, aligning with the December 2019 year that the Part One analysis was based on. Statistical concordance tables were used to identify and map the potentially vulnerable products onto the industries that use them. This mapping is not perfect. Its usefulness relies on the accuracy of the concordance tables.

This section explores two approaches for mapping our vulnerable products to industries:

1. Method One uses Stats NZ's concordance tables to ***directly*** convert HS coded products to "predominant" ANZSIC industries.[23] This method can be used for both imports and exports.
2. Method Two uses Stats NZ's concordance tables in the Input-Output (IO) tables to ***indirectly*** covert HS products to "main" ANZSIC industries. This method can only be used for imports.

Both approaches provide a way to rank industries in terms of their exposure or vulnerability to trade shocks and are tested below with the merged 2017-2019 dataset, using 2019 figures.

Qualitative information and anecdotal experiences from engagement with industry experts and communities should inform any resulting prioritisation of supply chain analysis or mapping.

[22] https://www.stats.govt.nz/information-releases/national-accounts-input-output-tables-year-ended-march-2020/

[23] ANZSIC refers to Australian New Zealand Standard Industry Classification, jointly developed by the Australian Bureau of Statistics and the Statistics New Zealand to compare industry statistics between the two countries and the rest of the world. The 2006 classification aligns with the International Standard Industrial Classification of All Economic Activities (ISIC)(Revision 4). https://www.abs.gov.au/statistics/classifications/australian-and-new-zealand-standard-industrial-classification-anzsic/latest-release

# Method One: HS to “predominant” ANZSIC

This method to identify industries involves mapping the HS codes for the vulnerable goods identified in Part One of this paper to ANZSIC codes, using a concordance table provided by Stats NZ.[24] While products are imported by multiple industries, Stats NZ assigns the product to a predominant importing industry.

The concordance table included 15579 unique HSC10 codes; and 194 unique ANZSIC codes, out of slightly more than 500 ANZSIC codes available.[25]

For the 2019 import dataset, products mapped to all 194 ANZSIC codes (or ‘classes’), including six of the 18 one-digit ‘divisions’ and 27 of the 86 two-digit ‘sub-divisions’. For the 2019 *export* dataset, products mapped to 184 ANZSIC codes.

Table 11 shows the frequency of products that mapped to divisions using this method. Even though this distribution appears skewed, it’s important to remember that this mapping is to the “predominant” industry and, for most imports, their main use is likely to be in manufacturing.

**Table 11: HS products mapped to one-digit ANZSIC industry divisions (Method one)**

| | | Imports | | Exports | |
|---|---|---|---|---|---|
| A | Agriculture, Forestry and Fishing | 1576 | 1% | 3728 | 6% |
| B | Mining | 443 | 0% | 246 | 0% |
| C | Manufacturing | 129879 | 98% | 59611 | 93% |
| G | Retail Trade | 19 | 0% | 21 | 0% |
| J | Information Media and Telecommunications | 285 | 0% | 213 | 0% |
| R | Arts and Recreation Services | 176 | 0% | 123 | 0% |
| | | 132378 | 100% | 63942 | 100% |
| | **FILTERED DATASET** | (n=119) | | (n=23) | |
| A | Agriculture, Forestry and Fishing | 5 | | 2 | |
| B | Mining | 2 | | 0 | |
| C | Manufacturing | 112 | | 21 | |

Note: No products were mapped to the following industries: D-Electricity, Gas, Water and Waste Services, E-Construction, F-Wholesale Trade, H-Accommodation and Food Services, I-Transport, Postal and Warehousing, K-Financial and Insurance Services, L-Rental, Hiring and Real Estate Services, M-Professional, Scientific and Technical Services, N-Administrative and Support Services, O-Public Administration and Safety, P-Education and Training, Q-Health Care and Social Assistance, S-Other Services.

Using more detailed two-digit ANZSIC industry categories, Figure 10 shows industries exposed to vulnerable import products using the number of times a vulnerable product mapped to the industry.

[24] NZHSC v17.05 to Predom ANZSIC06 v1.0
https://aria.stats.govt.nz/aria/#ConcordanceSearch:q=nzhsc%2520v17%2520to%2520anzsic06&fl=name,source,target&sort=relevance-&start=20&rows=20

[25] There are 506 unique four-digit classes in list from ABS 2006 (rev 2).

**Figure 10: Exposure of "predominant" industries, by frequency of 119 vulnerable import products**


It is also possible to rank these industries by their share of imported inputs generally, using data from the IO tables.[26] This requires mapping the IO industries onto ANZSIC industries. While reasonably comparable, some IO industries represent groups or subsets of the ANZSIC industries. Stats NZ provides a concordance table for this in the IO tables. Of the 27 "predominant" industries in the 2019 import dataset, only 24 have a matched import share.

Figure 12 shows exposed industries in relation to all the ANZSIC two-digit industries captured in the import dataset, ranked according to the industry's import share calculated from table 3 of the IO tables.[27] Vulnerable industries are likely to be the same industries that import a high share of their production inputs. Orange industries are those matched with the 119 vulnerable imports, while blue industries are captured in the main import dataset.

The outliers indicate that importing a high share of production inputs *per se* is not the only indicator of import vulnerability. There may also be something about the criticality of the product itself (its relative importance in production) that makes the industry more exposed to any future disruption. The wood product manufacturing industry, for instance, is in the bottom third of the distribution of industries that

[26] Specifically, using data from tables 2 and 3 of the IO tables for imports: "Total basic prices" from table 3 (imports) row 206 / "Total basic prices" from table 2 (use) row 206; and data from table 6 for exports: "Exports" from table 6 (ult. disposition) row B / "Total" from table 6 (ult. disposition) row K, which is also equivalent to row 206 table 1 (supply).

[27] Only 79 of the 86 ANZSIC codes are captured in the 2019 import dataset. The import share was calculated from the IO tables by converting the IO industries to ANZSIC codes using the concordances tables Stats NZ provides in the tables.

rely on imports (with less than 10% of production being based on imports), but is the fourth-most vulnerable in terms of products (Figure 10).

Industry vulnerability may also be ranked using cumulative import coefficients. These reflect the value-added of an industry (in terms of wages and return on capital) plus the value added and import share of other industries that supply them with goods and services.

Figure 13, below, shows the same exposed industries ranked according to these coefficients, rather than import shares. The vulnerable industries identified are more concentrated in the top third of the distribution of industries that rely on imports. In other words, they appear to be even *more* exposed than import shares alone suggest. These industries are directly exposed to imports and indirectly exposed to imports through the goods and services they purchase from other industries. Wood and food product manufacturing industries have noticeably ranked higher.

It should be noted that the top ten exposed industries are the same irrespective of whether import share or import coefficients are used – only their relative order varies slightly. This is discussed further in the next section, illustrated in Table 12 and Table 13.

Figure 11 shows the industries most exposed to the vulnerable *export* products using the number of times a vulnerable product mapped to the industry.

**Figure 11: Export exposure of predominant industries, by frequency of 23 vulnerable products**

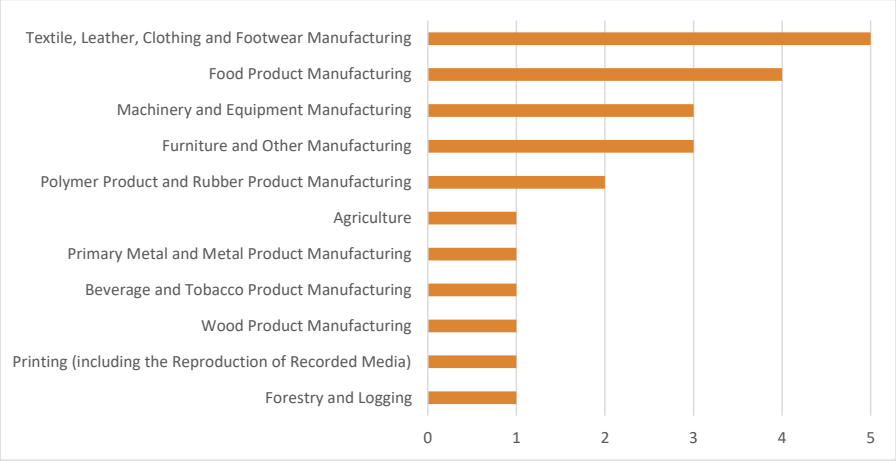


**Figure 12: Import exposed industries, ranked by import share**

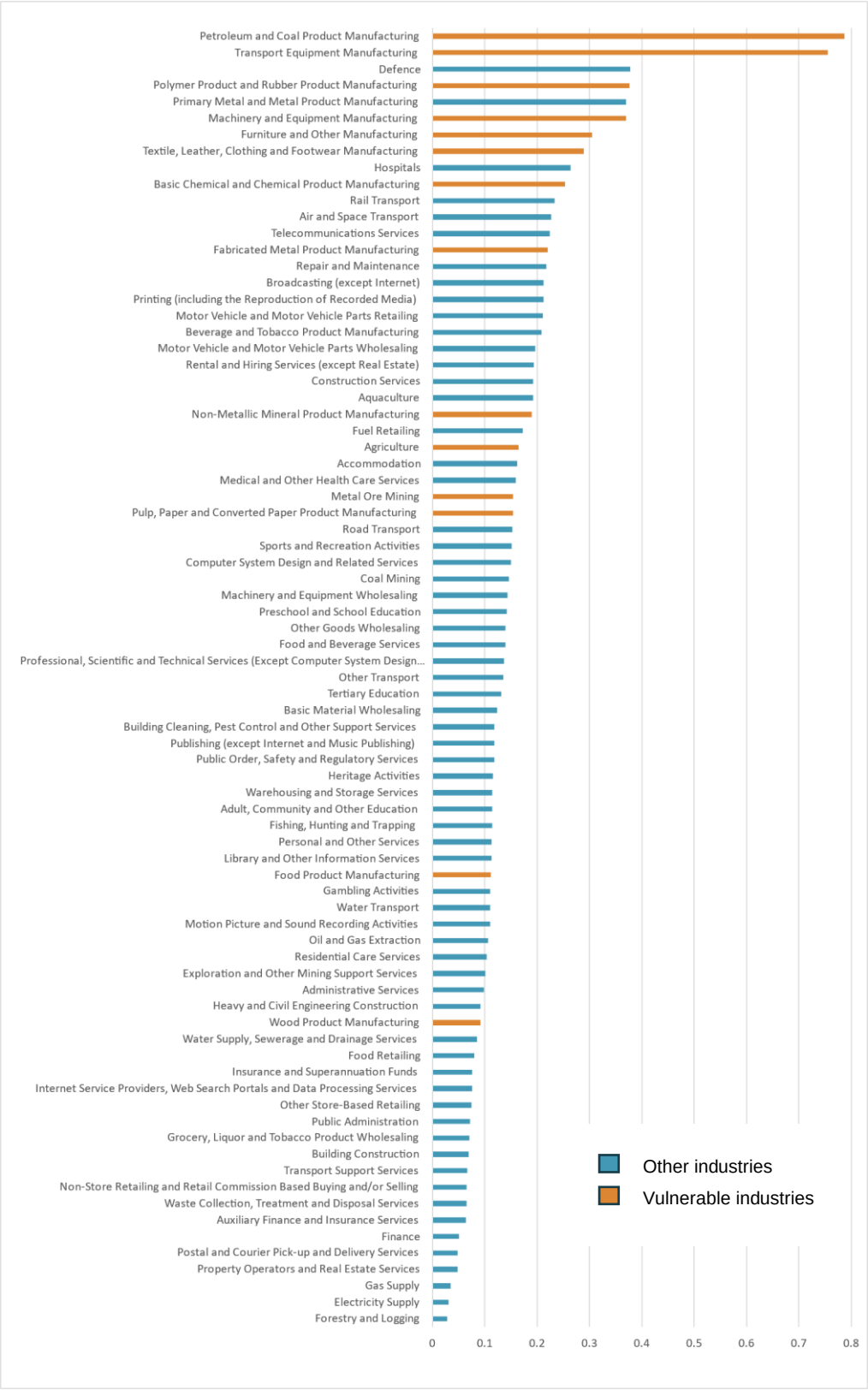


**Figure 13: Import exposed industries, ranked by import coefficient**

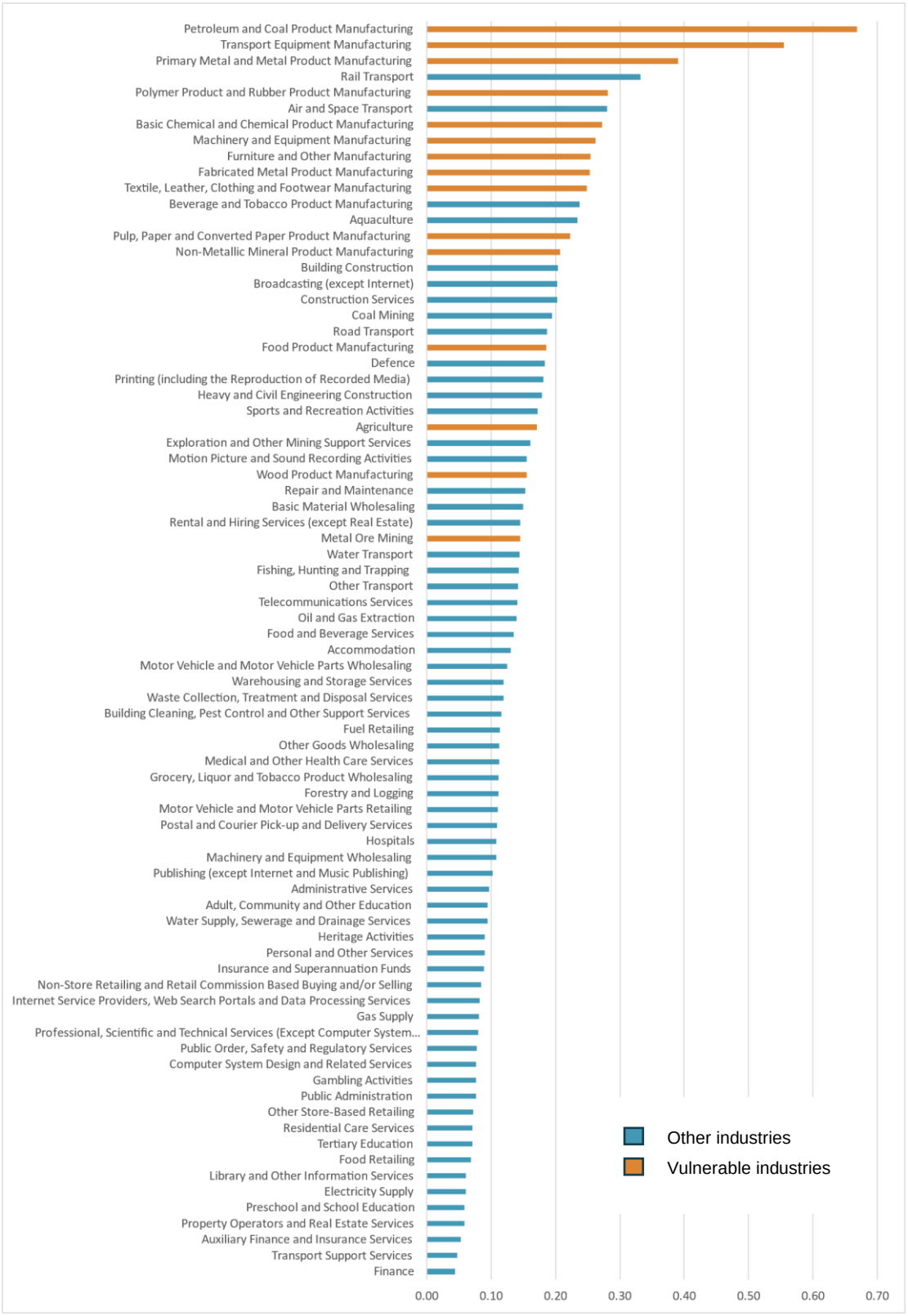
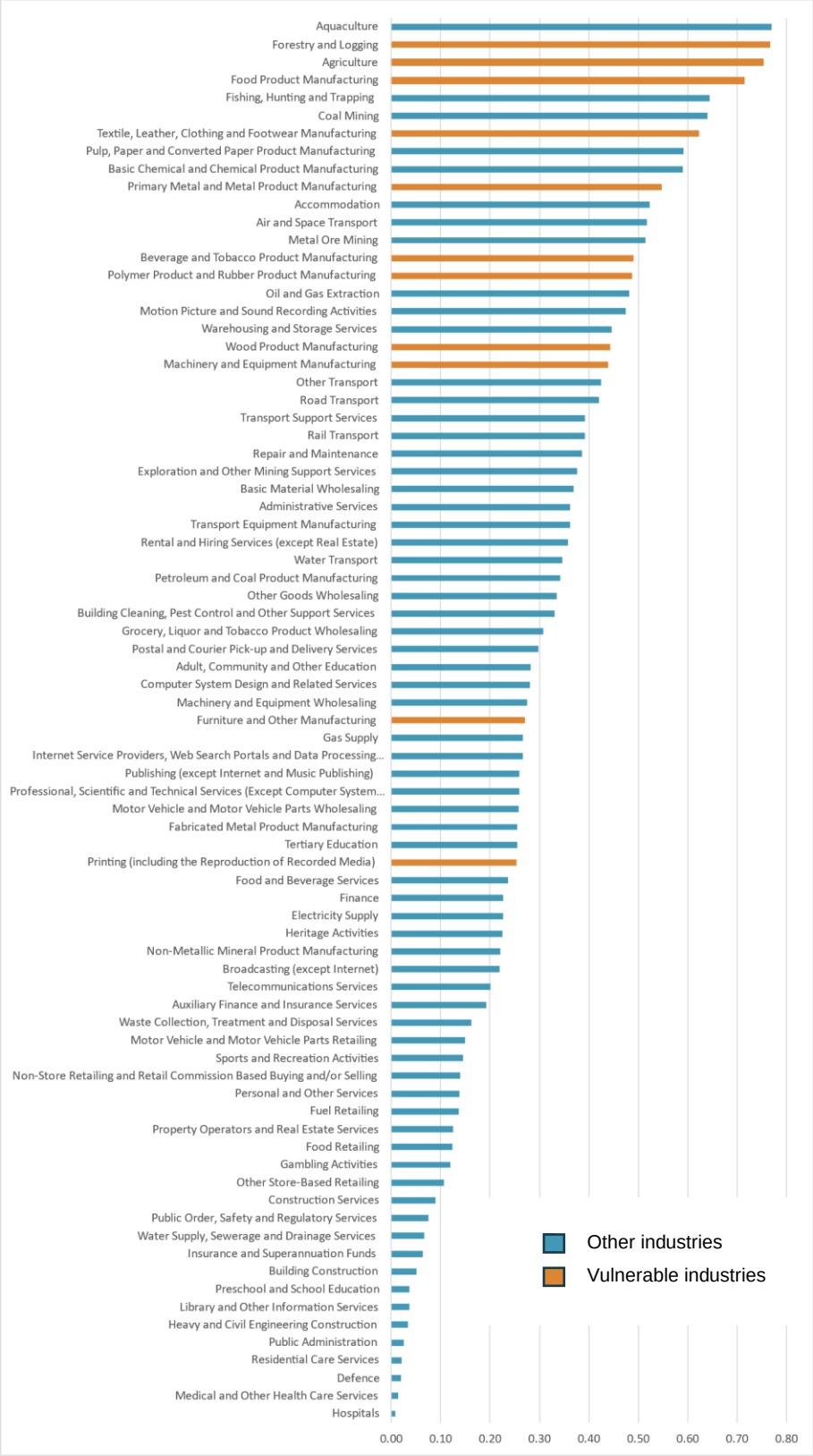


**Figure 14: Export exposed industries, ranked by export share**



# Method Two: HS to IO products, industries

This method to identify industries involves mapping the HS codes for the vulnerable goods identified in Part One of this paper to the product groupings in the IO tables and then, as also done with method one, to the industry groupings to ANZSIC codes, both using the concordance tables provided by Stats NZ in the IO tables.

