TOWARDS THE MODELLING OF CHANGES IN NEW ZEALAND'S SANITARY AND PHYTOSANITARY MEASURES

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Abstract

Non-tariff measures (NTMs), both sanitary and phytosanitary (SPS) measures and technical barriers to trade (TBTs), are widely understood to influence trade flows. Modelling the effect of these measures has long been a challenge due to the absence of detailed information on individual country regulations constituting non-tariff measures. However, current efforts to improve data in this area, including a multi-country project led by UNCTAD, will help to fill this gap and facilitate improved future modelling and analysis.

The current paper uses preliminary NTM data for New Zealand, from the UNCTAD-led project, to explore potential impacts of expanding the number of countries having access to export fruit and vegetables to New Zealand. Our focus is the regime established under the Biosecurity Act 1993, whereby animal and plant products that may present a biosecurity risk for the introduction of pests and diseases cannot be imported until a risk analysis assessment, consistent with international standards, has been completed. This process, triggered by a request from a country interested in exporting the product, involves the development of an import health standard that aims to mitigate the risk associated with importing that product. Specifically, we propose indices to measure the extent to which potential fruit and vegetable imports from individual countries are constrained by the absence of import health standards for some of their exports. We then use these indices to calculate estimated bilateral trade if import health standards were extended to cover all countries and implement these in the GTAP framework to obtain overall changes in fruit and vegetable imports to New Zealand.

1. INTRODUCTION

Non-tariff measures, both sanitary and phytosanitary (SPS) measures and technical barriers to trade (TBTs), are widely understood to influence trade flows. Modelling the effect of these measures, however, has long been a challenge due to the absence of detailed information on individual country regulations constituting non-tariff measures.

A growing body of work is focused on estimating the *ad valorem* equivalent of non-tariff measures (NTMs) (see, for instance, Vanzetti et al. 2015). One issue with modelling NTMs, however, is that they may prevent trade entirely for some products from some countries. In some ways this is analogous to a prohibitive tariff (for a discussion of prohibitive tariffs in the GTAP framework see Brockmeier et al 2006), however, the archetypical prohibitive tariff prevents trade from all countries to protect domestic producers.

While some NTMs prevent trade from all countries, a particularly interesting case is where the effect of the NTM is that only some countries are able to export. This can occur for a variety of reasons, for instance a certification requirement might specify particular laboratories for which it is only feasible that some countries can utilize, or information might be required that can only be provided in some countries. In an extreme – but transparent – case, an importing country may restrict imports to countries that are free from, or have proven that they can mitigate the risks of transmitting, pests or diseases.

We focus on a particular aspect of the New Zealand SPS regime whereby animal and plant products that may present a biosecurity risk for the introduction of pests and diseases cannot be imported until a risk analysis assessment, consistent with international standards, has been completed. These requiredimport health standards do not currently cover all fruit and vegetables from all of New Zealand's trading partners, providing an opportunity to explore the impacts of changes in this regime.

2. SPS MEASURES AND THE NEW ZEALAND CONTEXT

Under the World Trade Organization's SPS Agreement, countries are able to set their own measures for food safety and animal and plant health, which should be based on: recognized

international standards; science, including a scientific approach and a temporary precautionary principle in the absence of international standards or scientific evidence.[1] In New Zealand, which is free of many diseases and pests affecting international animal and plant product trade, animal and plant products that may present a biosecurity risk for the introduction of pests and diseases cannot be imported until a risk analysis assessment, consistent with international standards, has been completed. In terms of New Zealand's SPS measures, the principal Act establishing New Zealand's SPS regime is the Biosecurity Act 1993. Under this Act, animal and plant products that may present a biosecurity risk for the introduction of pests and diseases cannot be imported until a risk analysis assessment, consistent with international standards, has been completed.[2] This process, triggered by a request from a country interested in exporting the product, involves the development of an import health standard that mitigates the risk associated with importing that product; pursuant to the New Zealand Biosecurity Act 1993. There are approximately 200 import health standards that cover a particular commodity or category of commodity; these may be generic, covering all countries, or country-specific.[3]

3. BUILDING A DATABASE OF NEW ZEALAND SPS MEASURES

Following the approach developed by UNCTAD (UNCTAD 2013 and UNCTAD 2014), we compiled detailed information on New Zealand's NTMs.[4] Non-tariff measures may be thought of as policy measures that exclude tariffs, but may have an impact on international trade in goods and services; it is important to note that "the classification does not judge on legitimacy, adequacy, necessity or discrimination of any form of policy intervention used in international trade" (UNCTAD, 2013). In the current study, we focus on a subset of the data collected for New Zealand.

[1] See https://www.wto.org/english/thewto_e/whatis_e/tif_e/agrm4_e.htm

[2] The rationale for this is that New Zealand's geographic isolation and biosecurity measures have meant that it is free from many OIE (World Organization for Animal Health) listed diseases that are common throughout much of the world. See the WTO Trade Policy Review of New Zealand 2009, particularly the Record of Meeting with Questions and Answers from Members. http://www.wto.org/english/tratop_e/tpr_e/tp_rep_e.htm .

[3] See http://www.mpi.govt.nz/importing/overview/import-health-standards/

[4] Two authors of the current study contributed the New Zealand NTM data to the UNCTAD-led research multi-country project. This significant international data collation initiative covers a range of countries, in addition to New Zealand, offering important opportunities for future research and modelling of NTMs.

As shown in table 1, sanitary and phytosanitary measures form one of the 16 Chapters in the Classification developed by UNCTAD and the Multi-Agency Support Team (MAST). Within each chapter, there is a hierarchy of classification, for instance the grouping A5 (Treatment for elimination of plant and animal pests and disease-causing organisms in the final product e.g. post-harvest treatment) includes the subgroupings A51 (Cold/heat treatment), A52 (Irradiation), A53 (Fumigation) and A59 (Treatment for elimination of plant and animal pests and disease-causing organisms in the final product, n.e.s.) (UNCTAD, 2013).

