Economic benefits of MRA-AEOs

Part 6: Scenario 4 for MRAs and SES firms as at 30 June 2020.

NZIER draft report to New Zealand Customs Service

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Key points

Trade facilitation

Trade facilitation has measurable economic benefits and is one result of New Zealand's mutual recognition arrangements (MRAs) with eight partner economies.

The MRA arrangement produces time saving that has an economic value for New Zealand and its MRA partners.

The Secure Export Scheme (SES) of the New Zealand Customs Service (NZCS) is an MRA arrangement for New Zealand exporters.

Empirical analysis

Our analysis quantifies this value using the 'iceberg' method of the Global Trade Analysis Project (GTAP) model, in terms of:

- gross domestic product (GDP)
- consumer welfare
- imports
- exports.

Update of Scenario 3 study

The specific changes made from the 2020 work that underpinned the prior Scenario 3 were:

- moving to SES firms as at 30 June 2020 (this updates from the set of SES firms as at 30 June 2019).
- adopting the most recent year unaffected by the COVID-19 pandemic (we assumed trade values for the year to 31 December 2019.)
- applying the GTAP model to the GTAP10 database, (compared with the GTA9 database.)

We used the same set of MRA global partners.

We used the same values of time saving for New Zealand firms. Consequently, our new scenario (referred to as 'Scenario 4') assumes time saving of:

- 0.5 days for all importers and SES firms generally
- additional specific values for vegetable and fruit traders and electronic goods traders.

Key results

Results show that over the long term (7 to 10 years):

- annual consumer welfare increases for all MRA economies
- annual GDP for New Zealand increases in the long term by US$0.35 billion.

We also investigated impacts for imports and exports. These are relatively small effects and likely to be greatly influenced by the iceberg method. We present these as illustrative results in an appendix.

Table 1 Change[1] in annual economic measures

2019 US$ billion

Region	GDP	Consumer welfare
New Zealand	0.35	0.25
Australia	0.13	0.02
Canada	-0.01	0.00
China[2]	0.04	0.04
Hong Kong	0.00	0.00
Japan	0.05	0.02
Korea	0.01	0.01
Singapore	0.00	0.00
United States[2]	-0.06	0.01

1 Results are for Scenario 4, where only SES exporters and all importers are assumed to generate the MRA benefits. A time saving of 0.5 days is assumed except for trade in fruit and electronics which have higher assumed time savings. Base year of change is 2019 except for consumer welfare for which the base year is 2014. This is because 2014 GTAP data are used in the GTAP model and consumer welfare results for 2014 are not translatable into 2019 values.

2 Negative results for nominal GDP are attributable to falls in the price levels of GDP, due in part to lower costs of imported inputs to production (Appendix A.4.2).

Source: NZIER modelling

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1 Introduction

1.1 Purpose

This study is Part 6 in our development of modelled estimates of global economic impacts from trade facilitation in customs border clearance. It revises our prior work (Williams et al, 2021) to account for:

- the new set of Secure Export Scheme (SES) firms in the year to 30 June 2020
- a range of updated key parameters, including gross domestic product and trade values by commodity of global economies
- the use of the latest 2014 macroeconomic database for the global trade model.

1.2 Trade facilitation from mutual recognition agreements

Trade facilitation is one of the benefits from New Zealand's MRAs with eight partner economies. Specifically, trade facilitation is achieved because goods of trusted authorised economic operators (AEOs) experience less time in transit. Our study and others quantify this type of trade facilitation as a removal of a non-tariff barrier. Specifically, we account for it as a time saving in customs border clearance.

This time saving results in lower costs of imports. This is valuable for firms and for consumers (Appendix A.3.2) because falls in import costs mean firms and consumer households in the importing country increase their productivity and consumer welfare. The cost of traded goods in MRA bilateral trade is adjusted by an ad valorem equivalent of this value. We then compare the state of global economies with and without the value adjustment. This reveals the value of trade facilitation due to the presence of bilateral MRAs with New Zealand.

The SES of the New Zealand Customs Service (NZCS) is an AEO arrangement for New Zealand exporters.

1.3 Approach

We used a similar approach to that for our prior work. The main differences are that:

- the set of SES firms attributed with producing impacts are those as at 30 June 2020
- we used the 2014 GTAP10 version of the Global Trade, Assistance and Production database (Appendix A)
- we calibrated modelled impacts (in percentage terms) to 2019 US dollar denominated GDP and trade data for the year to 31 December 2019. This expresses the current value of economic impact for nations in terms of changes in GDP, import and export values. The choice of 31 December 2019 rather than 30 June 2020 provides us with annual data representative of a typical year and not influenced by the extraordinary trade impacts of the COVID-19 pandemic.