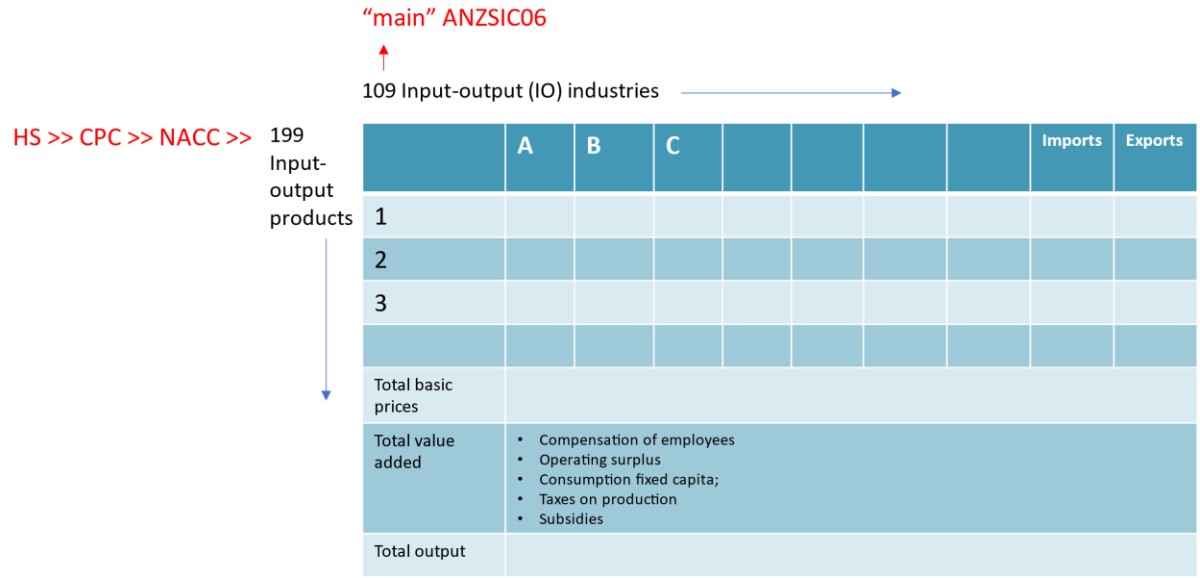
The main motivation for trying this approach was to see if we could map our vulnerable imports products to more industries than the direct concordance table provided by Stats NZ used in Method One. This approach requires further work. At this stage, the work presented here is exploratory and the results should be treated as indicative rather than final.

Theoretically, this alternative (indirect) approach allows us to access not just the import shares and coefficients for each industry provided in the IO tables, but also information about the share of products used by each industry. Therefore, we can use the IO tables to not just look the "main" industry that uses each vulnerable import product, but the number of vulnerable products each industry uses, and the importance of a specific product across different industries.

In this respect, this approach complements the analysis in Part One of the paper (which provides a measure of concentration) by providing a measure of strategic importance of the vulnerable imports identified. Both were identified as key for policy prioritisation in the OECD's series on policies to strengthen the resilience of global value chains – see Figure 7 from page 25 of Schwellnus et al. (2023).

Unfortunately, this approach can only be used for imports, as the IO tables do not provide detailed information on exports beyond aggregate product and industry shares. Figure 15 illustrates the mapping process.

**Figure 15: Industry mapping process**

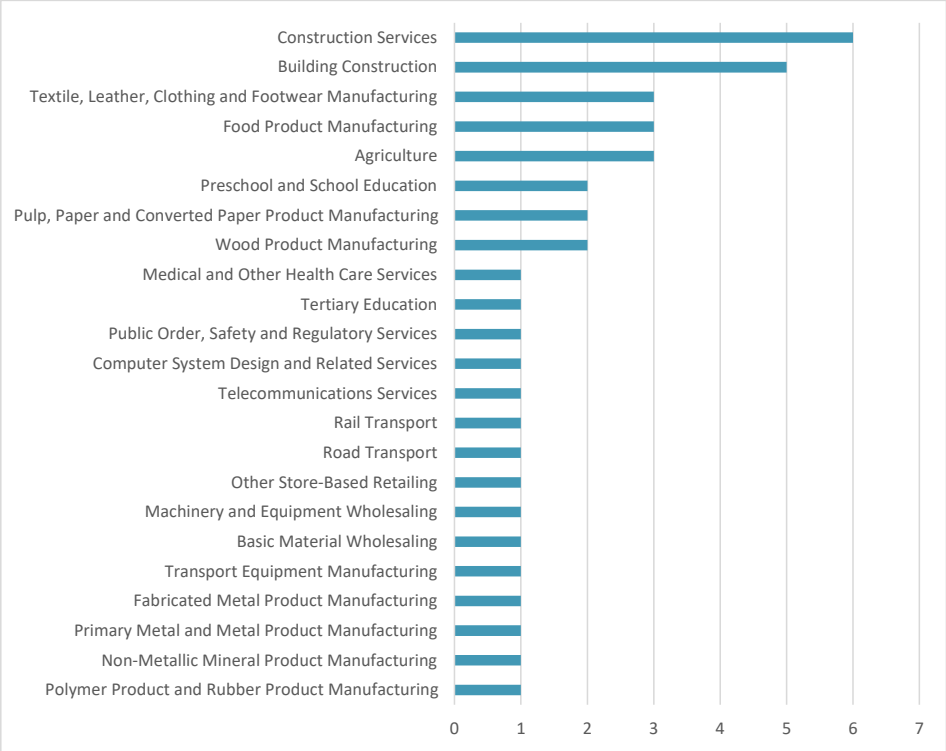


To map the HS products to IO products, HS codes were converted to CPC[28] codes then to NACC[29] codes. The 119 vulnerable import products across 2017 – 2019 were mapped to 41 unique IO products (and then converted to ANZSIC codes using the concordance provided by Stats NZ).

Using the matrix import information provided in IO table 3, these 41 products were mapped to 26 "main" industries – more than the 16 "predominant" ANZSIC industries identified with the concordance used in the previous section. The "main" industry was identified as being the industry that used the highest share of imports of each of these IO products *according to IO table 3 (**not** necessarily the specific share of the original vulnerable HS product)* – for a few products there were multiple industries with the same high share, so the frequency of products mapped to these industries could add to more than 41 (although it does not with this filtered three-year dataset).

Figure 16 shows the exposure of the "main" IO industries (converted to 23 ANZSIC two-digit subdivisions) to the 41 vulnerable imports.

**Figure 16: Exposure of "main" IO industries, by frequency of 41 vulnerable imports**




Construction services as well as a range of other service industries show up that were not captured with the earlier "predominant" concordance (Method One). This aligns with anecdotal evidence that these industries were strongly affected by recent global supply chain shocks caused by the pandemic.

[28] Central Product Classifications. These are developed by the United Nations as an international standard for organising and analysing data on industrial production, national accounts, trade and prices.

[29] National Account Commodity Classifications developed by Stats NZ.

Further work could also explore the import coefficient information in IO table 9 (as done with Method One), which captures the value added and import use of the main industry plus the value added and import use of the other industries that supply their products and services.

In addition, it would also be possible to look at the number of different vulnerable products used by each industry, *irrespective* of their share of imports of those particular products as specified in IO table 3. This would help us better understand the impact across industries of any disruption to a specific import product.

One benefit of bringing the IO tables into our analysis is that it allows us to think about how vulnerable products impact New Zealand production of services, as well and commodities. For imports, Education, Telecommunication and Computer System Design Services appear to be vulnerable; and for exports, Accomodation, Transport, Motion Picture and Warehousing are vulnerable.

The Commission decided not to use Method Two for the purposes of selecting industries for regional analysis. It's not possible to replicate this method of exports, and many of the products that are mapped across to these industries appear to be consumer goods.

# Vulnerable industries and regional exposure

This section identifies the industries that appear to be most vulnerable to trade distruption based on the analysis in the previous sections. While not based on a systematic statistical exercise, this assessment was intended to guide the findings and the direction of the Commission's inquiry into economic resilience and to inform priorities for consultation with interested parties – industry and community groups. The timing of the 2023 election and the subsequent decision to disestablish the Commission prevented detailed discussion of these indictative findings, but the work may be useful to inform future engagement in anticipation or in response to future disruptions that may affect the productive capacity, labour market impacts, and wiser wellbeing of communities, to focus attention on communities likely to be most affected and the policy objectives of a future government. The number of firms and workers in a community associated with a particularly industry is likely to be a useful indicator of how that community is likely to fare following a disruption.

There are two ways we have chosen to rank industries in terms of their trade vulnerability:

1. Exposure to imports and exports generally, calculated using Stats NZ's Input-Output tables.
2. Exposure to vulnerable imports and exports, as identified in this paper.

Perhaps unsurprisingly, analysis in the previous section suggests that these two approaches will produce similar results: industries exposed to vulnerable imports and exports are also exposed to imports and exports generally. This relationship has also been found with the CGE work Motu has been undertaking for the Commission – for the first modelled trade shock: "[the] impact (in proportional terms) are largest in sectors that export a high share of exports to the Rest of Asia".[30]

However, there are some differences, as shown in Tables 12 and 13 below. These tables compare the ranking of industries for imports and exports using the different approaches. The colours are simply intended to highlight industries that are common across all ranking approaches. And, as

[30] See Supplementary Information containing detailed findings from the trade shock modelling, and White and Winchester (2023).

previously explained, the IO tables provide additional methods for ranking imports that we cannot replicate for exports.

For imports, Petroleum and Coal Product Manufacturing does not appear as vulnerable in terms of either of the mapping methods. Polymer, Transport and Furniture manufacturing are also slightly less vulnerable than their import share and coefficients suggest; while Chemical, Metal, Wood and Food are slightly more vulnerable. For exports, aquaculture does not appear to be vulnerable, Forestry and Agriculture are slightly less vulnerable than their export share suggests, while Wood and Machinery manufacturing are noticeably more vulnerable.

In terms of the most vulnerable industries, Textile, Food and Machinery manufacturing industries appear in the top five rankings for both imports *and* exports, when ranked by frequency using Method One (the "predominant" ANZSIC concordance tables).

**Table 12: Industry rankings for imports**

| by frequency of vulnerable product | | by import share (top 17) | | by import coefficient (top 17) | |
|---|---|---|---|---|---|
| **subdiv** | **subdiv description** | **subdiv** | | **subdiv** | |
| 24 | Machinery and Equipment Manufacturing | 17 | 0.79 | 17 | 0.67 |
| 18 | Basic Chemical and Chemical Product Manufacturing | 23 | 0.76 | 23 | 0.56 |
| | | 76-Defence | 0.38 | 21 | 0.39 |
| | | | | 47 | |
| 13 | Textile, Leather, Clothing and Footwear Manufacturing | 19 | 0.38 | 19 | 0.28 |
| | | | | 49 | |
| 14 | Wood Product Manufacturing | 21 | 0.37 | 18 | 0.27 |
| 22 | Fabricated Metal Product Manufacturing | 24 | 0.37 | 24 | 0.26 |
| 11 | Food Product Manufacturing | 25 | 0.30 | 25 | 0.25 |
| 1 | Agriculture | 13 | 0.29 | 22 | 0.25 |
| 25 | Furniture and Other Manufacturing | 84-Hospitals | 0.26 | 13 | 0.25 |
| 15 | Pulp, Paper and Converted Paper Product Manufacturing | 18 | 0.25 | 12-Beverage and Tobacco Product Manufacturing | 0.24 |
| 20 | Non-Metallic Mineral Product Manufacturing | 47-Rail Transport | 0.23 | 2-Aquaculture | 0.23 |
| 19 | Polymer Product and Rubber Product Manufacturing | 49-Air and Space Transport | 0.23 | 15-Pulp, Paper and Converted Paper Product Manufacturing | 0.22 |
| 21 | Primary Metal and Metal Product Manufacturing | 58-Telecommunications Services | 0.22 | 20-Non-Metallic Mineral Product Manufacturing | 0.21 |
| 23 | Transport Equipment Manufacturing | 22 | 0.22 | 30-Building Construction | 0.2 |
| 9 | Non-Metallic Mineral Mining and Quarrying | 94-Repair and Maintenance | 0.22 | 56-Building Construction | 0.2 |
| 8 | Metal Ore Mining | 56-Broadcasting (except Internet) | 0.21 | 32-Construction Services | 0.2 |
| 17 | Petroleum and Coal Product Manufacturing | 16-Printing (including the Reproduction of Recorded Media) | 0.21 | 6-Coal Mining | 0.2 |

**Table 13: Industry rankings for exports**

| by frequency of vulnerable product | | by export share (top 20) | | |
|---|---|---|---|---|
| **subdiv** | **subdiv description** | **subdiv** | **subdiv description** | |
| 13 | Textile, Leather, Clothing and Footwear Manufacturing | 2 | Aquaculture | 0.77 |
| 11 | Food Product Manufacturing | 3 | Forestry and Logging | 0.77 |
| 25 | Furniture and Other Manufacturing | 1 | Agriculture | 0.75 |
| 24 | Machinery and Equipment Manufacturing | 11 | Food Product Manufacturing | 0.71 |
| 19 | Polymer Product and Rubber Product Manufacturing | 4 | Fishing, Hunting and Trapping | 0.64 |
| 3 | Forestry and Logging | 6 | Coal Mining | 0.64 |
| 16 | Printing (including the Reproduction of Recorded Media) | 13 | Textile, Leather, Clothing and Footwear Manufacturing | 0.62 |
| 14 | Wood Product Manufacturing | 15 | Pulp, Paper and Converted Paper Product Manufacturing | 0.59 |
| 12 | Beverage and Tobacco Product Manufacturing | 18 | Basic Chemical and Chemical Product Manufacturing | 0.59 |
| 21 | Primary Metal and Metal Product Manufacturing | 21 | Primary Metal and Metal Product Manufacturing | 0.55 |
| 1 | Agriculture | 44 | Accommodation | 0.52 |
| | | 49 | Air and Space Transport | 0.52 |
| | | 8 | Metal Ore Mining | 0.51 |
| | | 12 | Beverage and Tobacco Product Manufacturing | 0.49 |
| | | 19 | Polymer Product and Rubber Product Manufacturing | 0.49 |
| | | 7 | Oil and Gas Extraction | 0.48 |
| | | 55 | Motion Picture and Sound Recording Activities | 0.48 |
| | | 53 | Warehousing and Storage Services | 0.45 |
| | | 14 | Wood Product Manufacturing | 0.44 |
| | | 24 | Machinery and Equipment Manufacturing | 0.44 |

Given possible correlation with import and export exposure generally (based on shares from the IO tables), the group of industries with high trade exposure generally was compared with a group more exposed to vulnerable products identified in Part One of this paper.

Tables 14 and 15, below, set out the industry groups selected for heat maps of regional distribution. The maps (Figures 15 and 16) show the number of business establishments in each region associated with the group of industries, with ‘hotter’ or darker coloured regions representing a higher concentration of establishments. The heat maps were produced using data from Stats NZ’s Integrated Data Infrastructure (IDI), based on the method used for *Distributional Impacts of Economic Shocks* (Riggs, forthcoming) and the supplementary information to the Resilience Inquiry Final Report.