Table 1: Classification of non-tariff measures

Technical measures	A	Sanitary and Phyto-sanitary Measures
	B	Technical Barriers To Trade
	C	Pre-Shipment Inspection And Other Formalities
Non-technical measures	D	Contingent Trade-Protective Measures
	E	Non-Automatic Licensing, Quotas, Prohibitions And Quantity-Control Measures Other Than For SPS Or TBT Reasons
	F	Price-Control Measures, Including Additional Taxes And Charges
	G	Finance Measures
	H	Measures Affecting Competition
	I	Trade-Related Investment Measures
	J	Distribution Restrictions
	K	Restrictions On Post-Sales Services
	L	Subsidies (Excluding Export Subsidies Under P7)
	M	Government Procurement Restrictions
	N	Intellectual Property
	O	Rules Of Origin
Exports	P	Export-Related Measures

Source: UNCTAD, 2013.

An implication of New Zealand's approach of not allowing imports of risky animal and plant products until an import health standard is in place is that many countries are unable to export particular commodities to New Zealand. While this may seem restrictive, it is relatively common

for imports of fruit and vegetables to be sourced from a narrow range of countries. For instance, Seale et al. (2013) note that "in 2009, 99% of fresh tomatoes imported into the United States was from Mexico and Canada, 97% of cantaloupes imported into the United States was from three countries (i.e., Guatemala, Honduras, and Costa Rica), 95% of fresh onions was from Mexico, Peru, and Canada, 97% of fresh oranges imported was from four countries (i.e., South Africa, Australia, Chile, and Mexico), and 73% of spinach was from Mexico." The New Zealand import health standard approach has the advantage of being transparent about the import conditions, including through establishing a date from which specified countries can export particular products. This transparency enables us to estimate the effects of arguably the most significant type of measure – a prohibition on imports of a particular good from a given country.

Within the UNCTAD framework, countries that are unable to export a particular product to New Zealand are classified as facing a measure classified as A12 (Geographical Restrictions on Eligibility). The description of this measure in the UNCTAD classification guidelines provides useful background on such measures applied around the world: *"Prohibition of imports from specific countries or regions due to lack of evidence of sufficient safety conditions to avoid sanitary and phytosanitary hazards: The restriction is imposed automatically until the country proves employment of satisfactory sanitary and phytosanitary measures to provide a certain level of protection against hazards that is considered acceptable. Eligible countries are put on a "positive list" (UNCTAD, 2013). Imports from other countries are prohibited. The list may include authorized production establishments within the eligible country".*[5]

We choose to focus on geographical restrictions on eligibility for several reasons. First, as the effects of changes in SPS measures may be relatively subtle, and potentially obscured by the noisiness of trade data, it seems prudent to commence our research using this new database on examining arguably the most significant type of measure – a prohibition on imports of a particular good from a specific country. Second, as highlighted in Appendix 1 there are minimal differences between the SPS conditions for different countries exporting selected fruits to New Zealand.

[5] For seminal analysis of biosecurity restrictions in a partial equilibrium framework, see James and Anderson (1998).

The countries that are covered by New Zealand's import health standards for the products within the GTAP fruit and vegetable sector, along with the relative importance of each commodity are summarized in Appendix 2.

4. ILLUSTRATIVE MODELLING OF CHANGES IN NEW ZEALAND'S SPS MEASURES: QUANTIFYING THE EFFECT OF GEOGRAPHICAL RESTRICTIONS ON ELIGIBILITY

This section of our analysis presents a methodology to use the GTAP framework to quantify the effect of New Zealand's geographic restrictions on eligibility.[6]

4.1 Estimating Impacts on NZ Fruit and Vegetable Imports if Country Access Increases

The first step in our approach is to calculate an index of the degree to which each country's fruit and vegetable access to New Zealand is impeded by geographic restrictions on eligibility. (Recall that when there is no import health standard covering a particular product from a particular country, that country cannot export to New Zealand.) The Geographical Restrictions Index for New Zealand, GRI_i, is calculated by the following formula for each exporting region i:

$$GRI_i = \frac{\sum_j x_{ij} . D_{ij}}{\sum_j x_{ij}} \qquad (1)$$

where the subscript i denotes the exporter and the subscript j denotes each individual HS subheading within the GTAP fruit and vegetable sector; X_{ij} = the value of total exports of country i in HS subheading j (throughout this paper we use a capital X to denote exports to the world and a lower case x to denote exports to New Zealand); and D_{ij} is a dummy that is equal to 1 if country i is authorized to export products in HS subheading j to New Zealand i.e. an import health standard is in place.[7]

[6] UNCTAD NTM code A12.

[7] The data to calculate this index are obtained from the publicly available UN COMTRADE Database, see http://comtrade.un.org/. These data are available at the HS 6 digit level, which is the most detailed level at which common (harmonized) codes are used by all countries. Import Health Standards are often applied to specific products, thus a 6 digit HS subheading may contain both products that do, and do not have access to New Zealand. We classify a country as having access for a given HS 6 digit subheading if they have access for at least one product in this subheading. As we implement the simulations with version 9 of the GTAP database we use data for 2011.