As for our prior work (Williams et al, 2021), we:

- used the iceberg approach of the GTAP model that accounts for the value of time saving as a productivity improvement. This is a useful and reasonable approximation for the small impacts that we are concerned with (Appendix A.3).
- assumed a time saving made up of two parts:
  - a generic duration of 0.5 days in transit applicable for imports and SES exports, as in our previous study
  - an additional specific saving based on insights of two firms for the following two commodity groups:
    - vegetables and fruit:

      China, an additional 3.0 days

      rest of world, an additional 1.0 day
    - manufactured computer, electronic and optical goods

      China, an additional 1.0 day

      rest of world, zero additional days.
- report the impacts in terms of changes for global economies in GDP, consumer welfare and values of imports and exports
- estimate import impacts as arising from all imports
- estimate export impacts as arising from exports of only SES firms.

We refer to the modelled results as 'Scenario 4' in this report, because it follows 'Scenario 3' (Williams et al, 2021).

Because the set of MRAs and the set of SES firms differ from that for our prior work, we do not compare the Scenario 4 results here to prior Scenario 3 results.

Table 2 Assumed time saving for Scenario 4

Trade	General time saving	Specific additional time saving
NZ exports	All NZ exports 0.5 days	SES exports 0.5 days plus special amounts for: • (i) Vegetables and fruit and nuts • (ii) Manufactured computer, electronic and optical goods.
NZ imports	All NZ imports 0.5 days	All NZ imports 0.5 days plus special amounts for: • (i) Vegetables and fruit and nuts • (ii) Manufactured computer, electronic and optical goods.

Source: NZIER assumptions based on industry insights taken from firm interviews in 2019

1.4 Calibration to 2019 values

The GTAP10 database we use is based on 2014 nominal values of levels of economic measures. The 2014 data are the most recent for New Zealand. The GTAP model expresses

impacts as percentage changes of these nominal 2014 levels. In the case of GDP and trade data, we estimate impacts for 2019 levels by applying the percentage changes from the GTAP model to the levels denominated in 2019 US dollars.

In the case of household consumer welfare this is not possible since 2019 equivalents are not obtainable using the 2014-based results of the GTAP model. Hence, as in our prior work we report these impacts in nominal 2014 US dollar values.

2 Data

We used the GTAP10 database to represent real world economic prices and quantities.

Compared with the GTAP9 database the GTAP10 database has (Appendix A):

- 65 products and services (commodity groups) up from the 57 for GTAP9
- 121 countries and 20 aggregate regions compared with the 120 countries and 20 aggregate regions for GTAP9.

Importantly for this study, the GTAP10 database splits out the 'Electrical Equipment' sector from the GTAP9 sector of 'Other Machinery'.

In order to estimate the impact from SES export firms by commodity group, we:

- calculated the proportion that SES exports represent of all exports by commodity group
- applied the assumption of time saving exclusively to the value of exports represented by the SES proportion.

In order to calibrate the modelled impacts to 2019 values, we applied the percentage impacts, produced on the GTAP10 database from the GTAP model, to 2019 values of imports and SES exports corresponding to the 65 commodity groups of the GTAP10 database.

To produce values in this group, we aggregated 2019 (HS6[1]) bilateral trade data for New Zealand supplied by NZCS into the respective 65 GTAP10 commodity groups, by trading partner, for imports and exports (by SES firms and non-SES firms). To achieve the aggregation, we used a concordance reported by Aguiar (2016) and Aguiar et al (2019) of 65 GTAP10 commodity groups to the Harmonised System Level 6 classification system.

We grouped the aggregated data into the nine MRA regions (including New Zealand) and selected other geographic regions relevant to this study.

Scenario 4 assumes the same time saving for commodities as for Scenario 3. The value associated with each level of time saving by commodity is calculated using an ad valorem estimate associated with one day of time saving.

We used ad valorem estimates for each day of time saving that we believe represent the experience of New Zealand firms. These are largely similar to the values reported by Minor

[1] HS 6 Digit "The World Customs Organization's Harmonized System (HS) uses code numbers to define products. A code with a low number of digits defines broad categories of products; additional digits indicate sub-divisions into more detailed definitions. Six-digit codes are the most detailed definitions that are used as standard. Countries can add more digits for their own coding to subdivide the definitions further according to their own needs. Products defined at the most detailed level are "tariff lines." "– WTO Glossary

and Hummels (2013). The estimates for one commodity were made using confidential data of a former client. Hence, we do not disclose the set of ad valorem estimates here.