The groups were intended to be broadly comparable, with approximately five industries each – although selection was arbitrary and intended for initial exploration only. Industries with more than a 30% import share or more than 60% export share were selected for group 1 (Table 14).[31]

**Table 14: Group 1 industries (based on shares from IO tables)**

| IMPORT industries > 30% | EXPORT industries > 60% |
|---|---|
| 17 – Petroleum and Coal Product Manufacturing | 2 – Aquaculture |
| 23 – Transport Equipment Manufacturing | 3 – Forestry and Logging |
| ~~76 – Defence~~ | |
| 19 – Polymer Product and Rubber Product Manufacturing | 1 – Agriculture |
| 21 – Primary Metal and Metal Product Manufacturing | 11 – Food Product Manufacturing |
| 24 – Machinery and Equipment Manufacturing | 4 – Fishing, Hunting and Trapping |
| | 6 – Coal Mining |
| | 13 – Textile, Leather, Clothing and Footwear Manufacturing |

**Table 15: Group 2 industries (based on frequency of vulnerable products using Method 1)**

| IMPORT industries – top 5 | EXPORT industries – top 5 |
|---|---|
| 24 – Machinery and Equipment Manufacturing | 13 – Textile, Leather, Clothing and Footwear Manufacturing |
| 13 – Textile, Leather, Clothing and Footwear Manufacturing | 11 – Food Product Manufacturing |
| 18 – Basic Chemical and Chemical Product Manufacturing | 25 – Furniture and Other Manufacturing |
| 22 – Fabricated Metal Product Manufacturing | 24 – Machinery and Equipment Manufacturing |
| 11 – Food Product Manufacturing | 19 – Polymer Product and Rubber Product Manufacturing |

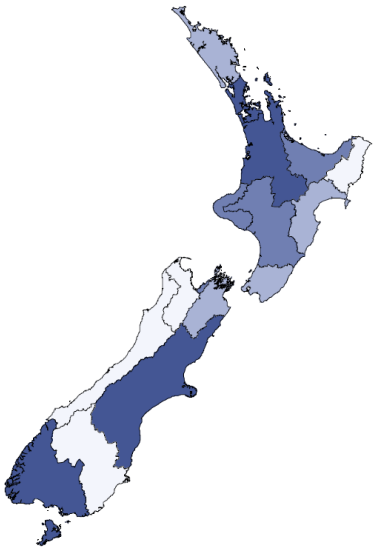
Further work could map industries based on their *import coefficients*, rather than their share of imports from the IO tables. This would better capture *use* of imports in production processes, rather than shares based on industry purchases of intermediate imports. A table showing the specific HSC-10 products that were mapped to some of the industries in these groups is provided in the Appendix.

[31] The Defence industry (76, share 0.38) was omitted from the import group in table 14, as it was likely to distort results and potentially breach IDI rules around releasing data for small groups.

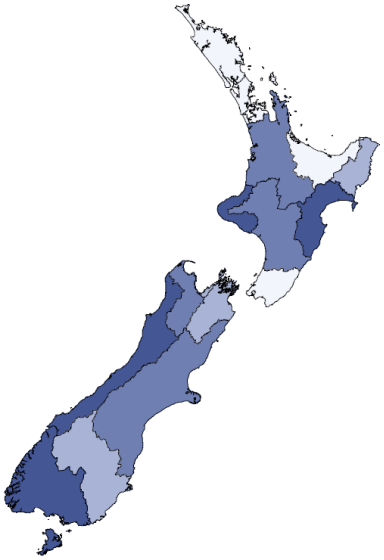
The following heat maps illustrate the distribution of industries based on the different rankings. Figure 17 compares import shares with the frequency rankings for the groups of import industries, while Figure 18 compares them for export industries.

**Figure 17: Heat maps for import industries**

Import industries > 30% (*used in final report for Inquiry*)



Import industries, Freq. Top 5



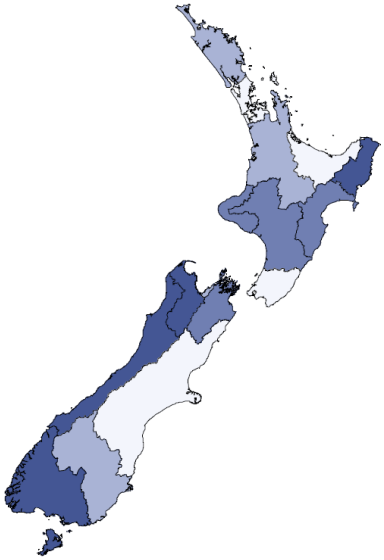
The maps of import industries show regional variation between the two ranking approaches, apart from Southland. Industries that rely on more than 30% of imports (according to the IO tables) are more likely to be located in Southland, Canterbury and Auckland/Waikato. However, the industries with the most vulnerable products mapped to them were more likely to be located in Southland, the West Coast, Taranaki and the Hawkes' Bay. The share analysis suggests the main urban centres are more vulnerable, whereas the frequency analysis suggests the less populated rural regions are more vulnerable.

While there appears to be correlation between import shares and industries affected by vulnerable products, this relationship is weaker when we take account of the *number* of those products an industry is relying on.

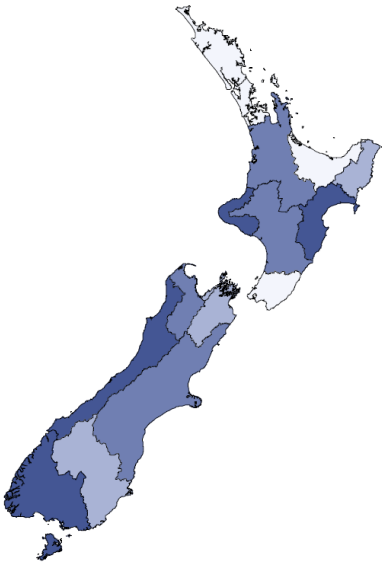
In this respect, using import shares is not a good proxy for identifying industries, and therefore regions, relying on *multiple* vulnerable products. However, as we identified earlier in this report, vulnerable products represent a very small share of overall products, and many are not persistently vulnerable across years. Furthermore, the mapping exercise in this section is exploratory and raises methodological questions, not least about the accuracy of the underlying concordance tables. For this reason, the Commission used import shares from IO tables as a *starting point* for thinking about the regional exposure to supply chain (trade) disruption, acknowledging the need for further work and consultation with industry experts.

**Figure 18: Heat maps for export industries**

Export industries > 60% (*used in final report for Inquiry*)



Export industries, Freq. Top 5



The maps of export industries appear more consistent, but there is still variation. Southland and the West Coast are exposed with both ranking approaches, but while the East Cape (Gisborne) and Northland are more exposed in the share analysis, Canterbury, Waikato, Hawkes' Bay and Taranaki show up as being more exposed in the frequency analysis. As with imports, it is not clear that export share is a useful proxy for identifying industries exposed to vulnerable products unless we consider number of products they might be exposed to.

Looking across both imports and exports in the share analysis, there is a clearer divide between exposure of the main populated regions (Auckland and Canterbury) with imports, and the less populated regions (West Coast and East Cape) with exports. For the frequency analysis, the distribution is almost identical. This partially reflects the overlap of the (main) industries in the frequency groups but may equally highlight limitations with the concordance tables used to map products to industries.

Only the maps based on the *IO table shares* (the left-hand side maps in Figure 17 and Figure 18 above) were used in the final report for the Inquiry. The shares can be calculated with input-output tables and therefore independently verifiable. While initial mapping of products to industries shows promising consistencies between the identified industries and those with high import and export IO shares, these consistencies dissappear when we account for the frequency of products mapped for each industry.

The regional distribution of 'vulnerable' industries identified with IO table shares is different to the Commission's CGE and distributional analysis of supply chain shock scenarios conducted for the Inquiry. The CGE modelling work identifies industries (and businesses and workers) in each region that would be most impacted by a particular shock. Both approaches use data from the IO tables, so while we might expect consistency, the CGE model allows for a new economy-wide equilibrium to be

reached, with multiple interactions between industries. The final industries and regions affected are therefore not necessarily those with the most greatest direct trade exposure.

# Conclusions and where next?

This study has mainly explored trade vulnerability by identifying which products are sourced from (or sold to) a small number of countries, and from countries are the main global sellers (or buyers) of those products. This study has also made preliminary steps to explore trade in services and exposure of industries and regions to vulnerable trade.

***119 imports and 23 exports were vulnerable from 2017 – 2019***

Our trade data analysis shows that in 2019, 119 (2%) of the 11041 HSC-10 products New Zealand imported were vulnerable to supply chain disruption – and were also vulnerable in 2017 and 2018. These products were worth $1.4 billion (2%) of New Zealand's $61 billion in total imports.

In terms of exports, 23 (0.3%) of the 8525 HSC-10 products New Zealand exported in 2019 were vulnerable to supply chain disruption – which were also vulnerable in 2017 and 2018. These products were worth $114 million of New Zealand's $56 billion in total exports.

***China was New Zealand's main source of, and Australia was New Zealand's main destination for vulnerable products***

New Zealand sources 71% of the value of its vulnerable products from China (despite China only accounting for 21% of New Zealand's total import value). New Zealand's next most concentrated import source was Argentina (12.3%), followed by Australia (4.8%).

Interestingly, Australia was New Zealand's largest destination for vulnerable products, both in terms of value and number of products. They acccounted for 35% of the total value of vulnerable products from 12 exported products, compared to China, which accounted for 18% of the value from 2 products. This effectively reverses their relative positions with total exports, where China accounted for 30% and Australia 14% of the traded value in 2019. Interestingly, even with total trade, New Zealand exports almost two thirds more HSC-10 products to Australia (5199) than China (1645).

***Computers and agricultural feed were New Zealand's most vulnerable imports***

New Zealand's three most vulnerable imported products were data processing machines, oil-cake and residues (likely for animal feed), and monitors for data processing machines.

***Wood and wool were New Zealand's most vulnerable exports***

New Zealand's three most vulnerable exported products were wood for fuel (non-coniferous) to Japan, wool to China, and plastic packaging to Australia.

***The Textile, Food, and Machinery Manufacturing industries are particularly exposed***

The Textile, Food and Machinery manufacturing industries had a high frequency of *both* vulnerable imports and exports mapped to them using Stats NZ's "predominant" ANZSIC concordance tables.

They all have a high degree of general exposure to import and exports according to Stats NZ's Input-Output tables.

***Trade in commercial services is less vulnerable than trade in travel and transport services***

While it is difficult to accurately compare trade in services with trade in commodities, New Zealand's imports of commercial services have grown relative to imports of transport and travel services, and appeared more resilient during the covid pandemic. While exports of commerical services have not grown as fast as exports of travel services, they also appear to have been more resilient.

***Main urban centres are potentially more exposed to import disruptions, while less populated regions are potentially more exposed to export disruptions***

The Commission's preliminary attempts to map the HS products that our analysis identified as vulnerable to specific industries (that use those products as intermediate inputs) showed correlation with broader import and export exposure of industries estimated using Stat NZ's IO tables. While this may be due to the concordance tables used for the mapping process, the Commission relied on the shares to inform its thinking about the potential exposure of regions and communities to persistent supply chain disruptions. Further work would be required to test this further.

# Where to next?

This study produced a dataset of traded products that can be filtered to identify which products might be vulnerable to disruption due to economy-specific market concentration (who we choose to trade with), or global market concentration (availability of markets to trade with). The dataset allowed us to filter those products by the main industry that uses them.

This has been attempted before, but not – as far as we're aware – been published or well documented. Based on this initial work, the Commission considers there would be merit in develop the data further and producing it for targeted feedback or consultation with relevant industries on a regular basis.

The dataset in this report should therefore be treated as a prototype for engaging with industry experts to identify products that might be particularly vulnerable to supply chain disruption. The process of identifying these products could also explore the criticality of those products for the industry and for New Zealand's wider economic and social wellbeing, and test different strategies to improve resilience around those products. Solutions could focus on adding robustness through larger inventories or contingency plans, adapting plans by identifying alternative sources or markets for those products and improving the efficiency with how existing products are used, or by identifying alternative products or production techniques.

Conceptually it would be possible to create a more detailed dataset that provided timely information to businesses on their supply chain risks. Many businesses may not directly import and export and could be unaware of these risks, but rely on businesses that do.

The following areas would be worth exploring:

- What extra information Customs NZ collects (or could collect) from businesses that import or export products that might not be captured by Statistics NZ – such as what is the purpose or

intended use of the product (rather than relying on BEC), whether the product has been imported or exported before or this is the first time, rationale for importing and exporting (eg. few or costly alternatives in New Zealand, achieving scale with exports) and which industry the product is connected with.

- How do we capture supply chains in the data? How are products linked to one another, how are they used (intermediate, capital, final consumption), where are they used (and how are they dispersed/travel around the country – internal infrastructure dependence), and who uses them? Is there some way of coding or classifying supply chains that makes it easier to see which one a product associated with?

- If industries can accurately be linked to different products, it would be possible to update the database with regular information about those industires, including the number of businesses and workers, as well as characteristics of those businesses and workers.

# References


Australian Productivity Commission. (2021). *Vulnerable supply chains* [Study Report]. www.pc.gov.au/inquiries/completed/supply-chains/report/supply-chains.pdf

Baldwin, R., Freeman, R., & Theodorakopoulos, A. (2022). *Horses for courses: Measuring foreign supply chain exposure* (Working Paper 30525). National Bureau of Economic Research. https://doi.org/10.3386/w30525

Baldwin, R., Rebecca, F., & Angelos, T. (2023, September 28). *Hidden exposure: Measuring U.S. supply chain reliance*. BPEA Conference. www.brookings.edu/wp-content/uploads/2023/09/2_Baldwin-et-al_unembargoed.pdf

European Commission. (2021). *Strategic dependencies and capacities: Updating the 2020 new industrial strategy: Building a stronger single market for Europe's recovery*. https://single-market-economy.ec.europa.eu/news/updating-2020-industrial-strategy-towards-stronger-single-market-europes-recovery-2021-05-05_en

German Council of Economic Experts. (2022, November 9). *Germany must adapt its economic model to the new reality* [Press Release]. www.sachverstaendigenrat-wirtschaft.de/fileadmin/dateiablage/gutachten/jg202223/JG202223_PressRelease_Chapter_7.pdf

Gervais, A., & Jensen, J. B. (2019). The tradability of services: Geographic concentration and trade costs. *Journal of International Economics*, *118*, 331–350. https://doi.org/10.1016/j.jinteco.2019.03.003

Jiang, K. (2021). *Identification of vulnerable Canadian imports*. www.international.gc.ca/trade-commerce/economist-economiste/analysis-analyse/id-vulnerables-canadiens-importations.aspx?lang=eng

Meehan, L. (2014). *New Zealand's international trade in services—A background note*. https://www.productivity.govt.nz/publications/new-zealands-international-trade-in-services/

NZPC. (2014). *Boosting services sector productivity*. www.productivity.govt.nz/inquiries/boosting-services-sector-productivity/

Rajanayagam, S. (2016). *The servicification of trade*. https://www.productivity.govt.nz/publications/servicification-of-trade/

Riggs, L. (forthcoming). *Distributional impacts of economic shocks*. NZPC. www.productivity.govt.nz/inquiries/resilience/

Riggs, L., & Mitchell, L. (2021). *Methodology for modelling eistributional impacts of emissions budgets on employment in New Zealand* (Working Paper 21–14). Motu Economic and Public Policy Research.

Schwellnus, C., Haramboure, A., & Samek, L. (2023). *Policies to strengthen the resilience of global value chains: Empirical evidence from the COVID-19 shock*. OECD Science, Technology and Industry Policy Papers, 141. https://doi.org/10.1787/fd82abd4-en

White, D., & Winchester, N. (2023). *Supplementary materials for CGE modelling* [dataset].

# Appendix 1: HSC-10 products

The following table outlines the specific HSC-10 products that were mapped to the Group 1 and Group 2 industries selected in the report.

| | |
|---|---|
| **Imports: Food Product Manufacturing** | |
| 1515300000 | Vegetable oils; castor oil and its fractions, whether or not refined, but not chemically modified |
| 1511900000 | Vegetable oils; palm oil and its fractions, other than crude, whether or not refined, but not chemically modified |
| 2304000000 | Oil-cake and other solid residues; whether or not ground or in the form of pellets, resulting from the extraction of soya-bean oil |
| 1108140000 | Starch; manioc (cassava) |
| 1210200100 | Hop cones; ground, powdered, or in the form of pellets |
| 1103190912 | Cereal groats and meal; of rice |
| **Exports: Food Product Manufacturing** | |
| 303920000 | Fish; frozen, shark fins |
| 713100100 | Vegetables, leguminous; peas (pisum sativum), shelled, whether or not skinned or split, dried |
| 813300000 | Fruit, edible; apples, dried |
| 2008970019 | Nuts and other edible parts of plants other than fruit; mixtures (other than those of subheading 2008.19), prepared or preserved in ways n.e.c. in heading no. 2007 and 2008, whether or not containing added sugar, other sweetening matter or spirit |
| **Imports: Textile, Leather, Clothing and Footwear Manufacturing** | |
| 5702200100 | Textile floor coverings; mats and matting, of coconut fibres (coir), woven, (not tufted or flocked), whether or not made up |
| 5101300006 | Wool; (not carded or combed), carbonised, exceeding 31.4, but not exceeding 35.4 microns in fibre diameter |
| 4303900931 | Furskin articles; n.e.c. in heading no. 4303, of sheep or lambskin |
| 5401200000 | Sewing thread; of artificial filaments, whether or not put up for retail sale |
| 6006221100 | Fabrics; knitted or crocheted fabrics, other than those of headings 60.01 to 60.04, of cotton, dyed, for meat wrapping |
| 5108100001 | Yarn; of fine animal hair, carded, dyed, not put up for retail sale |
| 5508100011 | Sewing thread; of synthetic staple fibres, containing less than 85% by weight of staple synthetic fibres, mixed mainly or solely with cotton, whether or not put up for retail sale |
| 5509690000 | Yarn; (not sewing thread), of acrylic or modacrylic staple fibres, mixed mainly or solely with fibres n.e.c. in item no. 5509.6, not put up for retail sale |
| 6001103501 | Fabrics, pile; long pile, knitted or crocheted, of synthetic fibres, (other than impregnated, coated, covered or laminated), not stitch bonded |
| 5402110015 | Yarn, synthetic; filament, monofilament (less than 67 decitex), of high tenacity nylon or other polyamides, textured or not; of aramids, between 16 and 230 decitex, untwisted or twisted 50 turns or less per metre, not for retail sale, not sewing thread |
| 6006321100 | Fabrics; knitted or crocheted fabrics, other than those of headings 60.01 to 60.04, of synthetic fibres, dyed, stitch-bonded |
| 5402200019 | Yarn, synthetic; filament, monofilament (less than 67 decitex), of high tenacity yarn of polyesters, whether or not textured, between 41 and 170 decitex, twisted more than 50 turns per metre, not for retail sale, not sewing thread |
| 5005000000 | Silk; yarn spun from silk waste, not put up for retail sale |
| 5208220009 | Fabrics, woven; containing 85% or more by weight of cotton, bleached, plain weave, weighing more than 100g/m2 but not more than 200g/m2, flannelette, winceyette and diaper cloth for apparel |
| 5210490021 | Fabrics, woven; containing less than 85% by weight of cotton, mixed mainly or solely with man-made fibres, of different coloured yarns, 3- or 4-thread (including cross) twill, 200g/m2 or less, furnishing fabrics and fabrics for household use |
| 5516140001 | Fabrics, woven; tyrecord fabrics, printed, containing 85% or more by weight of artificial staple fibres |
| 5801220001 | Fabrics; woven pile, of cotton, cut corduroy containing man-made staple fibres and weighing more than 186 grams m2, other than fabrics of heading no. 5802 or 5806 |
| **Exports: Textile, Leather, Clothing and Footwear Manufacturing** | |
| 6211320200 | Track suits and other garments n.e.c.; men's or boys', of cotton (not knitted or crocheted) |
| 6104430200 | Dresses; women's or girls', of synthetic fibres, knitted or crocheted |
| 6304930001 | Furnishing articles; bedding underlays, of synthetic fibres, not knitted or crocheted |
| 6302310919 | Bed linen; goods n.e.c. in item no. 6302.31, of cotton (not printed, knitted or crocheted) |
| 6307901900 | Cheese cloths and caps; wrist supporting straps; double combined or joined embroideries in the piece; loops and bands for umbrellas; weather seal |
| **Imports: Construction Services / Machinery and Equipment Manufacturing** | |
| 9405201100 | Lamps, electric; table, desk, bedside or floor-standing, of ceramics |
| 8467220019 | Tools; for working in the hand, with self-contained electric motor; circular saws capable of holding a blade of a diameter of less than 210 mm |
| 8467290047 | Tools; for working in the hand, with self-contained electric motor; garden tools, other than battery powered; line trimmers |