Our Geographic Restrictions Index GRI_i indicates the proportion of a region's total fruit and vegetable exports that are comprised of products that would have been be eligible for export to New Zealand.[8] As shown in Table 2, generally this index is higher for countries that have close trade and biosecurity links with New Zealand. For instance, the GRI is 0.88 for Australia, which can be interpreted in the following way: products accounting for 88% of Australia's total fruit and vegetable exports to all countries are approved for export to New Zealand. The GRI is also relatively high for regions such as the United States (0.79) but is close to zero for some regions including some countries in Africa and Latin America. The GRI is also relatively low for European countries, with only a small number of countries having access for a limited number of fruits.

Table 2: Current Exports, the Geographic Restrictions Index and Export Expansion

Region	Current Fruit and Veg Exports to NZ (US$ millions)	Average GRI	Unrestricted Fruit and Veg Exports to NZ (ux) (US$ millions)
Australia	55.30	0.88	63.13
ROceania	13.51	0.96	14.11
EastAsia	9.75	0.31	31.21
SEAsia	75.24	0.67	111.50
SouthAsia	3.54	0.62	5.69
NAmerica	72.19	0.73	98.57
LatinAmer	22.82	0.22	104.06
Europe	3.48	0.08	42.41
MEAfrica	23.18	0.13	173.33

The next step in our analysis is to use the Geographic Restrictions Index to adjust current exports of fruit and vegetables to New Zealand to obtain an estimate, for each region i, of the value of exports to New Zealand if the region had access to export all fruit and vegetable products to New Zealand. This is referred to as unrestricted exports, ux_i, and is calculated in the following way:

$$ux_i = x_i / GRI_i \qquad (2)$$

where x_i = total current fruit and vegetable exports to NZ by region i. (As noted earlier, we use a capital X to denote exports to the world and a lower case x to denote exports to New Zealand.)

[8] As this index is calculated at the HS 6 digit level for a country, it will be too high i.e. understate the level of restrictions if a region is only approved for some products within a HS 6 digit sub-heading or for exports from some parts of the region. In general, however, this distortion is likely to be small.

The rationale for this formula is as follows. The proportion of total exports that region i exports to New Zealand is $\frac{x_i}{X_i}$. However, the ratio of exports to New Zealand, to total exports of products that region i is approved to export to New Zealand is $\frac{x_i}{X_i.GRI_i}$. Therefore if we assume that a region would export the same proportion of total exports to New Zealand for products for which it does not have access as it does in the case of products for which it does have access, our estimate of this unrestricted trade ux_i is found by the formula $ux_i = x_i/GRI_i$ i.e. equation 2.[9]

4.3 A Weighted Geographical Restrictions Index

Utilizing the Geographical Restrictions Index described above, while relatively intuitive, has the limitation of not taking account of New Zealand's preferences for imports of particular commodities. As noted earlier, we assume that if access were to be given, a region would export to New Zealand the same percentage of total exports of the previously unauthorized commodities as it does of the commodities that are already authorized. A limitation of this approach is that a region may have a comparative advantage in a commodity for which New Zealand import demand is relatively low. Using the geographical restrictiveness index to estimate trade in the absence of geographical restrictiveness would lead to an estimate of trade that was too high.[10]

We thus propose a Weighted Geographical Restrictions Index as a sensitivity check. To understand our framework, suppose that there were no transportation and other transaction costs and consumers were indifferent to the origin of their products; we would therefore expect that each exporting region's share of the New Zealand market would be equal to their share of the world market for each commodity. Therefore the value of New Zealand imports from region i of commodity j – referred to as "weighted unrestricted" exports (wux_{ij}) - could be calculated from the

[9] Implicit here is the assumption that, for each region, the access conditions in new import health standards for products currently without access are on average as stringent as the import health standard conditions for products that are currently approved.

[10] Conversely, if a region has access for a commodity of which New Zealand imports relatively high levels, then using the (unweighted) Geographic Restrictions Index to estimate unrestricted trade would underestimate trade changes; the exporter would be expected to send a higher proportion of total exports of other commodities to New Zealand. The limitation of using import shares in the calculation of this index is that products that are not imported are assigned a zero weight, thus we do not incorporate them when considering the trade effects of extending SPS access. Thus strictly speaking, our Weighted Geographic Restrictions Index estimates the effect on trade of allowing all regions access for products that at least one exporter is currently exporting.

following formula $wux_{ij} = \frac{X_{ij}}{\sum_i X_{ij}}.m_j$ where: X_{ij} = total exports of country i in HS subheading j and m_j = total New Zealand imports in HS subheading j. It follows that:

$$wux_i = \sum_j wux_{ij} = \sum_j \frac{X_{ij}}{\sum_i X_{ij}}.m_j \qquad (5).$$

Now, suppose we restrict the regions that can export specific commodities to New Zealand, but continue to assume that there were no transportation and other transaction costs and consumers were indifferent to the origin of their products. We can do this by introducing the dummy variable D_{ij} which is equal to unity if region i is permitted to export product j to New Zealand and zero otherwise. In this case, the value of New Zealand imports from region i of commodity j – referred to as "weighted restricted" exports (wrx_{ij}) could be calculated from the following formula $wrx_{ij} = \frac{X_{ij}.D_{ij}}{\sum_i X_{ij}.D_{ij}}.zm_j$, where z is a scalar with value less than one reflecting the extent to which New Zealand fruit and vegetable imports are lower when exports are "restricted" i.e. constrained by geographic restrictions.[11] In terms of the intuition, the share of each approved exporting country is calculated by only considering other exporting countries also approved for New Zealand. It follows that:

$$wrx_i = \sum_j wrx_{ij} = \sum_j \frac{X_{ij}.D_{ij}}{\sum_i X_{ij}.D_{ij}}.zm_j \qquad (6)$$

Our Weighted Geographical Restrictiveness Index for region i, $WGRI_i$, can then be calculated by dividing the estimated value of region i's exports to New Zealand taking geographical restrictions into account ("weighted restricted trade" from equation 6) by the estimated value of region i's exports to New Zealand where there were no geographical restrictions ("weighted unrestricted trade" from equation 5).[12] As z is simply a scaling factor we can define our WGRI as the index $_{WGRIi}{}^{*}$ multiplied by z.