3 Results

3.1 Introduction

This section presents the GTAP results for macroeconomic impacts for New Zealand and its eight MRA partners arising from time saving (above) due to trade facilitation from New Zealand's MRA-AEO arrangements based on the new modelling arrangements detailed above. We interpret these results with the guidance of literature presented in our prior report (Williams et al, 2021). In Appendix B we provide illustrative GTAP results for impacts on values of imports and exports. In Appendix C, we provide more detailed data for other countries or regions. Table 12 and Table 13 show GDP impacts for price and quantity as percentages of GDP.

We report the impacts for global economies as changes in annual values of: GDP, consumer welfare, trade balance and values of imports and exports. The changes are assumed to occur over the long term (7 to 10 years) - to allow the effects to be absorbed. We report the changes in the annual values of these economic variables. That is the change in annual values expected at the end of the long term. The change does not occur annually.

3.2 Sensitivity analysis

In the results tables in this report, we include standard deviations for the results to show their robustness. These are derived using the systematic sensitivity analysis methodology that we previously applied (Williams et al, 2021).

3.3 Consumer welfare – change

Welfare gains are associated with increased consumption opportunities from falls in import prices and consequent productivity improvements of importing firms.

Change in consumer welfare (Appendix C, Table 16) is an important economic impact from trade facilitation (Hertel 2012).

Table 3 shows welfare gains of US$249 million annually for New Zealand under Scenario 4.

Welfare gains are noticeable for Australia, China, Japan and the United States. The negative welfare result for Canada is mainly a result of a small positive technology effect component of welfare change being offset by a larger negative terms of trade component. The technology effect is attributable to a welfare gain from improved productivity of existing resources.

This result and indeed consumer welfare results for all MRA partners are influenced by the iceberg method used whereby terms of trade effects can be overestimated (Appendix A.3.3) with consequent impacts on the inter-regional distribution of goods and services between regions.

Similar to the findings in our prior study, welfare losses are incurred by all non-MRA economies (Table 16 in Appendix C). This is an inter-regional terms of trade effect on welfare arising from lower import costs for MRA partners.

Table 3 Consumer welfare – change[1]

2014 US$ millions

Region	Change	Standard deviation
New Zealand	249.19	3.85
Australia	21.79	1.63
Canada	-0.42	0.20
China	38.63	2.15
Hong Kong	0.52	0.05
Japan	21.32	1.05
Korea	6.34	0.45
Singapore	1.72	0.15
United States	11.85	1.25

1 Base year of change is 2014. This is because 2014 data are used in the GTAP model and consumer welfare results for 2014 are not translatable into 2019 values. Change is expressed in terms of annual results and occurs over the long term.

Source: NZIER modelling

3.4 GDP – change

New Zealand experiences the largest positive impact under both scenarios (Table 4 and Table 5) with annual GDP climbing 0.17 percent (US$0.35 billion).

Changes in nominal GDP are composed of changes in price (Table 12) and quantity (Table 13) of underlying GDP.

These are influenced by (Appendix A.4.2):

- productivity increases enabled from lower import costs for MRA economies – this tends to result in a rise in the volume of GDP and a fall in its price level
- increased exports due to terms of trade effects where cheaper imports force export prices down to balance the trade account meaning a depreciation of the real exchange rate
- increased costs of capital effects from higher investment demand for production that in turn forces a rise in the rate of return.

Real GDP (quantity) changes (Table 13) are positive or zero for all nine economies. Price changes are positive or zero only for New Zealand, Australia, China, Japan, Korea and Singapore.

Table 4 GDP – change[1]

2019 US$ billions

Region	GDP	Change
New Zealand	207	0.35
Australia	1,393	0.13
Canada	1,736	-0.01
China	14,343	0.04
Hong Kong	366	0.00
Japan	5,082	0.05
Korea	1,642	0.01
Singapore	372	0.00
United States	21,374	-0.06

1 Base year of change is 2019 for nominal GDP. Change is expressed in terms of annual results and occurs over the long term. For negative results see Note 2 to Table 1.

Source: World Bank national accounts data, OECD national accounts data files and NZIER modelling

Table 5 GDP – percentage change

Percent

Region	Change	Standard deviation
New Zealand	0.1712	0.0023
Australia	0.0093	0.0008
Canada	-0.0007	0.0000
China	0.0003	0.0001
Hong Kong	-0.0004	0.0000
Japan	0.0009	0.0001
Korea	0.0005	0.0001
Singapore	0.0004	0.0001
United States	-0.0003	0.0000

1 Percentages are derived from the GTAP model. Change is expressed in terms of total change in annual results occurring over the long term. For negative results see Note 2 to Table 1.