| | |
|---|---|
| 8467210011 | Tools; for working in the hand, with self-contained electric motor; drills, battery powered, capable of holding a drill bit of a diameter of 13 mm or more |
| 9405300000 | Lighting sets; of a kind used for Christmas trees |
| 8513100011 | Lamps; portable, electric, designed to function by their own energy source (e.g. dry batteries), not lighting equipment of heading no. 8512, flashlights, torches (not designed as miners' safety lamps) |
| 9405404901 | Lamps and light fittings; electric, n.e.c. in heading no. 9405, of glass, other than spotlights |
| 9405201911 | Lamps, electric; table, desk, bedside or floor-standing, of glass |
| **Imports: Machinery and Equipment Manufacturing** | |
| 8516500000 | Ovens; microwave, of a kind used for domestic purposes |
| 8516791905 | Electro-thermic appliances; deep fryers |
| 8516720000 | Electro-thermic appliances; toasters, of a kind used for domestic purposes |
| 7321190900 | Cooking appliances and plate warmers (non-electric); other than for gas, liquid or solid fuels, of iron or steel |
| 8516791909 | Electrical machinery and equipment and parts thereof; other electro-thermic appliances n.e.c. in heading no. 8516 |
| 8419110100 | Heaters; instantaneous gas water heaters, non-electric, domestic |
| 8433190100 | Mowers; for lawns, parks or sport-grounds, manually operated, other than with the cutting device rotating in a horizontal plane |
| 9109100015 | Clock movements; complete and assembled, of alarm clocks, electrically operated, by means other than solar cells |
| 8471300000 | Automatic data processing machines; portable, weighing not more than 10kg, consisting of at least a central processing unit, a keyboard and a display |
| 8472100000 | Office machines; duplicating machines |
| 8470210000 | Calculating machines; electronic, incorporating a printing device |
| 8518900100 | Headphones or earphones; parts |
| 8517610919 | Base stations; apparatus n.e.c. in item no. 8517.61 |
| 8528520000 | Monitors; other than cathode-ray tube; capable of directly connecting to and designed for use with an automatic data processing machine of heading 84.71 |
| 8705100001 | Vehicles; crane lorries, new |
| 8480200000 | Mould bases; for metal, metal carbides, glass, mineral materials, rubber or plastics |
| **Exports: Machinery and Equipment Manufacturing** | |
| 8412100000 | Engines; reaction, other than turbo-jets |
| 8412901909 | Engines; parts, for hydraulic powered engines and motors |
| 8531100001 | Signalling apparatus; electric sound or visual, fire alarm systems |