[11] This is driven by the underlying supply and demand elasticities, and is compatible with the GTAP elasticity assumptions.

[12] The impact of a change in D_{ij} on the Weighted Geographical Restrictions Index is as follows:

$$WGRI_{i|D_{ij}=1} - WGRI_{i|D_{ij}=0} = \frac{\frac{X_{ij}}{\sum_i X_{ij}.D_{ij}}.m_j}{\sum_j \frac{X_{ij}}{\sum_i X_{ij}}.m_j} \qquad (8)$$

$$WGRI_i = \frac{WGRI_i^*}{z} = \frac{\sum_j \frac{X_{ij} \cdot D_{ij}}{\sum_i X_{ij} \cdot D_{ij}} \cdot m_j}{\sum_j \frac{X_{ij}}{\sum_i X_{ij}} \cdot m_j} = \frac{wrx_i}{wux_i} \quad (7)$$

In contrast to the (unweighted) Geographic Restrictions Index, the Weighted Geographic Restrictions index can assume any number greater than or equal to zero. This is because regions that have access for a product have an increased market share due to other regions being unable to export.

Rearranging equation (7) shows that unrestricted trade could be calculated from dividing restricted trade by the Weighted Geographical Restrictions Index:

$$wux_i . z^{-1} = \frac{wrx_i}{WGRI_i} \quad (9)$$

In actuality, however, the value of a region's fruit and vegetable exports to New Zealand differs from the estimated value due to region specific factors and costs. To calculate our unrestricted trade estimate we therefore divide actual trade by the Weighted Geographical Restrictions Index. In order for this to provide a useful estimate, we must assume that the region specific factors that cause actual trade to deviate from the "restricted trade" values are the same for products that a region has access as for products for which a region does not have access.

Addressing the necessary scaling factor, *z*, future econometric analysis at the commodity level may provide useful estimates of this. In the absence of these econometric estimates and to allow comparability with estimates derived from the GRI, we assume that the percentage expansion in equilibrium fruit and vegetable import quantities is the same as across all commodities and the overall supply response is the same as implied by the GRI index.[13] These assumptions enable us

A change in D_{ij} therefore has a larger effect where m_j is higher and the larger X_{ij} is relative to $\sum_i X_{ij,}$ i.e. where countries have a comparative advantage in commodities j. In this way, our index can be considered to be "weighted".

[13] Our reliance on results from the GRI means that as presently calculated the WGRI is not suitable as a standalone approach, and is best considered a sensitivity check on the assumption that in the unrestricted case New Zealand would import the same commodity mix as the rest of the world.

to apply a constant scaling factor of $\frac{\sum_i ux_i}{\sum_i x_i}$ to obtain our estimate of expanded weighted unrestricted trade i.e.

$$ewux_i = wux_i . \frac{\sum_i ux_i}{\sum_i x_i}$$

Table 3 summarizes the Weighted Geographic Restrictions Index, Weighted Unrestricted Fruit and Vegetable Exports and expanded Weighted Unrestricted Fruit and Vegetable Exports. Comparing this with the results from the Geographic Restrictions Index, the results are generally consistent with Oceania and Australia have the highest values for both indices whereas Latin America, Europe and the Middle East and Africa have the lowest value. A key difference is that while Europe had the most restricted access based on the GRI its WGRI value is higher than Latin America and the Middle East and Africa. This reflects the fact that their comparative advantage rests in products that make up a smaller than average proportion of New Zealand's fruit and vegetable imports. We can also see that due to the construction of the Weighted Geographic Restrictions Index, fruit and vegetable exports from Australia, Oceania decrease in the unrestricted cases. This reflects that their restricted exports are inflated by the fact that supply of products from other countries is limited.

Table 3: Current Exports, the Weighted Geographic Restrictions Index and Export Expansion

Region	Current Fruit and Veg Exports to NZ (US$ millions)	Average WGRI	Weighted Unrestricted Fruit and Veg Exports to NZ (wux) (US$ millions)	Expanded Weighted Unrestricted Fruit and Veg Exports to NZ (ewuxi) (US$ millions)
Australia	55.30	5.36	10.32	23.829
ROceania	13.51	31.15	0.43	1.001
EastAsia	9.75	0.61	16.10	37.171
SEAsia	75.24	1.66	45.23	104.387
SouthAsia	3.54	0.85	4.17	9.616
NAmerica	72.19	1.74	41.39	95.528
LatinAmer	22.82	0.33	68.14	157.278
Europe	3.48	0.36	9.75	22.513
MEAfrica	23.18	0.17	132.59	306.041

4.4 Implementing Estimates in the GTAP Framework

We use the GTAP model (Hertel, 1997), along with the version 9 data base (Narayanan et al. 2015). This database has a base year of 2011 for 140 countries or regions and 57 sectors. We aggregate the sectors to vegetables and fruit along with eight others, while we aggregate the regions to New Zealand along with nine other regions of interest. The latest version 9 database is particularly useful since it includes updated input-output data for New Zealand (Strutt and Siameja, 2015).

Incorporating our estimated fruit and vegetable imports in the GTAP framework provides an opportunity to compare the magnitude of shocks alongside other distortions in international trade, including tariffs and NTMs quantified through other research. Specifically we apply separately to each region the percentage shock to real exports that would increase exports to the unrestricted export value. From this simulation we can calculate the endogenously determined shifter needed for the demand curve for New Zealand's imports from each country.[14] We then use the shifters derived for each region to simultaneously shock the model, providing an estimate of the change in exports from each region to New Zealand after price adjustments and substitution between exporters has been accounted for.