Source: World Bank national accounts data, OECD national accounts data files and NZIER modelling

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Appendix A Aid to interpretation of the GTAP model results

This Appendix provides a selection of insights from reported literature to aid the interpretation of the GTAP model results. Comprehensive discussions are available including recent work of Corong et al. (2017) and Aguiar et al. (2016 and 2019).

A.1 GTAP model and GTAP database

A.1.1 GTAP model

The analysis in this research uses the Global Trade, Assistance and Production (GTAP) model (Hertel and Tsigas 1997; Corong et al. 2017). This model is a CGE model. It consists of a mathematical system of equations and real-world data (the GTAP database).

The theoretical system represents the simultaneous investment, production and consumption of all economies in the world and shows their mutual responsiveness to changes (shocks) affecting the global equilibrium.

The system is combined with real-world data (the GTAP database) providing a snapshot of the global economy, in equilibrium, in a given year. The resulting model (system and data) finds a global equilibrium where prices and quantities clear the supply and demand for consumption, savings, investment, government expenditure and bilateral trade flows.

Changes to the global equilibrium, such as from the removal of non-tariff measures (NTMs), are represented as perturbations or shocks to the initial equilibrium. The GTAP model calculates economic settings for a global equilibrium before and after the shock. Hence, we can assess the impact of the shock on global economies.

The GTAP model calculates this new equilibrium in a systematic and detailed way at a disaggregated level. Hence, the GTAP model provides insights into the direction and magnitude of changes in production, consumption, trade and economic welfare resulting from real-world events.

A.1.2 GTAP 10 database

In this study, we use the GTAP10 version of the GTAP database, which is explained in detail by Aguiar et al. (2019). The full database contains information on 141 countries and regions and 65 products and services and has base years for different countries and regions at 2004, 2007 and 2011 and 2014.

Notably, relative to the GTAP9 version:

- The 2014 base year is available.
- Tajikistan is the latest country to be extracted from one of the aggregate regions.
- Input-output tables for 50 countries have been updated.
- Regular updates have been made for: macroeconomic data, income and factor taxes and energy data.
- 65 products and services are considered, up from 57 in previous versions. GTAP10 has more manufacturing and services sectors than previous versions. In particular:

- There are three new sectors in manufacturing: chemicals, pharmaceuticals and rubber products that were previously aggregated as a single sector.
- The electrical equipment sector is separately distinguished from other machinery.
- A number of services are now separately identified: accommodation and food services, warehousing, real estate activities, education and health services.

- The reconciliation of trade data and estimates of transport margins have been updated.

A.1.3 Closure condition

The long run closure condition for the GTAP model applied in this work, implements full factor employment with perfect factor (labour and capital) mobility across sectors within each region. That is, the time frame is long enough for capital to move inter-sectorally. Each region's factor (including capital) supply is fixed, so capital does not contribute to GDP changes on the income-side. Each region contributes their savings to a global savings pool collected by a so-called 'global bank'.

The global bank allocates these savings (in the form of investment) across regions until the percentage change in the global rate of return equalises with the percentage change in each region's expected rate of return. Proportionate changes in the expected regional rates of return to investment are achieved.

A.2 GTAP modelling approaches

A.2.1 Trade facilitation is a kind of non-tariff measure (NTM)

Trade facilitation is expected to have impacts on the quantities and potentially the prices of traded goods and therefore fits the broader definition of an NTM (Walmsley and Minor 2016). Pre-shipment inspection is classified as an NTM in section C of the classification of United Nations Conference on Trade and Development (2019). Trade facilitation is mitigation of this NTM and is a kind of negative NTM.

A.2.2 NTM effects

The three main kinds of economic effects that NTMs generate are protection, supply and demand (Fugazza and Maur 2008).

- Protection effects are cost-raising and trade-restricting and act at the border.
- Supply effects occur when regulations are applied to comply with international standards (e.g. phytosanitary) and can include specifying the production process.
- Demand effects occur following changes in the willingness to pay for traded goods due to a change in some attribute of the good.

A.2.3 Modelling NTM effects in the GTAP environment

Supply and demand effects are complex to analyse and require functional forms for supply and demand functions. Protection effects can be modelled in the GTAP model by:

- Estimating ad valorem equivalents (AVEs) – the part of the difference between world and domestic prices at the border not explained by formal tariff measures.
- Introducing the AVEs into the GTAP model in two main ways:
  - as tariff equivalents (or export tax equivalents if on the export side)
  - introducing non-revenue-generating price wedges (iceberg costs).