# Appendix 2: R code

```
##############################################
# R code for IMPORT Analysis – version 2.0
##############################################
# PART 1 – trade vulnerabilities
##########################

# Creates 2 datasets ("SNZ") and ("BACI") then merges them ("Main") and applies import filters ("Filtered")
# Started with 2019, as this was pre-covid and data for both SNZ and BACI available.
# Does not include additional code created for summarising results, tables, or merging results with SNZ/BACI merged dataset
(see full R code in supplementary materials).

#############
#   SNZ dataset
#############
# source: https://www.stats.govt.nz/large-datasets/csv-files-for-download/overseas-merchandise-trade-datasets (this web page
has some useful acronym definitions)
# create Rformat files as R does not like chr format (did this for 2017 – 2020 datasets)
# manually altered format of qty, vfd, cif data in excel then re-read
# manually created hsc6 and hsc2 as R code for this didn't work reliably (used =LEFT(cell,LEN(cell)-4 and -2 respectively)
# simplified heading names
SNZ=read.csv("2019_Imports_HS10_by_Country_Rformat.csv")                    # repeat for 2017, 2018, 2020
str(SNZ)  #'data.frame':  696192 obs. of  11 variables (month, hsc10, hsdescription, hsc6, hsc2, unit, country, vfd, cif, q, status)
sum(SNZ$cif)                                                                # 64365870256
#SNZ_ = SNZ %>% distinct(hsc10, country, .keep_all = T)                     # n=135665

# Collapse months / reduce dataset
SNZ_=aggregate(cif ~ hsc10 + country, data = SNZ, FUN = sum, na.rm = TRUE) # aggregates cif for months, for each
hsc:country combination
colnames(SNZ_) = c("hsc10","country","cif_total")                           # distinguishes aggregated cif
SNZ = merge(x = SNZ, y = SNZ_, by=c("hsc10","country"), all.x = TRUE)       # n=696192
SNZ = SNZ %>% distinct(hsc10, country, .keep_all = TRUE)                    # n=135665, collapses dataset to years, but
keeps other variables
SNZ = SNZ[ , c(1:2,4:6,12)]                                                 # removes variables: month, unit, vdf, cif, q
colnames(SNZ) = c("hsc10","country","hscdescription","hsc6","hsc2","cif")   # reverts name of aggregate cif to "cif"
str(SNZ)  #'data.frame':   135665 obs. of  7 variables:
sum(SNZ$cif)         #64365870256 ok
#SNZ_ = SNZ %>% distinct(hsc10, country, .keep_all = T)    #135665

# Remove NZ as importer
# SNZ_=SNZ[SNZ$country=="New Zealand", ]      # n=2349
# sum(SNZ$cif)                                # 64365870256
# sum(SNZ_$cif)                               # 186679354 (0.29%)
SNZ=SNZ[SNZ$country!="New Zealand", ]         # n=133316
sum(SNZ$cif)                                  # 64179190902
#SNZ_ = SNZ %>% distinct(hsc10, country, .keep_all = T)    #133316

# Calculate NZshare_hsc10 using cif
totalcif <- aggregate(SNZ$cif, by=list(SNZ$hsc10), FUN=sum)          # Calc total value of hsc10 product, then merge back
colnames(totalcif) = c("hsc10","cif_hsc10")                          # rename columns
SNZ = merge(x = SNZ, y = totalcif, "hsc10", all.x = TRUE)            # merge back into original dataset
SNZ$NZshare_hsc10 = (SNZ$cif/SNZ$cif_hsc10)                          # share of import trade (totalcif) by each import country
# check number of observations without country name
        # sum(is.na(SNZ$country))     # n=0
        # freq=table(SNZ$country)
        # freq=data.frame(rbind(freq)) #converts table to dataframe for R to export to excel
        # there are 232 countries and freq sums to 135665, so none are missing

# Convert to BACI country name spellings for merge, used iso2 codes to converge
# iso2 codes for SNZ HS10 data constructed from another SNZ survey
# 14 SNZ countries missing from BACI data
# included in both ISO2_CREATED datasets for now (as SNZ dataset spellings) for merging purposes
# for TAIWAN, renamed as "OTHER ASIA, NOT ELSEWHERE SPECIFIED" and used TW as iso2 code for both
# for Serbia and Montenegro, separate in both datasets, but new SNZiso2 code is joint CS
```

```
# BACI uses separate and joint
# decided to only use separate using BACI iso2codes ME and RS (ME drops out in filtered dataset anyway)
# iso2 code for Namibia (NA) changed to NB (duplicated when ran with original code)
# insert iso2 codes into SNZ data

SNZiso2=read.csv("ISO2_SNZ_HS10_CREATED.csv")                                  # n=232
SNZ_ = merge(x = SNZ, y = SNZiso2, "country", all.x = TRUE) # merge with SNZ n=133316
SNZ_= select(SNZ_,!c(country))                                                 # delete country variable
# insert new country variable with BACI spellings
BACIiso2=read.csv("ISO2_BACI_CREATED.csv")                                     # n=232
SNZ__ = merge(x = SNZ_, y = BACIiso2, "iso2", all.x = TRUE) # merge with SNZ n=133316
SNZ= select(SNZ__,!c(iso2))                                                   # delete iso2 variable
str(SNZ) #'data.frame':   133316 obs. of  9 variables: hsc10, hsdescription, hsc6, hsc2, cif, year, country, cif_hsc10,
NZshare_hsc10
sum(SNZ$cif)         #64179190902

##############
#   BACI dataset
##############

# source: http://www.cepii.fr/CEPII/en/bdd_modele/bdd_modele_item.asp?id=37
# What is BACI? Bilateral trade flow dataset
# The dataset is originally from the CEPII Research and Expertise on the World Economy
# The database is built from data directly reported by each country to the United Nations Statistical Division (Comtrade), more
than 5000 products and 200 countries
BACI=read.csv("BACI_HS17_Y2019_V202201.csv")            # repeat for Y2017, Y2018, Y2020
str(BACI) # 'data.frame':   10,985,138 obs. of  6 variables:  t year, i exporter, j importer, k product, v value, q quantity

# Calculate % global trade
# there are 218 (/239) countries trading to NZ with 5020 (/5384) products (from earlier exploratory analysis)
# use full original BACI dataset, want j=NZ (n=554), but need to keep all j data to compute global %
# calculate total value of product, then merge back in to full dataset
qGlobalvalue <- aggregate(BACI$v, by=list(BACI$k), FUN=sum)
str(Globalvalue) #'data.frame':   5381 obs. of  2 variables (Group.1, x)
colnames(Globalvalue) = c("k","v_global")                                      # rename columns
BACIa = merge(x = BACI, y = Globalvalue, "k", all.x = TRUE)                    # merge back into original dataset, right-outer
join, to only keep all rows from BACI2019
BACIa$v_share = (BACIa$v/BACIa$v_global)                                       # calculate proportion of trade
# add up shares for exporter countries - one country is likely to be exporting to more than one country
# careful: need to add for i and k, not just i
# then, merge back into original dataset
BACIa_= aggregate(v_share ~ k + i, data = BACIa, FUN = sum, na.rm = TRUE)
colnames(BACIa_) = c("k","i","v_sharetotal")                                   # first, rename cols
BACIb = merge(x = BACIa, y = BACIa_, by=c("k","i"), all.x = TRUE)              # merge back, with 2 variables

# Calculate VALUE of global trade
BACIb_= aggregate(v ~ k + i, data = BACIb, FUN = sum, na.rm = TRUE)
colnames(BACIb_) = c("k","i","v_total")                                        # rename cols
BACIc = merge(x = BACIb, y = BACIb_, by=c("k","i"), all.x = TRUE)              # merge back, with 2 variables

# Reduce dataset to j=554 (NZ as importer)
BACInz=BACIc[BACIc$j==554, ]           # n=95223
# Add HHIwld, calculated as country shares of global trade
        # OK to calc with reduced dataset, as simply reduces dataset to products going to NZ
        # but v_share and v_sharetotal calc for full dataset (all products and countries exporting those products)
BACInz$v_sharesq=(BACInz$v_sharetotal*BACInz$v_sharetotal)                     # square first
BACInz$hsc6=BACInz$k
HHIwld = aggregate(BACInz$v_sharesq, by=list(BACInz$hsc6), FUN=sum)            # sum squares
colnames(HHIwld) = c("hsc6","HHIwld")                                          # re-merge with dataset on "k"...which is hsc6
BACInz = merge(x = BACInz, y = HHIwld, "hsc6", all.x = TRUE)
        #summary(BACInz$HHIwld)
        #   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
        # 0.00000 0.07763 0.10812 0.14341 0.16996 0.94727

# BACI does not have country names - need to merge in first
BACIcountry=read.csv("BACI_full country names.csv")
BACInz = merge(x = BACInz, y = BACIcountry, "i", all.x = TRUE)

BACI = BACInz[ ,c("hsc6","v","q","v_global","v_sharetotal","v_total","HHIwld","country")]      # reduce variables
```

```
str(BACI) #'data.frame':   95223 obs. of  10 variables (hsc6, year, v, q, v_global, v_sharetotal, v_total, country, v_sharesq, HHIwld)

##########################
#  MERGE SNZ and BACI data
##########################

# BACI: hsc6, v, q, v_global,v_sharetotal,v_total,country,HHIwld
# SNZ: hsc10,hscdescription,hsc6,hsc2,cif,year,country,cif_hsc10,NZshare_hsc10

IMPORTS = merge(x = BACI, y = SNZ, by=c("hsc6","country"), all = TRUE) # merge on hsc6 and country          # n=146189
IMPORTS=na.omit(IMPORTS)              # remove nas >> n=132378
sum(IMPORTS$cif)                      # 60774124323

#IMPORTS_=distinct(IMPORTS, hsc6, .keep_all = TRUE)                    # n=4788
#IMPORTS_=distinct(IMPORTS, hsc10, .keep_all = TRUE)                   # n=11041
#IMPORTS_ = IMPORTS %>% distinct(hsc10, country, .keep_all = T)        # n=132378 ok
#IMPORTS = select(IMPORTS,!c(year.x,year.y))                           # remove year.x and year.y
#IMPORTS = select(IMPORTS,!c(year))

# Add hs2 categories
        # https://www.allianceexperts.com/en/knowledge/exports/hs-code/
        # table of first 2 digits taken from here, saved as "HS2 codes"
hsc2=read.csv("HS2 codes.csv")
IMPORTS = merge(x = IMPORTS, y = hsc2, "hsc2", all.x = TRUE)

# Add hsc6 description (from original BACI download files)
hsc6=read.csv("BACI_product_codes_HS17_V202201.csv")
IMPORTS = merge(x = IMPORTS, y = hsc6, "hsc6", all.x = TRUE)

# Add BEC codes
# Requires concordance with BEC
# SNZ provides a concordance via aria: NZHSC v17.05 to Predom BEC v1.0 v1.0.0
#...but does not have "end use", only 123 product categories
# Instead, using sheet 2 (hs2017) from HS2012-17-BEC5_08_Nov_2018 file downloaded from
#...https://unstats.un.org/unsd/classifications/Econ#Correspondences
# only using 3 columns: HS6, BEC5Category (which will call 'BEC_industry') and BEC5EndUse (which will call 'BEC_enduse')
# converted hsc to number, removed all formating and numbers in front of industry, checked no blanks
# deleted 2 blanks for end use & industry: hsc6 710820 and 711890
BEC=read.csv("BEC convergence.csv")          # n=5385, 3 vars (hsc6, BEC_enduse, BEC_industry)

# can only merge on hsc6
IMPORTS = merge(x = IMPORTS, y = BEC, by=c("hsc6"), all.x= TRUE)
        # sum(is.na(IMPORTS$BEC_enduse))   # n=0 OK, so 100% match rate
        # table(IMPORTS$BEC_enduse)
        # CAP   CAP/CONS  CAP/INT  CONS   CONS/CAP   CONS/INT   INT      INT/CAP  INT/CONS
        # 16776 649       1598     36901  3209       4640       64011    493      4101
        # table(IMPORTS$BEC_industry)
        # Agriculture, forestry, fishing, food, beverages, tobacco                                  # 15277
        # Construction, wood, glass, stone, basic metals, housing, electrical appliances, furniture # 43995
        # Government, military and other                                                            # 1090
        # Health, pharmaceuticals, education, cultural, sport                                       # 12074
        # ICT, media, computers, business and financial services                                    # 9757
        # Mining, quarrying, refinery, fuels, chemicals, electricity, water, waste treatment        # 11701
        # Textile, apparel, shoes                                                                   # 24255
        # Transport equipment and services, travel, postal services                                 # 14229
str(IMPORTS)      #'data.frame':   132378 obs. of  39 variables:
sum(IMPORTS$cif) #60774124323
#IMPORTS_ = IMPORTS %>% distinct(hsc10, country, .keep_all = T)   # n=132378 ok

##############################
# INSERT CODE HERE FOR PART 2
# to create main dataset with all variables, before filtered
# See code below which introduces industry codes and concordance tables to link HS products to industries
##############################
str(IMPORTS)      # 'data.frame':   132378 obs. of  43 variables        # extra variables with inserted code
# sum(IMPORTS$cif) # 60774124323 ok

#############
```

```
# Apply filters
#############

# F1: main supplier > 80% NZ imports
IMPORTS=IMPORTS[IMPORTS$NZshare_hsc10>0.8, ]                # n=3744 (hsc10 distinct)
        # IMPORTS_=distinct(IMPORTS, hsc6, .keep_all = TRUE)  # n=2159 (hsc6 distinct)
        sum(IMPORTS$cif)                                    # 9087631221

# F2: HHIwld>16996 "OR" highest (global) market share > 50%
# NOTE top quartile of HHIwld calculated above is > 0.16996 (APC used 3100, presumably this represented their top 1/4)
        # 2017: 0.1783      # 2018: 0.17262     # 2020: 0.16853

IMPORTS=IMPORTS[(IMPORTS$HHIwld>0.16996 | IMPORTS$v_sharetotal>0.5), ]      # n=979 (hsc10 distinct)
        # when repeat for other years, remember to change HHIwld variable

        # IMPORTS_=IMPORTS[(IMPORTS$HHIwld>0.31 | IMPORTS$v_sharetotal>0.5), ]
        # this is previous code, matching APC exactly
                # n=1527 - based on HHIwld calc using merged dataset...
                # this will have removed countries that do export products imported by NZ
                        #HHI (SUM of sq shares will therefore be smaller)
                # n=469  - based on HHIwld calculated with original BACI data...think this is more accurate
        # IMPORTS=IMPORTS[(IMPORTS$HHIwld>0.16996 | IMPORTS$v_sharetotal>0.5), ]
                # n=979 - HHI and top quartile calc with original BACI data

#IMPORTS_=distinct(IMPORTS, hsc6, .keep_all = TRUE)             # n=561 (hsc6 distinct)
sum(IMPORTS$cif)                                               # 4053909490

# F3: supply = main global supplier
# rank and split dataset for top exporter (i) for each product

IMPORTS_sort = IMPORTS[order(-IMPORTS$cif_hsc10),]             # sorts by cif_hsc10 - to sort hsc10 level data
IMPORTS_sort2 = IMPORTS_sort[order(-IMPORTS_sort$v_global),]   # re-sorts by v_global
IMPORTS_sort3 = IMPORTS_sort2[order(-IMPORTS_sort2$v_sharetotal),]      # re-sorts by v_share
IMPORTS_bigI=distinct(IMPORTS_sort3, hsc6, .keep_all = TRUE)   # keeps top row, which should be biggest global
exporter/supplier country for each product
IMPORTS_bigI_=select(IMPORTS_bigI,c(hsc6, country))            # reduces dataset to 2 vars: hsc6 and country for
matching purposes
IMPORTS_bigI_$main_country="yes"    # creates dummy variables for main country

IMPORTS = merge(x = IMPORTS, y = IMPORTS_bigI_, by=c("hsc6","country"), all.y= TRUE)# n=808 (hsc10 distinct)
        # IMPORTS_=distinct(IMPORTS, hsc6, .keep_all = TRUE)
        # n=561 (hsc6 distinct) NOTE same as for F2
        sum(IMPORTS$cif)                                       # 3972058147

# F4: Limited Domestic Production (similar to Canada study Jiang 2023)
# calculate export:import ratio (proxy) as (value export / value import) < 1

EXPORTS=read.csv("SNZexports.csv")                             # n=64520, brings in export data
EXPORTS=select(EXPORTS,c(hsc10,fob))                           # only need hsc10 and fob
EXPORTS=distinct(EXPORTS, hsc10, .keep_all = TRUE)             # reduce to unique hsc10, n=8561

IMPORTS = merge(x = IMPORTS, y = EXPORTS, by=c("hsc10"), all.x= TRUE)   #n=808, keeps all x, but blanks for some ys

IMPORTS$fob[is.na(IMPORTS$fob)] = 0                            # convert unmatched totalfobs to 0

IMPORTS$ratio = IMPORTS$fob / IMPORTS$cif                      # n=808
IMPORTS=IMPORTS[IMPORTS$ratio<1, ]                             # n=776
        # check=na.omit(IMPORTS)                               # n=776
        # IMPORTS_=distinct(IMPORTS, hsc6, .keep_all = TRUE)   # n=544
        # IMPORTS_=IMPORTS[IMPORTS$ratio>=1, ]                 # 87 imports NZ exports more of
        sum(IMPORTS$cif)                                       # 3949661600

# F5: Remove pure consumption goods
# remove only CONS n=416
IMPORTS=IMPORTS[IMPORTS$BEC_enduse!="CONS", ]                  # n=429
        # IMPORTS_=distinct(IMPORTS, hsc6, .keep_all = TRUE)   # n=347
        sum(IMPORTS$cif)                                       # 3048821118

# F6: Vulnerable in previous 2 years - 2017 and 2018
```

```
#(expecting n = 119, based on running full codes + filters separately for each year.
#But, in this dataset, only cif values for each year from SNZ (not SNZ+BACI) were matched.)

IMPORTS = IMPORTS[(IMPORTS$cif17>0 & IMPORTS$cif18>0),  ]    #n=299

##########################
# PART 2 – industry exposure
##########################
# this code was originally inserted before filters in part 1 (see above) to create main dataset with all variables

####################################
# METHOD 1: HS to 'predominant' ANZSIC

# Add ANZSIC codes
# from
https://aria.stats.govt.nz/aria/#ConcordanceSearch:q=nzhsc%2520v17%2520to%2520anzsic06&fl=name,source,target&sort=relevance-&start=20&rows=20
# NZHSC v17.05 to Predom ANZSIC06 v1.0
# n=15579 unique hsc10 (15561 many-to-one, and 18 one-to-one mappings)
# n=194 unique anzsic codes (of how many? there are 506 unique 4digit classes in list from ABS 2006 (rev 2) - so only 38%)
# there are also 194 unique anzsic06descriptions, but they seem brief...how compare with ABS codes??? look the same

anzsic=read.csv("anzsic codes.csv")      # n=15579
IMPORTS = merge(x = IMPORTS, y = anzsic, "hsc10", all.x = TRUE)
        # look at match rate for anzsic06
        # sum(is.na(IMPORTS$anzsic06))        # n=0 OK, so 100% match rate
                # how many anzsic codes do we import?
                # anzsic_=distinct(anzsic, anzsic06, .keep_all = TRUE)                # n=194 (out of about 500)
                # IMPORTS_=distinct(IMPORTS, anzsic06, .keep_all = TRUE)          # n=187 / 194 (96%)

# Add anzsic codes for divisions (A-S)...what about T?
# requires new variable with first digit from anzsic06 string, call this variable "div"

IMPORTS$div=str_sub(IMPORTS$anzsic06, start = 1, end = 1)
division=read.csv("anzsic division.csv")                                    # n=18
IMPORTS = merge(x = IMPORTS, y = division, "div", all.x = TRUE)     #
table(IMPORTS$div)                                                          # 6 / 18 (one third of categories only)
                #   A     B     C     G     J     R
                #  1576    443 129879    19    285    176
table(IMPORTS$divdescription)
                #   Agriculture, Forestry and Fishing (A)             # 1576
                #   Arts and Recreation Services (R)                  #   176
                #   Information Media and Telecommunications (J) #   285
                #   Manufacturing (C)                                 #   129879
                #   Mining (B)                                        #   443
                #   Retail Trade (G)                                  #   19
# missing 2/3 divisions...and massively loaded into manufacturing (remember is for main/predominant import category)
# does seem to be a lot more distribution across classes though (within divisions)

# Add anzsic codes for subdivisions - 2 digit codes
# requires new variable with 2nd and 3rd digits from anzsic06 string, call this variable "subdiv"
IMPORTS$subdiv=str_sub(IMPORTS$anzsic06, start = 2, end = 3)
IMPORTS$subdiv=as.numeric(IMPORTS$subdiv)
subdiv=read.csv("anzsic subdivision.csv")                                   # n=86
IMPORTS = merge(x = IMPORTS, y = subdiv, "subdiv", all.x = TRUE)  #
table(IMPORTS$subdiv)                                                       # n=27 / 86 (31%)

# Add freq count & rank for anzsic subdiv
        # only want it for genuine industries in trade data
        # do this before bring in import share / ioindustries...otherwise will affect counts
        # due to multiple ioindustries for some subdivs...
subdiv = IMPORTS %>% add_count(subdiv)
subdiv_ = distinct(subdiv , subdiv, .keep_all = TRUE)
subdiva =subdiv_ [ ,c("subdiv","n")]
colnames(subdiva) = c("subdiv","freq_subdiv")
subdiva = subdiva[order(-subdiva$freq_subdiv),]
subdiva$rank_subdiv <- seq.int(nrow(subdiva))
IMPORTS=merge(x = IMPORTS, y = subdiva, "subdiv", all.x = TRUE)  # add back to IMPORTS
```

```
# Add import share from IO tables
# first, need to convert IO industry data to anzsic subdiv
# using data and convergence tables in SNZ IO tables 2020
ioindustry=read.csv("nzsioc to io table industry groups.csv")  # n=118
        #check=distinct(ioindustry, ioindustry, .keep_all = TRUE)       # n=109
        #so, there are more nzsioc codes (118) than ioindustries (109)
        #...industries duplicated in this dataset
nzsioc=read.csv("anzsic to nzsioc.csv")                                 # n=508
IO = merge(x = ioindustry, y = nzsioc, "nzsioc", all.y = TRUE)          # n=508

# Add subdiv to IO
IO$subdiv=str_sub(IO$anzsic06, start = 2, end = 3)
IO$subdiv=as.numeric(IO$subdiv)
        # IO_ = distinct(IO, subdiv)                                    # n=87
        # table(IO_$subdiv) # WHAT is extra subdiv code????
        # sum(is.na(IO$subdiv)) # there are 2 nas
        # check <- IO[is.na(IO$subdiv), ]
        # obs#222 nzscio:EE111 "Owner-builder construction (national accounts only)"
                #>>>IO industry "Residential building construction"
                #NO anzsic06 code
        # obs#400 nzscio:LL211 "Owner-occupied property operation (national accounts only)"
                #>>>IO industry "Owner-occupied property operation"
                #NO anzsic06 code
        # delete these
IO=na.omit(IO)      # remove nas >> n=506
subdiv=read.csv("anzsic subdivision.csv")                               # n=86
        # table(subdiv$subdiv)
IO = merge(x = IO, y = subdiv, "subdiv", all.x = TRUE)
table(IO$subdiv)                                                        # n=86 (from '96')

# reduce to subdiv and io industry      #satisfied that subdiv descriptions comparable
IO = IO[ ,c("subdiv","ioindustry")]