A similar approach to achieve an empirically derived change in bilateral imports was undertaken in Trewin, Vanzetti and Thang (2015). These authors modelled an empirical finding that a 1% decrease in the stringency of the tetracycline standard in pork increases trade by 0.59%. A conceptual framework for this can be found in Andriamananjara et al. (2003) which discusses how SPS, TBT and other regulatory measures may create efficiency losses, and describes these as institutional frictions or 'sand in the wheels'.

Our simulation results are shown in Table 4. Utilizing the Geographic Restrictions Index estimates that extending SPS access to all countries would lead to increased fruit and vegetable imports from Europe (500% increase), Latin America (163% increase), Middle East and Africa (429% increase) and East Asia (50% increase) at the expense of imports from Australia (48% decrease), Oceania (53% decrease), South East Asia (25% decrease), South Asia (29% decrease) and North America (34% decrease).

[14] See Minor (2013) for in-depth discussion of modelling changes in trade facilitation within the GTAP framework.

Table 4: Results of Implementing the Geographic Restrictions Index and Weighted Geographic Restrictions Index: Estimated Change in Real Fruit and Vegetable Exports to New Zealand, percentage change and millions of 2012 USD

	Utlitizing the Geographic Restrictions Index		Utlitizing the Weighted Geographic Restrictions Index	
Region	Percentage change	Change in USDm	Percentage change	Change in USDm
Australia	-48.00	-26.54	-89.07	-49.26
ROceania	-53.41	-7.22	-98.35	-13.29
EastAsia	49.77	4.85	16.14	1.57
SEAsia	-25.22	-18.98	-56.33	-42.38
SouthAsia	-28.73	-1.02	-22.10	-0.78
NAmerica	-33.82	-24.42	-59.38	-42.86
LatinAmer	163.72	37.37	214.43	48.94
Europe	500.53	17.44	92.23	3.21
MEAfrica	429.93	99.64	976.6	226.33
World	29.07	81.12	47.12	131.48

Comparing the results from the Geographic Restrictions Index and the Weighted Geographic Restrictions Index, we can see that utilizing the latter provides a more dramatic reduction in imports from Australia (89% decrease compared to a 48% decrease when using the GRI), Oceania (98% compared to 53%), North America (59% compared to 34%) and South East Asia (56% compared to 25%) and a greater increase in imports from Middle East and Africa (976% compared to 430%) and Latin America (214% increase compared to 164%). There is a smaller increase in imports from East Asia (16% compared to 50%) and Europe (92% compared to 500%) reflecting that their comparative advantage rests in products that make up a smaller than average portion of New Zealand imports.

As noted earlier, as we are using results from the Geographic Restrictions Index as an input to our analysis with the Weighted Geographic Restrictions Index, the Weighted Geographic Restrictions Index cannot yet be considered a standalone methodology. We therefore consider that its value lies in providing a sensitivity check on the effect of not taking New Zealand's commodity mix into account when calculating the Geographic Restrictions Index. On this basis – with the exception of changes in imports from Europe and East Asia – we can view our estimates from utilizing the Geographic Restrictions Index as conservative.

5 CONCLUSIONS

This paper has examined a particular feature of the New Zealand biosecurity regime, the requirement for animal and plant products presenting a biosecurity risk to be covered by an import health standard. In the absence of an import health standard a country cannot export a particular commodity. These measures fit within the UNCTAD NTM classification of geographic restrictions on eligibility A12.

We have proposed the Geographic Restrictions Index as a way of quantifying the extent to which fruit and vegetable trade from individual trading partners is restricted by these geographical restrictions on eligibility. This index is more than merely a frequency index since it takes into account the proportion of global exports affected by the measure.

We find that for regions such as Australia, the USA and island states in Oceania with which New Zealand has a relatively extensive trade and biosecurity relationship, there is a relatively high Geographic Restrictions Index. In contrast, some African and Latin American states can only potentially export a relatively small proportion of their global fruit and vegetable trade to New Zealand.

By making the assumption that a region would seek to export the same proportion of total exports to New Zealand for products for which it does not have access as it does for the products for which it does have access, we are able to use the Geographic Restrictions Index to obtain an estimate of how supply would shift if a country had access for all products. These supply shifts are then incorporated into the GTAP framework, with a simulation quantifying the overall changes in quantity of fruit and vegetables imported.

Our GTAP simulations show that extending SPS access to all countries could lead to increased fruit and vegetable imports from Europe, Latin America, Middle East and Africa and East Asia at the expense of imports from Australia, Oceania, South East Asia, South Asia and North America.

We then propose a Weighted Geographic Restrictions Index that weights commodities by their share of New Zealand imports as a sensitivity check for cases where regions may have a comparative advantage in commodities of which New Zealand imports relatively little. As this index requires an estimate of the extent to which import quantities might shift, it is currently

calibrated by results from the Geographic Restrictions Index rather than being a standalone methodology. Our assessment is that the changes estimated from utilizing the Geographic Restrictions Index are likely to be conservative for most regions: Utilizing the Weighted Geographic Restrictions Index we see greater decreases for fruit and vegetable imports from Australia, Oceania, North America and South East Asia and a greater increase in imports from Middle East and Africa and Latin America. The results from utilizing the Weighted Geographic Restrictions Index do, however, suggest that increases in imports from East Asia and Europe might be overstated in our earlier simulations, reflecting that their comparative advantage rests in products that make up a smaller than average portion of New Zealand fruit and vegetable imports.

The methodology set out in this paper shows how SPS measures that can lead to foregone trade can be included in a CGE framework. This approach could be generalized to other cases where NTM measures cause trade to deviate from expected levels providing a strong foundation for further research. In future work, we will supplement this research with econometric analysis to better quantify how import demands for fruit and vegetables may respond to an increase in the number of potential suppliers.

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APPENDIX 1: SUMMARY DATA ON KEY FRUIT IMPORTS

An interested reader may wish to have more information on the extent to which SPS access is utilized and other NTMs that may apply. Table A1 provides this information through summarizing key features of some of New Zealand's main fresh fruit imports.

A clear feature is the concentration of imports from very few countries. For the majority of fruit summarized in the table, two source countries account for over 90% of New Zealand imports (Pineapples, Oranges, Mandarins, Pawpaws, Bananas and Pears). Grapes and Mangoes are sourced from a wider variety of countries, but even they only have four significant supply countries i.e. those accounting for more than 5% of supply.

In many cases, the principal suppliers have long standing SPS access going back before the implementation of the Biosecurity Act 1993 (Pineapples, Oranges, Mandarins, Bananas and Pears and Grapes). In other cases, however, the major supplier(s) only obtained access relatively recently (Australia for Mangoes, all major suppliers of Pawpaws). Thus, changes in SPS regime have caused major changes in supply patterns for some, but not all, fruit

We should note, however, that despite the few numbers of actual suppliers, there have been significant increases in the number of potential suppliers over the past 20 years with the number of countries with import health standards increasing from between 1-7 to 4-14 for the key fruit shown in table 2. It is obvious that many of these countries with SPS access are not using the access to any great degree.

For several products (pineapples and bananas) all major supplying countries face the same biosecurity NTMs as summarized by the UNCTAD NTM classification. While there are slight differences in the requirements for other products, all countries face certification (A83), inspection (A84) and treatment requirements (ie. A51 or A59), which are perhaps the most rigid. Thus the concentration cannot be explained through the leading suppliers facing lower SPS measures.

Table A1: Summary Data on Key Fruit Imports

	Average Imports 2013/14 NZ$	Average Imports 2013/2014 (Tonnes)	Average Import Price 2013/2014 ($/kg)	Percentage of Total Imports	Date Import Health Standard Approved (dd-mm-yr)	NTMs applicable[15]
Pineapples (HS 0804300001) (3 countries with SPS access in 1993, 7 in 2014)						
Philippines	8,148,708	6853.5	1.19	98.05	01-10-93	A33, A59, A83, A84, A61
Ecuador	68,518	139.5	0.49	0.82	29-07-99	A33, A59, A83, A84, A61
Australia	12,254	11.5	1.07	0.15	01-10-93	A84, A69, A33, A59, A83
Mangoes (and guavas/mangosteens) (HS 0804500001) (2 countries with SPS access for mangos in 1993, 14 in 2014)						
Australia	2,176,559	2944	0.74	33.59	31-03-04	A84, A52, A59, A33, A59, A83
Mexico	1,713,219	880	1.95	26.44	01-10-93	A33, A59, A83, A84, A59, A51, A32, A59
Peru	999,430	667.5	1.50	15.42	20-01-99	A33, A59, A83, A84, A59, A51
Ecuador	997,116	619	1.61	15.39	29-07-99	A33, A59, A83, A84, A51, A32
Oranges (HS 0805100001) (3 countries with SPS access in 1993, 6 in 2014)						
United States	9,577,955	7567.5	1.27	71.12	01-10-93	A33, A59, A83, A84, A9, A69, A59
Australia	3,880,170	3832.5	1.01	28.81	01-10-93	A84, A51, A59, A33, A59, A83
Vanuatu	9,249	12.5	0.74	0.07	17-03-06	A33, A59, A83, A84, A51, A59
Mandarins (including tangerines and satsumas) (HS 0805200002) (2 countries with SPS access in 1993, 5 in 2014)						
United States	8,661,288	4059	2.13	81.30	01-10-93	A33, A59, A83, A84, A9, A69, A59
Australia	1,828,753	731.5	2.50	17.17	01-10-93	A84, A51, A59, A33, A59, A83
Japan	143,068	40	3.58	1.34	12-01-00	A33, A59, A83, A84, A13
Grapes (HS 0806100000) (4 countries with SPS access in 1993, 8 in 2014)						
United States	21,380,076	6394.5	3.34	51.32	01-10-93	A33, A59, A83, A84, A9
Australia	12,531,212	4367.5	2.87	30.08	01-10-93	A84, A51, A59, A33, A59, A83
Chile	3,920,585	1559	2.51	9.41	01-10-93	A33, A59, A83, A84, A9, A59
Mexico	2,125,384	648	3.28	5.10	01-10-93	A33, A59, A83, A84, A59, A59, A53
Peru	1,563,273	427.5	3.66	3.75	21-03-12	A33, A59, A83, A84, A59, A51
Pawpaws/Papaya (HS 0807200000) (2 countries with SPS access in 1993, 8 in 2014)						
Philippines	1,703,138	808	2.11	90.43	18-05-00	A33, A59, A83, A84, A51, A59
Fiji	143,019	107	1.34	7.59	09-11-99	A33, A59, A83, A84, A51
Australia	33,182	10.5	3.16	1.76	18-12-06	A84, A59, A52, A33, A59, A83
Bananas (including plantains) (HS 0803) (7 countries with SPS access for bananas in 1993, 9 in 2014)						
Philippines	38,051,548	45121.5	0.84	60.03	01-10-93	A33, A59, A83, A84, A61
Ecuador	24,321,083	35020.5	0.69	38.37	01-10-93	A33, A59, A83, A84, A61
Mexico	313,928	462.5	0.68	0.50	01-10-93	A33, A59, A83, A84, A61
Pears (HS 080830) (1 countries with SPS access in 1993, 4 in 2014)						