# NOTE, there are multiple ioindustries for some subdiv in this dataset
# reduce to distinct ioindustries, add import share data
# then remove multiples by averaging across them
IO_ = distinct(IO, ioindustry, .keep_all = TRUE)    # n=108

# Add import share data here
ioimportshare=read.csv("io import share.csv")                           # n=109
        #(still includes industry for which there is no anzsic code)    # n=109
IO_2 = merge(x = IO_, y = ioimportshare, "ioindustry", all.x = TRUE)    # n=108
# want unique subdiv...
# BUT, there are some duplicates with ioindustry...so would lose some data
# So, average ioimportshare across subdiv duplicates
IO_3=aggregate(ioimportshare ~ subdiv, data = IO_2, FUN = mean, na.rm = TRUE)
# n=79, less than original 86 anzsic subdivisions

# Merge into IMPORTS dataset
IMPORTS=merge(x=IMPORTS, y=IO_3, "subdiv", all.x=TRUE)
        # REMEMBER: there are only 27 "predom" anzsic codes in IMPORT dataset
        # and only 24 that have matched ioimportshare!!!

########################################
# METHOD 2: HS to IO products and industries
# (explores traded goods ACROSS IO industries)

# First, need to bring in NACC codes
# anzsic categories do not match national account product groupings
# try using SNZ convergences: HSC17 > CPC > NACC (also from SNZ aria concordances website)
        # CPC codes are Central Product Classifications
                # dev by United Nations Statistical Commission as an
                # international standard for organizing and analyzing data on
                # industrial production, national accounts, trade, prices etc...
        # NACC codes are National Account Commodity Classifications

# Add CPC codes
cpc=read.csv("HS to CPC code.csv")    # n=15564
IMPORTS = merge(x = IMPORTS, y = cpc, "hsc10", all.x = TRUE)
```

```
	# sum(is.na(IMPORTS$CPC))# n=0 OK, so 100% match rate

	# how many CPC codes do we import?
	# cpc_=distinct(cpc, CPC, .keep_all = TRUE)	# n=1428
	# IMPORTS_=distinct(IMPORTS, CPC, .keep_all = TRUE)	# n=1349 / 1428 (94.5%)

# Add NACC codes
nacc=read.csv("CPC to NACC code.csv")		# n=2738
IMPORTS = merge(x = IMPORTS, y = nacc, "cpc", all.x = TRUE)
	# Note, some modifications were made to SNZ's NACC to CPC code
	# there are two unmatched NACC codes in nacc dataset...have removed:
		#98500 non-profit institutions serving households final consumption expenditure (NPISH FCE)
		#98600 Fringe benefit values including GST)
	# and 59 duplicates (2%) of 2795 CPC values found...
		# example: 2111 cpc cattle has two npcc codes 2200 beef cattle and 2300 dairy cattle
		# found 36 CPC codes that map to 1 or more nacc codes
		# majority are services (27/36) - npcc more complex coding...eg loc. and cent. govt, not just public admin
		# also found 3 npcc codes without CPC (deleted):
			# 62000 land improvements
			# local government fce
			# central government fce
		# solution? not so worried about services as OMT data does not pick up
		# decided to effectively replace all nacc with cpc description, unless nacc has similar name
		#...so do lose some nacc codes and detail.
	# sum(is.na(IMPORTS$nacc))# n=0 OK, so 100% match rate
IMPORTS = select(IMPORTS,!c(cpc,cpcdescription))		# Removes cpc and cpcdescription
	# how many NACC codes do we import?
	# nacc_=distinct(nacc, NACC, .keep_all = TRUE)  # n=291 (was 302 before modified dataset)
	# IMPORTS_=distinct(IMPORTS, NACC, .keep_all = TRUE) # n=152 / 291 (52%)

# Second, bring in IO PRODUCT data
	# created flat file "io table 3" using excel to create industry counts etc.
	# note, ioindustry refers to MAIN industry or industry with highest share of imported product use
	# converted IO products to NACC (using convergence tables in SNZ's IO tables)
		#ioproduct=read.csv("nacc to io products.csv")	# n=299
		#check=distinct(ioproduct, ioproduct, .keep_all = TRUE)	# n=197
		#so, there are more nacc codes than ioproducts
		#also 2 fewer ioproducts than expected...??? come back to this
	# created 2 files:
		# io product to number industries ("numindus"), and number with share > 5% ("share_5")
		# io product to main industry ("ioindustry" and "iosubdiv")
		# io industry to product (NEW: created to give count of products in each industry…
		# …NOT INTEGRATED INTO CODE YET)
			# this counts number of ALL different products in io tables used by industry
			# not necessary just the vulnerable products!!!!!

# bring in this data and merge with IMPORTS
numindus=read.csv("io product to industry.csv")	#n=229
numindus=numindus[ , c("ioproduct","nacc","numioindus", "share_5")]  #n=nacc=291
IMPORTS = merge(x = IMPORTS, y = numindus, "nacc", all.x = TRUE)
	#match rate?
	#IMPORTS_=distinct(IMPORTS, NACC, .keep_all = TRUE)  #n=NACC=152
	#sum(is.na(IMPORTS_$ioproduct))	#n=6...so 6 non matches
	#sum(is.na(IMPORTS_$numioindus))	#n=6
ioindus=read.csv("io product to main industry.csv")#n=229
ioindus=select(ioindus,!c(ioproduct))
IMPORTS = merge(x = IMPORTS, y = ioindus, "nacc", all.x = TRUE)
	# check ioproduct.x = ioproduct.y
	# IMPORTS_$check=ifelse(IMPORTS_$ioproduct.x==IMPORTS_$ioproduct.y, 1, 0)		# n=1=128508
	# sum(is.na(IMPORTS_$ioindustry))	#n=3870, 132378-3870=128508...ok
	# ..so could actually merge these 2 files and import content together!???

# Add freq count & rank for iosubdiv
iosubdiv = IMPORTS %>% add_count(iosubdiv)
iosubdiv_ = distinct(iosubdiv , iosubdiv, .keep_all = TRUE)	# n=39
iosubdiva =iosubdiv_ [ ,c("iosubdiv","n")]
colnames(iosubdiva) = c("iosubdiv","freq_iosubdiv")
iosubdiva = iosubdiva[order(-iosubdiva$freq_iosubdiv),]
iosubdiva$rank_iosubdiv <- seq.int(nrow(iosubdiva))		# n=39
```

```
IMPORTS=merge(x = IMPORTS, y = iosubdiva, "iosubdiv", all.x = TRUE)          # add back to IMPORTS

# bring in import share again for iosubdiv…?
# table(IMPORTS$iosubdiv)   #n=38 (...or 39?), which is more than via "predom" concordance (n=24/27)
# use IO_3 created above
# IO_3=aggregate(ioimportshare ~ subdiv, data = IO_2, FUN = mean, na.rm = TRUE)
# n=79, less than original 86 anzsic subdivisions...
colnames(IO_3)=c("iosubdiv","ioimportshare2")     # renames subdiv as iosubdiv

# merge into IMPORTS dataset
IMPORTS=merge(x=IMPORTS, y=IO_3, "iosubdiv", all.x=TRUE)
# table(IMPORTS$ioimportshare2)        #n=37, so 1 less

# add io import coefficients from table 7 of the IO table [NOT INTEGRATED INTO CODE]
# IMPORTS=read.csv("IMPORTS_main.csv")
# ioimportcoef=read.csv("io import coefficient.csv")
# need to first bring in anzsic codes...repeat earlier code:
        #ioindustry=read.csv("nzsioc to io table industry groups.csv")          # n=118
        #nzsioc=read.csv("anzsic to nzsioc.csv")                                # n=508
        #IO = merge(x = ioindustry, y = nzsioc, "nzsioc", all.y = TRUE)         # n=508
        #IO$subdiv=str_sub(IO$anzsic06, start = 2, end = 3)
        #IO$subdiv=as.numeric(IO$subdiv)
        #IO=na.omit(IO)     # remove nas >> n=506
        #subdiv=read.csv("anzsic subdivision.csv")                              # n=86
        #IO = merge(x = IO, y = subdiv, "subdiv", all.x = TRUE)
        #IO = IO[ ,c("subdiv","ioindustry")]
        #IO_ = distinct(IO, ioindustry, .keep_all = TRUE) #n=108
        #IO_2 = merge(x = IO_, y = ioimportcoef, "ioindustry", all.x = TRUE)    #n=108
        #IO_3=aggregate(ioimportcoef ~ subdiv, data = IO_2, FUN = mean, na.rm = TRUE)
                # save as "anzsic import coefficient"
                # remerge subdiv description
                # IO_4=merge(x=IO_3, y=subdiv, "subdiv", all.x = TRUE)
                # save as excel file "IO results 01 June 2023"
        #re-merge with IMPORTS: 2 ways (with "predom" and with "main")
        #(1)    #IMPORTS=merge(x=IMPORTS, y=IO_3, "subdiv", all.x=TRUE)
                #REMEMBER: there are only 27 "predom" anzsic codes in IMPORT dataset
                #and only 24 (?) that have matched ioimportcoefficient!!!
                #table(IMPORTS$ioimportcoef)          #n=24
        #(2)    #colnames(IO_3)=c("iosubdiv","ioimportcoef2")     #renames subdiv as iosubdiv
                #IMPORTS=merge(x=IMPORTS, y=IO_3, "iosubdiv", all.x=TRUE)
                #table(IMPORTS$ioimportcoef2)          #n=32...a few less than for ioimportshare2
```

```
##############################################
# R code for EXPORT Analysis – version 2.0
##############################################
# PART 1 – trade vulnerabilities
############################

# Creates 2 datasets ("SNZ") and ("BACI") then merges them ("Main") and applies import filters ("Filtered")
# Started with 2019, as this was pre-covid and data for both SNZ and BACI available.
# Does not include additional code created for summarising results, creating tables, or merging results with SNZ/BACI merged dataset. Also, does not include code for other years (2017, 2018, 2020) and analysis across years. (see full R code in supplementary materials).

#############
#   SNZ dataset
#############
# Source: https://www.stats.govt.nz/large-datasets/csv-files-for-download/overseas-merchandise-trade-datasets
# Variables (renamed):      Month                                 (month)
#                           Harmonised.System.Code                (hsc10)
#                           Harmonised.System.Description         (hscdescription)
#                           Unit.Qty                              (unit)
#                           Country                               (country)  "of destination"
#                           Exports...NZD.fob.                    (fob)      "free on board"
#                           Exports.Qty                           (qty)
#                           Re.exports...NZD.fob.                 (reexfob)
#                           Re.exports.Qty                        (reexqty)
#                           Total.Exports...NZD.fob.              (totfob)
#                           Total.Exports.Qty                     (totqty)
#                           Status                                (status)
# Variables created: fob10, fob10share (using fob, not reexfob or totalfob)
# n=79207, 14 variables

# SNZ=read.csv("2019_Exports_HS10_by_Country.csv")                # original version
SNZ=read.csv("2019_Exports_HS10_by_Country_Rformat.csv")        # n=279279          # repeat for 2017-2020
# R version, with modified variable names and converted fob and q to numeric
# also created hsc6 and hsc2 as R code for this hasn't worked well! (used =LEFT(cell,LEN(cell)-4 and -2 respectively)

# check fob variable
sum(is.na(SNZ$fob))          # n=0
summary(SNZ$fob)             # min=0...so are zeros
sum(SNZ$fob==0)              # n=56170 / 279279 (20%)...some fob products have exports too
sum(SNZ$reexfob>0)           # n=91468 / 279279 (33%) are re-exported

# remove fob=0
SNZ_=SNZ[SNZ$fob>0, ]        # n=223109 (=279279-56170) ok

# aggregate monthly data
fob_year=aggregate(fob ~ hsc10 + country, data = SNZ_, FUN = sum, na.rm = TRUE)        # n=64520
colnames(fob_year) = c("hsc10","country","fob_year")
SNZexports = merge(x = SNZ_, y = fob_year, by=c("hsc10","country"), all.x = TRUE)          # n=223109

# collapse dataset to years
SNZexports = SNZexports %>% distinct(hsc10, country, .keep_all = TRUE)
SNZexports = select(SNZexports,c(hsc10,country,hscdescription,hsc6,hsc2,fob_year))        # n=79207 # removes variables that no longer make sense: month, unit,fob, qty, reexfob, reexqty, totalfob, totalqty, status
colnames(SNZexports) = c("hsc10","country","hscdescription","hsc6","hsc2","fob")              # renames fob_year as fob
fob10 = aggregate(SNZexports$fob, by=list(SNZexports$hsc10), FUN=sum)       # fob for each hsc10 product (n=8561)
colnames(fob10) = c("hsc10","fob10")
SNZexports = merge(x = SNZexports, y = fob10, "hsc10", all.x = TRUE)
SNZexports$fob10share = (SNZexports$fob/SNZexports$fob10)                   # proportion of trade (should be no NAs)
        # summary(SNZexports$fob10share) # >> 0 NAs :)
str(SNZexports)              #'data.frame':   64520 obs. of  8 variables:
sum(SNZexports$fob)          # 57826556924 NZD

#############
# BACI dataset
#############

# Source: http://www.cepii.fr/CEPII/en/bdd_modele/bdd_modele_item.asp?id=37
# Aim:                       Retain global info for products NZ exports
```

```
# Original variables: k, j, t, i, v, q, (k=product, j=importer, t=year, i=exporter, v=value, q=quantity)
# Added variables:  v_global, v_share, v_NZ, v_sharetotal, v_squareshare, HHIwld

BACI=read.csv("BACI_HS17_Y2019_V202201.csv")          # 10,985,138 obs. of  6 variables          # repeat for 2017-2020
        # ASIDE: Total value of global trade and NZ trade...required to calculate RCA later
        # sum(BACI$v)       # 18,119,639,264
        # reduce database to NZ exports and sum again:
        # NZ=BACI[BACI$i==554, ]    # n=73637
        # sum(NZ$v)                 # 40,797,526 (0.225%) of global trade
Globalvalue <- aggregate(BACI$v, by=list(BACI$k), FUN=sum)          # creates total value of each good traded
colnames(Globalvalue) = c("k","v_global")                           # renames columns
BACIa = merge(x = BACI, y = Globalvalue, "k", all.x = TRUE)         # merge back into original dataset
BACIa$v_share = (BACIa$v/BACIa$v_global)                            # calculates proportion of trade for each product:country
pairing
BACIa_= aggregate(v_share ~ k + j, data = BACIa, FUN = sum, na.rm = TRUE)   # note calculating for j=imports
colnames(BACIa_) = c("k","j","v_sharetotal")
BACIb = merge(x = BACIa, y = BACIa_, by=c("k","j"), all.x = TRUE)   # This takes R a few minutes to process
NZexports=BACIb[BACIb$i==554, ]                                     # reduces dataset to NZ exports
NZvalue = aggregate(NZexports$v, by=list(NZexports$k), FUN=sum)             # creates total value of goods exported by NZ
colnames(NZvalue) = c("k","v_NZ")                                           # used to calc RCA latter
NZexports = merge(x = NZexports, y = NZvalue, "k", all.x = TRUE)            # merge back into original dataset

# add HHIwld variable, calculated as country shares of global trade
        # OK to calc with reduced dataset, as simply reduces dataset to products going from NZ
        # but v_share and v_sharetotal calc for full dataset (all products and countries importing those products)
NZexports$v_sharesq=(NZexports$v_sharetotal*NZexports$v_sharetotal)         # square first
HHIwld = aggregate(NZexports$v_sharesq, by=list(NZexports$k), FUN=sum)      # sum squares
colnames(HHIwld) = c("k","HHIwld")                                          # re-merge with dataset on "k"...which is hsc6
NZexports = merge(x = NZexports, y = HHIwld, "k", all.x = TRUE)             # n=73637 merging back with original dataset
        # summary(NZexports$HHIwld)
        #   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
        # 0.00000 0.01589 0.03868 0.04534 0.06132 0.76033
str(NZexports)      #'data.frame':   73637 obs. of  12 variables:
sum(NZexports$v)  # 40797526 USD(000)

############################
# MERGE BACI and SNZ datasets
############################

# merge on hsc6 and country, BACI does not have hsc10 level data, but want to keep it from SNZ dataset
NZexports$hsc6 = NZexports$k # create hsc6 variable which simply duplicates k for merging purposes
BACIcountry=read.csv("BACI_full country names_j.csv") # add country names to BACI
NZexports = merge(x = NZexports, y = BACIcountry, "j", all.x = TRUE)
NZexports=select(NZexports, !c(j)) # delete j
# standardise country spellings
# repeat code created for imports: this changes SNZ to BACI spelling (should be able to use code to do in reverse as well)
SNZiso2=read.csv("ISO2_SNZ_HS10_CREATED.csv") # n=232 # insert iso2
SNZexports_ = merge(x = SNZexports, y = SNZiso2, "country", all.x = TRUE) # n=64520
SNZexports_= select(SNZexports_,!c(country)) # delete original country variable
BACIiso2=read.csv("ISO2_BACI_CREATED.csv") # n=232 # use iso2 to insert new country variable with BACI spellings
SNZexports__= merge(x = SNZexports_, y = BACIiso2, "iso2", all.x = TRUE) # n=64520
SNZexports = select(SNZexports__,!c(iso2)) # delete iso2 variable

EXPORTS = merge(x = SNZexports, y = NZexports, by=c("hsc6","country"), all = TRUE)      # n=93482, 26 variables
EXPORTS=na.omit(EXPORTS)            # n= 63942, removes all missing (unmatched) observations (460 deleted)
        # sum(EXPORTS$fob)          # 56224630150 NZD (a 'loss' of $1.6b NZD export value, or 2.8%)
        # before n=64520, now=63942, so loss of 578 observations (0.9%)...so value loss is more than proportional
        # would need to reduce dataset to unique hsc6:country to check merged value of "v" from BACI dataset...

# Add hs2 categories
hsc2=read.csv("HS2 codes.csv")
EXPORTS = merge(x = EXPORTS, y = hsc2, "hsc2", all.x = TRUE)

# Add hsc6 description (from original BACI download files)
hsc6=read.csv("BACI_product_codes_HS17_V202201.csv")
EXPORTS = merge(x = EXPORTS, y = hsc6, "hsc6", all.x = TRUE)

######
# insert code to map to industries here (repeat code for imports above)
```

```
# Unlike imports, cannot EXPLORE traded goods ACROSS IO industries ('Method 2')
# IO tables do not have equivalent table 3. Table 6 does allow us to see export shares across industries,
# …but no allocation of share of exported products across industries, so cannot work out main industry or num industry
######

# add RCA
# add measure of revealed comparative advantage to dataset
# RCA = (share of product j in country i's total exports) / (share of product j in world exports)
# RCA = (v_NZ/sum of v for nz) / (v_global/sum of v for global)
        # From earlier code for BACI:
        # ASIDE: Total value of global trade and NZ trade...required to calculate RCA later
        # sum(BACI$v)       # 18,119,639,264
        # reduce database to NZ exports and sum again:
        # NZ=BACI[BACI$i==554, ]    # n=73637
        # sum(NZ$v)                 # 40,797,526 (0.225%) of global trade
# RCA = (v_NZ/40,797,526) / (v_global/18,119,639,264)
EXPORTS$rca=((EXPORTS$v_NZ/40797526)/(EXPORTS$v_global/18119639264))

#EXPORTS_=distinct(EXPORTS, hsc6, .keep_all = TRUE)                    # n=4010
#EXPORTS_=distinct(EXPORTS, hsc10, .keep_all = TRUE)                   # n=8525
#EXPORTS_ = EXPORTS %>% distinct(hsc10, country, .keep_all = T) # n=63942 ok
str(EXPORTS)'data.frame':     63942 obs. of  35 variables (this includes industry variables)
sum(EXPORTS$fob)              # 56224630150

############
# Apply filters
############

# F1
# A single destination market accounts for 80 per cent or more of NZ's exports of a product.
# "This filter identifies whether Australian exports are highly concentrated in a single market, as concentration entails risk."
EXPORTS=EXPORTS[EXPORTS$fob10share>=0.80, ]                            # n=3929 (hsc10 distinct)
        # EXPORTS_=distinct(EXPORTS, hsc6, .keep_all = TRUE)  # n=2368 (hsc6 distinct)
        # sum(EXPORTS$fob)                                              # 8632784444

# F2
# The product's Herfindahl-Hirschman Index (HHI) is in the top quartile of HHI values (calc using importing nations' market
# share) OR The biggest importer accounted for over 50 per cent of global imports.
# use HHIwld for importing nation's global share of types of products that NZ exports
        # HHIwld calc with BACI data, before merge, so calc top 1/4 using this same dataset
        # summary(NZexports$HHIwld)
        #   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
        # 0.00000 0.01589 0.03868 0.04534 0.06132 0.76033
EXPORTS = EXPORTS[(EXPORTS$HHIwld>=0.06132 | EXPORTS$v_sharetotal>=0.5), ]  # n=746 (hsc10 distinct)
        # EXPORTS_=distinct(EXPORTS, hsc6, .keep_all = TRUE)                  # n=317 (hsc6 distinct)
        # sum(EXPORTS$fob)                                                    # 4471066641
        # 2017 HHIwld>=0.06292 # 2018 HHIwld>=0.06184 # 2020 HHIwld>=0.06159

# F3
# Biggest destination = biggest importer. If main destination market is not the biggest importer globally,
# it would be easier for exporters to switch to alternative markets without experiencing large price increases.
# biggest destination = totfob10share (after sorted via v_NZ)....could also use v_shareNZ
# need to id top destination for each product
# biggest importer = v_sharetotal
# need to id top importer for each product
EXPORTS_sort = EXPORTS[order(-EXPORTS$fob10),]                         # sorts by totfob10
EXPORTS_sort2 = EXPORTS_sort[order(-EXPORTS_sort$fob10share),]         # re-sorts by totfob10share
EXPORTS_bigD=distinct(EXPORTS_sort2, k, .keep_all = TRUE)              # keeps top row, which should be biggest
destination country for each product
EXPORTS_sort = EXPORTS[order(-EXPORTS$fob10),]                         # sorts by totfob10 - to sort hsc10 level data
EXPORTS_sort2 = EXPORTS_sort[order(-EXPORTS_sort$v_global),] # re-sorts by v_global
EXPORTS_sort3 = EXPORTS_sort2[order(-EXPORTS_sort2$v_sharetotal),]# re-sorts by v_share
EXPORTS_bigJ=distinct(EXPORTS_sort3, k, .keep_all = TRUE)              # keeps top row, which should be biggest
global importer country for each product
EXPORTS = merge(x = EXPORTS_bigD, y = EXPORTS_bigJ, "k", all = TRUE)    # want full outer-join
EXPORTS$country_same=ifelse(EXPORTS$country.x==EXPORTS$country.y, 1, 0)
table(EXPORTS$country_same)
        # 2019: 0:82, 1:234 >> 316
# 74% of our concentrated HSC6 exports are also to world's biggest importers
```

```
# reduce EXPORTS to "same"
EXPORTS=EXPORTS[EXPORTS$country_same==1, ]        # n=234, 70 variables

EXPORTS = EXPORTS[ , c(1:31)]
colnames(EXPORTS) = c("k","subdiv","div","hsc10","hsc6","hsc2","country","hsc10description",
            "fob","fob10","fob10share","t","i","v","q","v_global","v_share","v_sharetotal",
            "v_NZ","v_sharesq","HHIwld","hsc2description","hsc6description","anzsic06","anzsic06description",
            "divdescription","subdivdescription","freq_subdiv","rank_subdiv","ioexportshare","rca")
                        #"fob17","fob18","fob20","fob21"
            # EXPORTS_=distinct(EXPORTS, hsc10, .keep_all = TRUE)          # n=234 (hsc10 distinct)
            # EXPORTS_=distinct(EXPORTS, hsc6, .keep_all = TRUE)           # n=234 (hsc6 distinct, same, ok)
            # sum(EXPORTS$fob)                                             # 700320851
```