[15] The NTM codes are explained in UNCTAD, 2013. The following NTMs are applicable to all food products: B15, A14, A31, B31, A859, A22, A21, B33, A851, A852, A853, A64, A21

Australia	2,915,727	1724.5	$1.69	48.00	01-10-93	A84, A51, A33, A59, A83, A33
United States	2,309,145	1375.5	$1.68	38.02	30-09-99	A33, A59, A83, A84, A9, A33
China	461,536	342.5	$1.35	7.60	01-02-10	A33, A59, A83, A84, A59, A51

Sources: Statistics NZ Merchandise Imports provided by NZ Ministry of Foreign Affairs and Trade, NZ Ministry for Primary Industries

APPENDIX 2: COVERAGE OF NEW ZEALAND IMPORT HEALTH STANDARDS

HS Code	Product	Countries covered by Import Health Standards (in 2011)	NZ Imports 2011 (US$)	Share of total NZ imports in Fruit and Vegetable Sector (%)	Share of Global Fruit and Vegetable Trade (%)
070110	Seed potatoes	None[16]	144	0.00	0.68
070190	Other potatoes, fresh or chilled	None	0	0.00	2.81
070200	Tomatoes, fresh or chilled	Tonga and Australia*	4,235,768	1.46	6.23
070310	Onions and shallots, fresh or chilled	USA and Japan (both only for onions)	1,575,297	0.54	2.11
070320	Garlic, fresh or chilled	USA	3,939,158	1.36	1.49
070390	Leeks and other alliaceous vegetables, nes	Fiji	0	0.00	0.27
070410	Cauliflowers and headed broccoli, fresh or chilled	Australia	531,869	0.18	0.63
070420	Brussels sprouts, fresh or chilled	None	0	0.00	0.08
070490	White and red cabbages, kohlrabi, kale...etc	Samoa, Tonga, Vanuatu (all only for Island cabbage/pele)	27,787	0.01	1.01
070511	Cabbage lettuce, fresh or chilled	New Caledonia	0	0.00	0.64
070519	Lettuce, fresh or chilled, (excl. cabbage lettuce)	Australia, China and USA (considered "approved processed commodities")	976,752	0.34	0.89
070521	Witloof chicory, fresh or chilled	None*	44	0.00	0.08
070529	Chicory, fresh or chilled, (excl. witloof)	None	0	0.00	0.11
070610	Carrots and turnips, fresh or chilled	Australia, China, South Africa and USA (considered "approved processed commodities")	14,879	0.01	0.84
070690	Beetroot...radishes and other similar edible roots	Fiji	15,001	0.01	0.42
070700	Cucumbers and gherkins, fresh or chilled	Australia, New Caledonia and Vanuatu (all only for cucumbers)	143,689	0.05	1.48
070810	Peas, fresh or chilled	USA, South Africa, Zambia and Zimbabwe	774,193	0.27	0.26
070820	Beans, fresh or chilled	Zimbabwe, South Africa, New Caledonia and Vanuatu	5,151,909	1.77	0.64
070890	Leguminous vegetables, fresh or chilled, nes	None*	81,260	0.03	0.06
070920	Asparagus, fresh or chilled	USA	301,958	0.10	0.87
070930	Aubergines, fresh or chilled	Vanuatu, Fiji, New Caledonia, Samoa and Tonga	983,120	0.34	0.32
070940	Celery, fresh or chilled	None	0	0.00	0.17
070951	Mushrooms, fresh or chilled	None*	787	0.00	0.78

[16] * The recording of imports in this subheading may be an error or reimports of New Zealand products. In general the values are relatively low. Imports in HS subheadings not covered by import health standards are recorded from the following countries: 0701.10 - Tonga; 0705.21 – Netherlands; 0708.90 – Fiji; 0709.51 – Italy and USA.

070952	Truffles, fresh or chilled	All	124,429	0.04	0.48
070960	Fruits of genus Capiscum or Pimenta, fresh or chilled	Australia, Netherlands and New Caledonia (all for capsicum only). Cook Islands, Fiji and Tonga (all for chilli only).	2,408,691	0.83	3.31
070970	Spinach, fresh or chilled	Fiji (Khatta/roselle leaves only)	10,838	0.00	0.14
070990	Other vegetables, fresh or chilled, nes	Australia, Fiji, New Caledonia, Niue, Papua New Guinea, Samoa, South Africa, Thailand, Tonga, Vanuatu and Zimbabwe all have at least one vegetable in this group approved.	5,792,872	2.00	2.16
071310	Dried peas, shelled	All	413,845	0.14	1.38
071320	Dried chickpeas, shelled	All	1,685,747	0.58	0.67
071331	Dried beans, shelled	All	0	0.00	0.00
071332	Dried adzuki beans, shelled	All	0	0.00	0.00
071333	Dried kidney beans, incl. white pea beans, shelled	All	6,403,931	2.21	1.12
071339	Dried beans, shelled, nes	All	486,379	0.17	0.32
071340	Dried lentils, shelled	All	893,991	0.31	1.03
071350	Dried broad beans and horse beans, shelled	All	20,934	0.01	0.31
071390	Dried leguminous vegetables, shelled, nes	All	283,951	0.10	0.46
071410	Manioc, fresh or dried	Cook Islands, Fiji, Niue, Papua New Guinea, Samoa, Solomon Islands, Tonga, Vanuatu	787,441	0.27	1.25
071420	Sweet potatoes, fresh or dried	Fiji, Niue, Papua New Guinea, Samoa, Tonga, Vanuatu	141,204	0.05	0.15
071490	Roots and tubers with high starch content, fres	Cook Islands, Fiji, Niue, Papua New Guinea, Samoa, Solomon Islands, Tonga, Vanuatu	8,597,055	2.96	0.27
080111	Coconuts, desiccated	All	5,887,267	2.03	0.53
080119	Coconuts (excl. desiccated)	Cook Islands, Fiji, Kiribati, New Caledonia, Papua New Guinea, Niue, Philippines, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu and Vanuatu	664,451	0.23	0.20
080121	Brazil nuts in shell, fresh or dried	All	0	0.00	0.01
080122	Brazil nuts, shelled, fresh or dried	All	2,997,711	1.03	0.18
080131	Cashew nuts in shell, fresh or dried	All	888	0.00	1.36
080132	Cashew nuts, shelled, fresh or dried	All	18,424,644	6.35	1.80
080211	Almonds in shell, fresh or dried	All	1,155	0.00	0.50
080212	Almonds without shells, fresh or dried	All	12,035,769	4.15	2.00