# Appendix 3: Data files

This appendix sets out the data files used or created in the R code.

Where files are readily downloadable, internet links are provided. All minor data files are collated in a single excel file: “Data files for Appendix 3”. Some of these files are printed in this appendix in case this data file is lost.

## PART 1 - Filtering

### SNZ data files

https://www.stats.govt.nz/large-datasets/csv-files-for-download/overseas-merchandise-trade-datasets

Yearly datasets of imports and exports from 2015 onward – downloaded 3 Nov 2022

| | |
|---|---|
| 2017_Imports_HS10_by_Country | 2017_Exports_HS10_by_Country |
| 2018_Imports_HS10_by_Country | 2018_Exports_HS10_by_Country |
| 2019_Imports_HS10_by_Country | 2019_Exports_HS10_by_Country |
| 2020_Imports_HS10_by_Country | 2020_Exports_HS10_by_Country |

### BACI data files

http://www.cepii.fr/CEPII/en/bdd_modele/bdd_modele_item.asp?id=37

Downloaded 18 Oct 2022, version Jan 2022

| | |
|---|---|
| BACI_HS17_Y2017_V202201.csv | |
| BACI_HS17_Y2018_V202201.csv | |
| BACI_HS17_Y2019_V202201.csv | |
| BACI_HS17_Y2020_V202201.csv | |
| country_codes_V202201.csv | BACI_full country names.csv |
| product_codes_HS17_V202201.csv | BACI_product_codes_HS17_V202201.csv |

### HSC2 codes.csv

| hsc2 | hsc2description |
|---|---|
| 1 | Live animals |
| 2 | Meat and edible meat offal |
| 3 | Fish and crustaceans, molluscs and other aquatic invertebrates |
| 4 | Dairy produce; birds’ eggs; natural honey; edible products of animal origin, not elsewhere specified or included |
| 5 | Products of animal origin, not elsewhere specified or included |
| 6 | Live trees and other plants; bulbs, roots and the like; cut flowers and ornamental foliage |
| 7 | Edible vegetables and certain roots and tubers |
| 8 | Edible fruit and nuts; peel of citrus fruit or melons |
| 9 | Coffee, tea, mate and spices |
| 10 | Cereals |
| 11 | Products of the milling industry; malt; starches; inulin; wheat gluten |
| 12 | Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; industrial or medicinal plants ; straw and fodder |
| 13 | Lac; gums, resins and other vegetable saps and extracts |
| 14 | Vegetable plaiting materials; vegetable products not elsewhere specified or included |
| 15 | Animal or vegetable fats and oils and their cleavage products; prepared edible fats; animal or vegetable waxes |
| 16 | Preparations of meat, of fish or of crustaceans, molluscs or other aquatic invertebrates |
| 17 | Sugars and sugar confectionery |
| 18 | Cocoa and cocoa preparations |
| 19 | Preparations of cereals, flour, starch or milk; pastrycooks’ products |

| | |
|---|---|
| 20 | Preparations of vegetables, fruit, nuts or other parts of plants |
| 21 | Miscellaneous edible preparations |
| 22 | Beverages, spirits and vinegar |
| 23 | Residues and waste from the food industries; prepared animal fodder |
| 24 | Tobacco and manufactured tobacco substitutes |
| 25 | Salt; sulphur; earths and stone; plastering materials, lime and cement |
| 26 | Ores, slag and ash |
| 27 | Mineral fuels, mineral oils and products of their distillation; bituminous substances; mineral waxes |
| 28 | Inorganic chemicals; organic or inorganic compounds of precious metals, of rare-earth metals, of radioactive elements or of isotopes |
| 29 | Organic chemicals |
| 30 | Pharmaceutical products |
| 31 | Fertilisers |
| 32 | Tanning or dyeing extracts; tannins and their derivatives; dyes, pigments and other colouring matter; paints and varnishes; putty and other mastics; inks |
| 33 | Essential oils and resinoids; perfumery, cosmetic or toilet preparations |
| 34 | Soap, organic surface-active agents, washing preparations, lubricating preparations, artificial waxes, prepared waxes, polishing or scouring preparations, candles and similar articles, modelling pastes, “dental waxes” and dental preparations with a basis of plaster |
| 35 | Albuminoidal substances; modified starches; glues; enzymes |
| 36 | Explosives; pyrotechnic products; matches; pyrophoric alloys; certain combustible preparations |
| 37 | Photographic or cinematographic goods |
| 38 | Miscellaneous chemical products |
| 39 | Plastics and articles thereof |
| 40 | Rubber and articles thereof |
| 41 | Raw hides and skins (other than furskins) and leather |
| 42 | Articles of leather; saddlery and harness; travel goods, handbags and similar containers; articles of animal gut (other than silk-worm gut) |
| 43 | Furskins and artificial fur; manufactures thereof |
| 44 | Wood and articles of wood; wood charcoal |
| 45 | Cork and articles of cork |
| 46 | Manufactures of straw, of esparto or of other plaiting materials; basketware and wickerwork |
| 47 | Pulp of wood or of other fibrous cellulosic material; waste and scrap of paper or paperboard |
| 48 | Paper and paperboard; articles of paper pulp, of paper or of paperboard |
| 49 | Printed books, newspapers, pictures and other products of the printing industry; manuscripts, typescripts and plans |
| 50 | Silk |
| 51 | Wool, fine or coarse animal hair; horsehair yarn and woven fabric |
| 52 | Cotton |
| 53 | Other vegetable textile fibres; paper yarn and woven fabrics of paper yarn |
| 54 | Sewing thread of man-made filaments, whether or not put up for retail sale |
| 55 | Man-made staple fibres |
| 56 | Wadding, felt and nonwovens; special yarns; twine, cordage, ropes and cables and articles thereof |
| 57 | Carpets and other textile floor coverings |
| 58 | Special woven fabrics; tufted textile fabrics; lace; tapestries; trimmings; embroidery |
| 59 | Impregnated, coated, covered or laminated textile fabrics; textile articles of a kind suitable for industrial use |
| 60 | Knitted or crocheted fabrics |
| 61 | Articles of apparel and clothing accessories, knitted or crocheted |
| 62 | Articles of apparel and clothing accessories, not knitted or crocheted |
| 63 | Other made up textile articles; sets; worn clothing and worn textile articles; rags |
| 64 | Footwear, gaiters and the like; parts of such articles |
| 65 | Headgear and parts thereof |
| 66 | Umbrellas, sun umbrellas, walking-sticks, seat-sticks, whips, riding-crops and parts thereof |
| 67 | Prepared feathers and down and articles made of feathers or of down; artificial flowers; articles of human hair |
| 68 | Articles of stone, plaster, cement, asbestos, mica or similar materials |
| 69 | Ceramic products |
| 70 | Glass and glassware |
| 71 | Natural or cultured pearls, precious or semi-precious stones, precious metals, metals clad with precious metal, and articles thereof; imitation jewellery; coin |
| 72 | Iron and steel |
| 73 | Articles of iron or steel |
| 74 | Copper and articles thereof |
| 75 | Nickel and articles thereof |
| 76 | Aluminium and articles thereof |
| 78 | Lead and articles thereof |

| | |
|---|---|
| 79 | Zinc and articles thereof |
| 80 | Tin and articles thereof |
| 81 | Other base metals; cermets; articles thereof |
| 82 | Tools, implements, cutlery, spoons and forks, of base metal; parts thereof of base metal |
| 83 | Miscellaneous articles of base metal |
| 84 | Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof |
| 85 | Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles |
| 86 | Railway or tramway locomotives, rolling-stock and parts thereof; railway or tramway track fixtures and fittings and parts thereof; mechanical (including electro-mechanical) traffic signalling equipment of all kinds |
| 87 | Vehicles other than railway or tramway rolling-stock, and parts and accessories thereof |
| 88 | Aircraft, spacecraft, and parts thereof |
| 89 | Ships, boats and floating structures |
| 90 | Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus; parts and accessories thereof |
| 91 | Clocks and watches and parts thereof |
| 92 | Musical instruments; parts and accessories of such articles |
| 93 | Arms and ammunition; parts and accessories thereof |
| 94 | Furniture; bedding, mattresses, mattress supports, cushions and similar stuffed furnishings; lamps and lighting fittings, not elsewhere specified or included; illuminated signs, illuminated name-plates and the like; prefabricated buildings |
| 95 | Toys, games and sports requisites; parts and accessories thereof |
| 96 | Miscellaneous manufactured articles |
| 97 | Works of art, collectors' pieces, and antiques |

### ISO2_BACI_CREATED.csv

| iso2 | country | | | | | | |
|---|---|---|---|---|---|---|---|
| AF | Afghanistan | DK | Denmark | LY | Libya | PM | Saint Pierre and Miquelon |
| AL | Albania | DJ | Djibouti | LI | Liechtenstein | VC | Saint Vincent and the Grenadines |
| DZ | Algeria | DM | Dominica | LT | Lithuania | WS | Samoa |
| AS | American Samoa | DO | Dominican Republic | LU | Luxembourg | SM | San Marino |
| AD | Andorra | EC | Ecuador | MG | Madagascar | ST | Sao Tome and Principe |
| AO | Angola | EG | Egypt | MW | Malawi | SA | Saudi Arabia |
| AI | Anguilla | SV | El Salvador | MY | Malaysia | SN | Senegal |
| AQ | Antarctica | GP | Equatorial Guinea | MV | Maldives | RS | Serbia |
| AG | Antigua and Barbuda | ER | Eritrea | ML | Mali | ME | Montenegro |
| AR | Argentina | EE | Estonia | MT | Malta | SC | Seychelles |
| AM | Armenia | ET | Ethiopia | MH | Marshall Islands | SL | Sierra Leone |
| AW | Aruba | FO | Faeroe Islands | MQ | Martinique | SG | Singapore |
| AU | Australia | FK | Falkland Islands (Malvinas) | MR | Mauritania | SK | Slovakia |
| AT | Austria | FM | Federated State of Micronesia | MU | Mauritius | SI | Slovenia |
| AZ | Azerbaijan | FJ | Fiji | YT | Mayotte | SB | Solomon Islands |
| BS | Bahamas | FI | Finland | MX | Mexico | SO | Somalia |
| BH | Bahrain | SD | Former Sudan | MC | Monaco | ZA | South Africa |
| BD | Bangladesh | FR | France, Monaco | MN | Mongolia | GS | South Georgia and the South Sandwich Islands |
| BB | Barbados | GF | French Guiana | MS | Montserrat | SS | South Sudan |
| BY | Belarus | PF | French Polynesia | MA | Morocco | ES | Spain |
| BE | Belgium | TF | French Southern Territories | MZ | Mozambique | LK | Sri Lanka |
| BZ | Belize | GA | Gabon | MM | Myanmar | PS | State of Palestine |
| BJ | Benin | GM | Gambia | NB | Namibia | SR | Suriname |
| BM | Bermuda | GE | Georgia | NR | Nauru | SZ | Swaziland |
| BT | Bhutan | DE | Germany | NP | Nepal | SE | Sweden |
| BA | Bosnia Herzegovina | GH | Ghana | NL | Netherlands | CH | Switzerland, Liechtenstein |
| BW | Botswana | GR | Greece | NC | New Caledonia | SY | Syria |
| BR | Brazil | GL | Greenland | NZ | New Zealand | TW | Other Asia, not elsewhere specified |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| IO | British Indian Ocean Territories | GD | Grenada | NI | Nicaragua | TJ | Tajikistan |
| VG | British Virgin Islands | GU | Guam | NE | Niger | TH | Thailand |
| BN | Brunei Darussalam | GT | Guatemala | NG | Nigeria | MK | The Former Yugoslav Republic of Macedonia |
| BG | Bulgaria | GN | Guinea | NU | Niue | TL | Timor-Leste |
| BF | Burkina Faso | GW | Guinea-Bissau | NF | Norfolk Islands | TG | Togo |
| BI | Burundi | GY | Guyana | MP | Northern Mariana Islands | TK | Tokelau |
| CV | Cabo Verde | HT | Haiti | NO | Norway, Svalbard and Jan Mayen | TO | Tonga |
| KH | Cambodia | HN | Honduras | OM | Oman | TT | Trinidad and Tobago |
| CM | Cameroon | HU | Hungary | PK | Pakistan | TN | Tunisia |
| CA | Canada | IS | Iceland | PW | Palau | TR | Turkey |
| KY | Cayman Islands | IN | India | PA | Panama | TM | Turkmenistan |
| CF | Central African Republic | ID | Indonesia | PG | Papua New Guinea | TC | Turks and Caicos Islands |
| TD | Chad | IR | Iran | PY | Paraguay | TV | Tuvalu |
| CL | Chile | IQ | Iraq | PE | Peru | UG | Uganda |
| CN | China | ND | Ireland | PH | Philippines | UA | Ukraine |
| HK | China, Hong Kong Special Administrative Region | IL | Israel | PN | Pitcairn | AE | United Arab Emirates |
| MO | China, Macao Special Administrative Region | IT | Italy | BO | Plurinational State of Bolivia | GB | United Kingdom |
| CX | Christmas Islands | JM | Jamaica | PL | Poland | TZ | United Republic of Tanzania |
| CC | Cocos Islands | JP | Japan | PT | Portugal | UM | United States Minor Outlying Islands |
| CO | Colombia | JO | Jordan | PR | Puerto Rico | UY | Uruguay |
| KM | Comoros | KZ | Kazakhstan | QA | Qatar | US | USA, Puerto Rico and US Virgin Islands |
| CG | Congo | KE | Kenya | KR | Republic of Korea | UZ | Uzbekistan |
| CK | Cook Islands | KI | Kiribati | MD | Republic of Moldova | VU | Vanuatu |
| CR | Costa Rica | KW | Kuwait | RE | Reunion | VE | Venezuela |
| CI | Cote d'Ivoire | KG | Kyrgyzstan | RO | Romania | VN | Viet Nam |
| HR | Croatia | LA | Lao People's Dem. Rep. | RU | Russian Federation | VI | Virgin Islands, United States |
| CU | Cuba | LV | Latvia | RW | Rwanda | WF | Wallis and Futuna Islands |
| CY | Cyprus | LB | Lebanon | SH | Saint Helena | YE | Yemen |
| CZ | Czechia | LS | Lesotho | KN | Saint Kitts and Nevis | ZM | Zambia |
| CD | Democratic Republic of the Congo | LR | Liberia | LC | Saint Lucia | ZW | Zimbabwe |

### ISO2_SNZ_HS10_CREATED.csv

| iso2 | country | | | | | | |
|---|---|---|---|---|---|---|---|
| AF | Afghanistan | DO | Dominican Republic | LI | Liechtenstein | SM | San Marino |
| AL | Albania | EC | Ecuador | LT | Lithuania | ST | Sao Tome and Principe |
| DZ | Algeria | EG | Egypt | LU | Luxembourg | SA | Saudi Arabia |
| AD | Andorra | SV | El Salvador | MO | Macau (Special Administrative Region) | SN | Senegal |
| AO | Angola | ER | Eritrea | MG | Madagascar | RS | Serbia |
| AI | Anguilla | EE | Estonia | MW | Malawi | SC | Seychelles |
| AQ | Antarctica | SZ | Eswatini | MY | Malaysia | SL | Sierra Leone |
| AG | Antigua and Barbuda | ET | Ethiopia | MV | Maldives | SG | Singapore |
| AR | Argentina | FO | Faeroe Islands | ML | Mali | SK | Slovakia |
| AM | Armenia | FK | Falkland Islands | MT | Malta | SI | Slovenia |
| AW | Aruba | FJ | Fiji | MH | Marshall Islands | SB | Solomon Islands |
| AU | Australia | FI | Finland | MQ | Martinique | SO | Somalia |
| AT | Austria | FR | France | MR | Mauritania | ZA | South Africa |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| AZ | Azerbaijan | GF | French Guiana | MU | Mauritius | GS | South Georgia and the South Sandwich Islands |
| BS | Bahamas | PF | French Polynesia | YT | Mayotte | SS | South Sudan |
| BH | Bahrain | TF | French Southern Territories | MX | Mexico | ES | Spain |
| BD | Bangladesh | GA | Gabon | FM | Micronesia, Federated States of | LK | Sri Lanka |
| BB | Barbados | GM | Gambia | MD | Moldova | SH | St Helena |
| BY | Belarus | PS | Gaza Strip/Palestine/West Bank | MC | Monaco | KN | St Kitts and Nevis |
| BE | Belgium | GE | Georgia | MN | Mongolia | LC | St Lucia |
| BZ | Belize | DE | Germany | ME | Montenegro | PM | St Pierre and Miquelon |
| BJ | Benin | GH | Ghana | MS | Montserrat | VC | St Vincent and the Grenadines |
| BM | Bermuda | GR | Greece | MA | Morocco | SD | Sudan |
| BT | Bhutan | GL | Greenland | MZ | Mozambique | SR | Suriname |
| BO | Bolivia | GD | Grenada | MM | Myanmar | SE | Sweden |
| BA | Bosnia and Herzegovina | GP | Guadeloupe | NB | Namibia | CH | Switzerland |
| BW | Botswana | GU | Guam | NR | Nauru | SY | Syria |
| BR | Brazil | GT | Guatemala | NP | Nepal | TW | Taiwan |
| IO | British Indian Ocean Territory | GN | Guinea | NL | Netherlands | TJ | Tajikistan |
| BN | Brunei Darussalam | GW | Guinea-Bissau | NC | New Caledonia | TZ | Tanzania |
| BG | Bulgaria | GY | Guyana | NZ | New Zealand | TH | Thailand |
| BF | Burkina Faso | HT | Haiti | NI | Nicaragua | TL | Timor-Leste |
| BI | Burundi | HN | Honduras | NE | Niger | TG | Togo |
| CV | Cabo Verde | HK | Hong Kong (Special Administrative Region) | NG | Nigeria | TK | Tokelau |
| KH | Cambodia | HU | Hungary | NU | Niue | TO | Tonga |
| CM | Cameroon | IS | Iceland | NF | Norfolk Island | TT | Trinidad and Tobago |
| CA | Canada | IN | India | MK | North Macedonia | TN | Tunisia |
| KY | Cayman Islands | ID | Indonesia | MP | Northern Mariana Islands | TR | Turkey |
| CF | Central African Republic | IR | Iran | NO | Norway | TM | Turkmenistan |
| TD | Chad | IQ | Iraq | OM | Oman | TC | Turks and Caicos Islands |
| CL | Chile | ND | Ireland | PK | Pakistan | TV | Tuvalu |
| CN | China, People's Republic of | IL | Israel | PW | Palau | UG | Uganda |
| CX | Christmas Island | IT | Italy | PA | Panama | UA | Ukraine |
| CC | Cocos (Keeling) Islands | JM | Jamaica | PG | Papua New Guinea | AE | United Arab Emirates |
| CO | Colombia | JP | Japan | PY | Paraguay | GB | United Kingdom |
| KM | Comoros | JO | Jordan | PE | Peru | UM | United States Minor Outlying Islands |
| CG | Congo | KZ | Kazakhstan | PH | Philippines | US | United States of America |
| CD | Congo, the Democratic Republic of the | KE | Kenya | PN | Pitcairn | UY | Uruguay |
| CK | Cook Islands | KI | Kiribati | PL | Poland | UZ | Uzbekistan |
| CR | Costa Rica | KR | Korea, Republic of | PT | Portugal | VU | Vanuatu |
| CI | Cote D'Ivoire | KW | Kuwait | PR | Puerto Rico | VE | Venezuela |
| HR | Croatia | KG | Kyrgyzstan | QA | Qatar | VN | Viet Nam |
| CU | Cuba | LA | Laos | RE | Reunion | VG | Virgin Islands, British |
| CY | Cyprus | LV | Latvia | RO | Romania | VI | Virgin Islands, United States |
| CZ | Czechia | LB | Lebanon | RU | Russia | WF | Wallis and Futuna |
| DK | Denmark | LS | Lesotho | RW | Rwanda | YE | Yemen |
| DJ | Djibouti | LR | Liberia | WS | Samoa | ZM | Zambia |
| DM | Dominica | LY | Libya | AS | Samoa, American | ZW | Zimbabwe |

**BEC convergence.csv**

https://unstats.un.org/unsd/classifications/Econ#Correspondences

| | |
|---|---|
| HS2012-17- BEC5_08_Nov_2018, sheet 2 (hs2017) | BEC convergence.csv |

## PART 2 – Industry mapping

### anzsic codes.csv

https://aria.stats.govt.nz/aria/#ConcordanceSearch:q=nzhsc%2520v17%2520to%2520anzsic06&fl=name,source,target&sort=relevance-&start=20&rows=20

| | |
|---|---|
| NZHSC v17.05 to Predom ANZSIC06 v1.0 | anzsic codes.csv |

### anzsic division.csv

| div | divdescription |
|---|---|
| A | Agriculture, Forestry and Fishing |
| B | Mining |
| C | Manufacturing |
| D | Electricity, Gas, Water and Waste Services |
| E | Construction |
| F | Wholesale Trade |
| G | Retail Trade |
| H | Accommodation and Food Services |
| I | Transport, Postal and Warehousing |
| J | Information Media and Telecommunications |
| K | Financial and Insurance Services |
| L | Rental, Hiring and Real Estate Services |
| M | Professional, Scientific and Technical Services |
| N | Administrative and Support Services |
| O | Public Administration and Safety |
| P | Education and Training |
| Q | Health Care and Social Assistance |
| R | Arts and Recreation Services |
| S | Other Services |

### anzsic sub-division.csv

| subdiv | subdivdescription | | |
|---|---|---|---|
| 1 | Agriculture | 44 | Accommodation |
| 2 | Aquaculture | 45 | Food and Beverage Services |
| 3 | Forestry and Logging | 46 | Road Transport |
| 4 | Fishing, Hunting and Trapping | 47 | Rail Transport |
| 5 | Agriculture, Forestry and Fishing Support Services | 48 | Water Transport |
| 6 | Coal Mining | 49 | Air and Space Transport |
| 7 | Oil and Gas Extraction | 50 | Other Transport |
| 8 | Metal Ore Mining | 51 | Postal and Courier Pick-up and Delivery Services |
| 9 | Non-Metallic Mineral Mining and Quarrying | 52 | Transport Support Services |
| 10 | Exploration and Other Mining Support Services | 53 | Warehousing and Storage Services |
| 11 | Food Product Manufacturing | 54 | Publishing (except Internet and Music Publishing) |
| 12 | Beverage and Tobacco Product Manufacturing | 55 | Motion Picture and Sound Recording Activities |
| 13 | Textile, Leather, Clothing and Footwear Manufacturing | 56 | Broadcasting (except Internet) |
| 14 | Wood Product Manufacturing | 57 | Internet Publishing and Broadcasting |
| 15 | Pulp, Paper and Converted Paper Product Manufacturing | 58 | Telecommunications Services |
| 16 | Printing (including the Reproduction of Recorded Media) | 59 | Internet Service Providers, Web Search Portals and Data Processing Services |
| 17 | Petroleum and Coal Product Manufacturing | 60 | Library and Other Information Services |
| 18 | Basic Chemical and Chemical Product Manufacturing | 62 | Finance |
| 19 | Polymer Product and Rubber Product Manufacturing | 63 | Insurance and Superannuation Funds |

| | | | |
|---|---|---|---|
| 20 | Non-Metallic Mineral Product Manufacturing | 64 | Auxiliary Finance and Insurance Services |
| 21 | Primary Metal and Metal Product Manufacturing | 66 | Rental and Hiring Services (except Real Estate) |
| 22 | Fabricated Metal Product Manufacturing | 67 | Property Operators and Real Estate Services |
| 23 | Transport Equipment Manufacturing | 69 | Professional, Scientific and Technical Services (Except Computer System Design and Related Services) |
| 24 | Machinery and Equipment Manufacturing | 70 | Computer System Design and Related Services |
| 25 | Furniture and Other Manufacturing | 72 | Administrative Services |
| 26 | Electricity Supply | 73 | Building Cleaning, Pest Control and Other Support Services |
| 27 | Gas Supply | 75 | Public Administration |
| 28 | Water Supply, Sewerage and Drainage Services | 76 | Defence |
| 29 | Waste Collection, Treatment and Disposal Services | 77 | Public Order, Safety and Regulatory Services |
| 30 | Building Construction | 80 | Preschool and School Education |
| 31 | Heavy and Civil Engineering Construction | 81 | Tertiary Education |
| 32 | Construction Services | 82 | Adult, Community and Other Education |
| 33 | Basic Material Wholesaling | 84 | Hospitals |
| 34 | Machinery and Equipment Wholesaling | 85 | Medical and Other Health Care Services |
| 35 | Motor Vehicle and Motor Vehicle Parts Wholesaling | 86 | Residential Care Services |
| 36 | Grocery, Liquor and Tobacco Product Wholesaling | 87 | Social Assistance Services |
| 37 | Other Goods Wholesaling | 89 | Heritage Activities |
| 38 | Commission-Based Wholesaling | 90 | Creative and Performing Arts Activities |
| 39 | Motor Vehicle and Motor Vehicle Parts Retailing | 91 | Sports and Recreation Activities |
| 40 | Fuel Retailing | 92 | Gambling Activities |
| 41 | Food Retailing | 94 | Repair and Maintenance |
| 42 | Other Store-Based Retailing | 95 | Personal and Other Services |
| 43 | Non-Store Retailing and Retail Commission Based Buying and/or Selling | 96 | Private Households Employing Staff and Undifferentiated Goods- and Service-Producing Activities of Households for Own Use |

### HS to CPC code.csv

https://aria.stats.govt.nz/aria/#ConcordanceSearch:q=nzhsc%2520v17%2520to%2520anzsic06&fl=name,source,target&sort=relevance-&start=20&rows=20

| HSC17 > CPC > NACC | Files created: |
|---|---|
| SNZ NZHSC V17.05 to Predominant CPC V2.0V1.0.0 | **HS to CPC code.csv** |
| SNZ NA06CC V4.0 to CPC V2.0 | **CPC to NACC code.csv** |

### Data files created from 2020 IO tables

https://www.stats.govt.nz/information-releases/national-accounts-input-output-tables-year-ended-march-2020/

https://www.stats.govt.nz/assets/Uploads/National-accounts-input-output-tables/National-accounts-input-output-tables-Year-ended-March-2020/Download-data/national-accounts-input-output-tables-year-ended-march-2020-revised-22-december-2021.xlsx

| | Files created: |
|---|---|
| Sheet: Industry groupings (Concordance 1) | **nzsioc to io table industry groups.csv** |
| Sheet: NZSIOC to ANZSIC06 (Concordance 2) | **anzsic to nzsioc.csv** |
| Sheet: Product groupings (Concordance 3) | **nacc to io products.csv**<br>**io product to industry.csv**<br>**io product to main industry.csv**<br>**io industry to product.csv** |
| Sheet: NA06CC to CPC (Concordance 4) | **X** (used alternative SNZ aria source above) |

| | |
|---|---|
| **io import share.csv** | "Total basic prices" from table 3 (imports) row 206 / "Total basic prices" from table 2 (use) row 206 |
| **io import coeffient.csv** | Table 9 (Import coefficient), row 205 |
| **io export share.csv** | "Exports" from table 6 (ult. disposition) row B / "Total" from table 6 (ult. disposition) row K, which is also equiv to row 206 table 1 (supply) |

## io import share.csv

| ioindustry | ioimportshare | | |
|---|---|---|---|
| Petroleum and coal product manufacturing | 0.787718098 | Basic material wholesaling | 0.123309649 |
| Transport equipment manufacturing | 0.75566232 | Building cleaning, pest control, and other support services | 0.119047619 |
| Clothing, knitted products, and footwear manufacturing | 0.43495935 | Publishing (except internet and music publishing) | 0.118095238 |
| Electronic and electrical equipment manufacturing | 0.404824561 | Public order, safety, and regulatory services | 0.117881756 |
| Defence | 0.378410439 | Heritage and artistic activities | 0.115436242 |
| Polymer product and rubber product manufacturing | 0.376652987 | Warehousing and storage services | 0.11509716 |
| Primary metal and metal product manufacturing | 0.370445344 | Adult, community, and other education | 0.115012107 |
| Other manufacturing | 0.342323651 | Agriculture, forestry, and fishing support services | 0.114486847 |
| Machinery manufacturing | 0.33539823 | Library and other information services | 0.113207547 |
| Fertiliser and pesticide manufacturing | 0.300658979 | Pharmaceutical and other store based retailing | 0.11286844 |
| Pharmaceutical, cleaning, and other chemical manufacturing | 0.300414938 | Gambling activities | 0.110955056 |
| Furniture manufacturing | 0.267515924 | Water transport | 0.110328638 |
| Hospitals | 0.264341085 | Motion picture and sound recording activities | 0.110198494 |
| Veterinary and other professional services | 0.262345679 | Advertising, market research, and management services | 0.108708025 |
| Poultry, deer, and other livestock farming | 0.240973971 | Employment and other administrative services | 0.108352728 |
| Rail transport | 0.233151184 | Horticulture and fruit growing | 0.10741688 |
| Air and space transport | 0.226663689 | Oil and gas extraction | 0.106283941 |
| Telecommunications services | 0.224976759 | Residential care services and social assistance | 0.103274559 |
| Fabricated metal product manufacturing | 0.220541036 | Exploration and other mining support services | 0.101538462 |
| Repair and maintenance | 0.2172949 | Specialised food retailing | 0.098173516 |
| Fruit, oil, cereal, and other food product manufacturing | 0.21653615 | Scientific, architectural, and engineering services | 0.095238095 |
| Broadcasting and internet publishing | 0.212822796 | Heavy and civil engineering construction | 0.092042385 |
| Printing | 0.21242236 | Wood product manufacturing | 0.091980528 |
| Motor vehicle retailing, including parts | 0.21132457 | Central government administration services | 0.09016557 |
| Beverage and tobacco product manufacturing | 0.208355229 | Travel agency and tour arrangement services | 0.088467615 |
| Non-financial asset leasing | 0.198726115 | Sewerage and drainage services | 0.085051546 |
| Motor vehicle wholesaling, including parts | 0.196319018 | Legal and accounting services | 0.082063882 |
| Construction services | 0.193137896 | Religious services; civil, professional, and other interest groups | 0.07769276 |
| Fishing and aquaculture | 0.192073171 | Internet service providers, web search portals and data processing services | 0.075987842 |
| Non-metallic mineral product manufacturing | 0.190638713 | Non-residential building construction | 0.070834353 |
| Rental and hiring services (except real estate) | 0.188600556 | Grocery, liquor, and tobacco product wholesaling | 0.070711785 |
| Dairy cattle farming | 0.176556349 | Residential building construction | 0.068414122 |
| Fuel retailing | 0.173333333 | Owner-occupied property operation | 0.06695279 |
| Accommodation | 0.161527166 | Transport support services | 0.066634003 |
| Basic chemical and basic polymer manufacturing | 0.160071942 | Life insurance | 0.066610455 |

| | | | |
|---|---|---|---|
| Medical and other health care services | 0.159223301 | Non-store and commission based retailing | 0.065645514 |
| Metal ore and non-metallic mineral mining and quarrying | 0.153748412 | Waste collection, treatment, and disposal services | 0.065373563 |
| Pulp, paper, and converted paper product manufacturing | 0.153731898 | Auxiliary finance and insurance services | 0.064150943 |
| Road transport | 0.152828136 | Recreational, clothing, footwear, and personal accessory retailing | 0.063756064 |
| Sport and recreation services | 0.15171504 | Furniture, electrical, and hardware retailing | 0.062726176 |
| Computer system design and related services | 0.150380022 | Supermarket and grocery stores | 0.06068268 |
| Personal services; domestic household staff | 0.149479659 | Department stores | 0.057537399 |
| School education | 0.147558386 | Non-residential property operation | 0.055300947 |
| Coal mining | 0.145762712 | Local government administration services | 0.055016181 |
| Textile and leather manufacturing | 0.144444444 | Residential property operation | 0.051256614 |
| Machinery and equipment wholesaling | 0.143911439 | Banking and financing; financial asset investing | 0.050340136 |
| Seafood processing | 0.143236074 | Postal and courier services | 0.048675734 |
| Health and general insurance | 0.14139983 | Meat and meat product manufacturing | 0.047423084 |
| Other goods and commission based wholesaling | 0.139897929 | Electricity transmission and distribution | 0.045129334 |
| Food and beverage services | 0.139633286 | Dairy product manufacturing | 0.038536512 |
| Preschool education | 0.137176938 | Real estate services | 0.037339972 |
| Other transport | 0.135198135 | Gas and water supply | 0.035347777 |
| Tertiary education | 0.132008155 | Forestry and logging | 0.028771175 |
| Sheep, beef cattle, and grain farming | 0.13198935 | Superannuation and individual pension services | 0.020648968 |
| | | Electricity generation and on-selling | 0.017696084 |

### anzsic subdiv ioexportshare.csv

| ioindustry | ioexportshare | | |
|---|---|---|---|
| Agriculture | 0.752464123 | Other Store-Based Retailing | 0.1060927 |
| Aquaculture | 0.770032573 | Non-Store Retailing and Retail Commission Based Buying and/or Selling | 0.139400922 |
| Forestry and Logging | 0.766721946 | Accommodation | 0.522775549 |
| Fishing, Hunting and Trapping | 0.643987342 | Food and Beverage Services | 0.236578116 |
| Coal Mining | 0.63960396 | Road Transport | 0.421125119 |
| Oil and Gas Extraction | 0.481841064 | Rail Transport | 0.391369048 |
| Metal Ore Mining | 0.514002334 | Water Transport | 0.345714286 |
| Exploration and Other Mining Support Services | 0.376181474 | Air and Space Transport | 0.516892418 |
| Food Product Manufacturing | 0.713881967 | Other Transport | 0.425339367 |
| Beverage and Tobacco Product Manufacturing | 0.490188819 | Postal and Courier Pick-up and Delivery Services | 0.297969333 |
| Textile, Leather, Clothing and Footwear Manufacturing | 0.623500519 | Transport Support Services | 0.392605381 |
| Wood Product Manufacturing | 0.443092341 | Warehousing and Storage Services | 0.445894091 |
| Pulp, Paper and Converted Paper Product Manufacturing | 0.591234347 | Publishing (except Internet and Music Publishing) | 0.259873618 |
| Printing (including the Reproduction of Recorded Media) | 0.253396739 | Motion Picture and Sound Recording Activities | 0.475011899 |
| Petroleum and Coal Product Manufacturing | 0.341338854 | Broadcasting (except Internet) | 0.219366408 |
| Basic Chemical and Chemical Product Manufacturing | 0.590801397 | Telecommunications Services | 0.200496757 |
| Polymer Product and Rubber Product Manufacturing | 0.487165775 | Internet Service Providers, Web Search Portals and Data Processing Services | 0.266898955 |
| Non-Metallic Mineral Product Manufacturing | 0.221052632 | Library and Other Information Services | 0.036745407 |
| Primary Metal and Metal Product Manufacturing | 0.547492295 | Finance | 0.226227145 |
| Fabricated Metal Product Manufacturing | 0.255179457 | Insurance and Superannuation Funds | 0.063664087 |
| Transport Equipment Manufacturing | 0.361338638 | Auxiliary Finance and Insurance Services | 0.192969554 |
| Machinery and Equipment Manufacturing | 0.438481632 | Rental and Hiring Services (except Real Estate) | 0.357152845 |
| Furniture and Other Manufacturing | 0.271390762 | Property Operators and Real Estate Services | 0.125841365 |
| Electricity Supply | 0.225980369 | Professional, Scientific and Technical Services (Except Computer System Design and Related Services) | 0.259206285 |

| | | | |
|---|---|---|---|
| Gas Supply | 0.266977364 | Computer System Design and Related Services | 0.280920162 |
| Water Supply, Sewerage and Drainage Services | 0.066233766 | Administrative Services | 0.361814734 |
| Waste Collection, Treatment and Disposal Services | 0.162318841 | Building Cleaning, Pest Control and Other Support Services | 0.330706781 |
| Building Construction | 0.051057886 | Public Administration | 0.025375129 |
| Heavy and Civil Engineering Construction | 0.034606123 | Defence | 0.01952013 |
| Construction Services | 0.089064458 | Public Order, Safety and Regulatory Services | 0.07550969 |
| Basic Material Wholesaling | 0.368567843 | Preschool and School Education | 0.037071949 |
| Machinery and Equipment Wholesaling | 0.274812232 | Tertiary Education | 0.254719721 |
| Motor Vehicle and Motor Vehicle Parts Wholesaling | 0.257306889 | Adult, Community and Other Education | 0.281469476 |
| Grocery, Liquor and Tobacco Product Wholesaling | 0.307494647 | Hospitals | 0.008324257 |
| Other Goods Wholesaling | 0.335531739 | Medical and Other Health Care Services | 0.013521713 |
| Motor Vehicle and Motor Vehicle Parts Retailing | 0.148928571 | Residential Care Services | 0.021624074 |
| Fuel Retailing | 0.136653895 | Heritage Activities | 0.225188624 |
| Food Retailing | 0.124366996 | Sports and Recreation Activities | 0.14465739 |
| | | Gambling Activities | 0.119693095 |