080221	Hazlenuts in shell, fresh or dried	All	0	0.00	0.07
080222	Hazlenuts without shells, fresh or dried	All	1,748,222	0.60	1.09
080231	Walnuts in shell, fresh or dried	All	1,184	0.00	0.46
080232	Walnuts without shells, fresh or dried	All	3,844,148	1.32	0.82
080240	Chestnuts, fresh or dried	All	22,053	0.01	0.18
080250	Pistachio, fresh or dried	All	1,040,771	0.36	1.45
080260	Macadamia nuts	All	4,272,579	1.47	0.26
080290	Other nuts, fresh or dried, nes	All	3,806,614	1.31	1.19
080300	Bananas, including plantains, fresh or dried	Australia, Ecuador, Fiji, Mexico, Niue, Panama, Philippines, Samoa and Tonga	62,039,979	21.37	10.06
080410	Dates, fresh or dried	All	3,162,399	1.09	0.52
080420	Figs, fresh or dried	All	672,544	0.23	0.28
080430	Pineapples, fresh or dried	Australia, Ecuador, Fiji, New Caledonia, Philippines, Thailand and Vanuatu. (Malaysia has access for peeled and chopped pineapples as "approved processed commodities".)	7,101,755	2.45	1.76
080440	Avocados, fresh or dried	Australia and Tonga	0	0.00	1.61
080450	Guavas, mangoes and mangosteens, fresh or dried	Australia, Cook Islands, Ecuador, Fiji, Mexico, New Caledonia, Peru, Philippines, Taiwan, Thailand, Tonga, USA. India was authorized for Mangoes from 12/4/12. Vietnam was authorized for Mangoes from 22/12/11Indonesia was authorized for Mangosteen from 28/8/13. Samoa has access for peeled and chopped mango as an "approved processed commodity")	5,718,572	1.97	1.21
080510	Oranges, fresh or dried	Australia, Egypt, Mexico, Spain, USA and Vanuatu	13,197,343	4.55	3.46
080520	Mandarins, clementines, wilkings...etc, fresh or dried	Australia, Egypt, Japan, USA and Vanuatu	7,448,704	2.57	3.09
080530	Lemons and limes, fresh or dried	Australia, Egypt, New Caledonia, Samoa, USA and Vanuatu	362,994	0.13	0.74
080540	Grapefruit, fresh or dried	Australia, Egypt, USA and Vanuatu	2,667,055	0.92	1.51
080590	Citrus fruit, fresh or dried, nes	None	80,450	0.03	0.04
080610	Fresh grapes	Australia, Chile, China, Italy, Mexico. Korea and Peru were approved on 22/22/11 and 21/03/12 respectively.	28,818,855	9.93	5.56
080620	Dried grapes	All	20,459,107	7.05	1.27

080711	Watermelons, fresh	Australia, New Caledonia and Tonga	2,289,645	0.79	0.79
080719	Melons (excl. watermelons), fresh	Australia and New Caledonia (both for honey dew and rock melon only)	3,721,773	1.28	1.22
080720	Papaws (papayas), fresh	Australia, Cook Islands, Fiji, Philippines, Samoa, Tonga, USA and Vanuatu	1,719,402	0.59	0.18
080810	Apples, fresh	Chile, Japan and USA	1,729,275	0.60	4.77
080820	Pears and quinces, fresh	Australia, China, Korea and USA	4,389,950	1.51	2.00
080910	Apricots, fresh	USA	3,440	0.00	0.31
080920	Cherries, fresh	USA	664,109	0.23	1.10
080930	Peaches, including nectarines, fresh	USA	2,895,576	1.00	1.59
080940	Plums and sloes, fresh	Chile	1,033,081	0.36	0.64
081010	Strawberries, fresh	Australia, New Caledonia and USA	1,735,722	0.60	1.71
081020	Raspberries, blackberries, mulberries and logan	None	19,563	0.01	0.73
081040	Cranberries, milberries...etc, fresh	None	42,178	0.01	0.89
081050	Kiwifruit, fresh	Italy and USA	1,101,963	0.38	1.53
081060	Durians, fresh	Thailand	97,732	0.03	0.31
081090	Other fruit, fresh, nes	Australia, Fiji, New Caledonia, Samoa, Taiwan, Thailand, Tonga and USA all have at least one fruit in this HS subheading approved.	804,864	0.28	1.71
081310	Dried apricots	All	7,498,448	2.58	0.34
081320	Dried prunes	All	3,315,492	1.14	0.33
081330	Dried apples	All	555,714	0.19	0.14
081340	Other dried fruit, nes	All	2,334,544	0.80	0.41
081350	Mixtures of dried fruit and nuts, nes	All	1,120,920	0.39	0.19