CGE models such as GTAP use AVEs as inputs to the model to estimate the impact of removing the barrier on an economy or on economic variables such as wages, employment, GDP and welfare.

AVEs for removal of NTMs can be negative. An example is the removal of sanitary and phytosanitary standards that hinder trade through reducing confidence in safety of goods.

A.2.4 Tariff equivalents

We can model NTMs as a tariff. NTMs are not usually associated with taxes or fees, but it can be argued (Fugazza and Maur 2008) that the NTM causes economic rents, most likely due to imperfect competition, that accrue to either the importing or exporting country and that changes in rents from the existence of NTMs can be modelled as changes in import and export taxes. The key concern with this tariff approach is the adjustment of the tariff revenue and accounting for where it goes in the model.

A.2.5 Iceberg costs

Alternatively, we can model the NTM as an iceberg trade cost that drives a wedge between world and landed prices much like a tariff, although it does not generate any revenue. The fact that there are no revenues involved with iceberg trade costs creates a major technical advantage. No adjustments need to be made to the underlying equilibrium data of the GTAP model.

A.3 Modelling MRA impacts with the iceberg approach

A.3.1 MRA impacts are modelled as efficiency shocks

Fugazza and Maur (2008) describe MRAs as a form of trade facilitation whose impact on the price of traded goods can be modelled as an AVE in the GTAP model. MRAs remove hindrances or 'sand in the wheels' of trade such as customs inspections. To make the GTAP model tractable, this is stylised as an exogenous efficiency improvement. This results in falls in import costs at the border. Consequently, in the model the productivity of the importer increases.

A.3.2 The iceberg approach for MRAs

Iceberg method at a glance

Our modelling approach within the GTAP model is called the 'iceberg method' – as above. It is used as a proxy to include trade facilitation effects in the model.

The introduction of the MRAs lowers import costs. This is conceptualised as an efficiency improvement associated with time saving. This is a necessary abstraction of the theoretical model. In reality, the change in the costs of imports happens through the interaction of

supply and demand factors in each economy finding a new equilibrium. But those costs are not observed and the assumption of an efficiency change makes the scenario tractable within the established model.

Falls in import costs mean firms and consumer households in the importing country increase their productivity and consumer welfare. They demand more imports and import volumes rise. This is the main effect. Increased productivity is achieved because the initial inefficiency (time delay meaning costs) has been reduced.

In the iceberg method reduction in import costs is conceptualised as consisting of two opposing effects: (a) expansion of import volume and (b) price substitution towards the lower priced imports. Expansion of import volume (a) results in reduced, effective (i.e. efficiency-inclusive) import demand, while price substitution (b) works in the opposite direction and increases import demand, through a price-induced substitution effect in favour of the cheapening supplier.

Robustness of the iceberg method

In the GTAP model, demand elasticities (called Armington elasticities) are sufficiently high so that the elasticity of substitution to lower priced imports is always greater than 1. The price substitution effect dominates the expansion effect. The latter is assumed to lower demand for imports. Overall, more imports are demanded from a given partner—unless another MRA partner provides cheaper imports.

One shortcoming of the iceberg approach is the conceptualisation that the importer is assumed to have lower effective demand, under the expansion effect. This is a stylised effect used in the model to process the rise in importer efficiency. Essentially, in reality, it does not happen. It is unlikely to affect the model's significant results.

Falling import costs result in cheaper production costs, which in turn raises the competitiveness of exports. Overall, in the case of sufficiently high import demand, the importing nation experiences rises in import and export value and increases in productivity, consumer welfare and output volume.

Acknowledging our caveat about its weakness, we consider our use of the iceberg approach to be reasonable as we are concerned with small changes in real costs of imports at the border.

Strength and weakness

The main strength of the iceberg approach is that it models the time saving as a small reduction in the real cost of imports for the importing firm at the border. It is also a simple technical solution compared to the technical complexity required for modelling the complexity of supply and demand effects in the GTAP model.

Fugazza (2013) notes that:

> *standard applied general equilibrium models (such as GTAP) do not offer many ways to include demand -shift and supply-shift effects and none of them are fully satisfactory.* (Fugazza 2013)

The main weakness of the iceberg approach is that it attributes significant productivity gains to the importer as a productivity change. This likely overstates the actual consumer welfare and increases in real GDP from productivity improvements.

Hertel et al. (2001) were the first to introduce a technology shock variable in GTAP to simulate the impact of lower non-tariff trade costs, such as customs clearance costs, in the investigation of the free trade agreement between Japan and Singapore. Walmsley and Minor (2016) note that the CGE community has tended to adopt the technology shock methodology when modelling trade facilitation.

A.3.3 Critiques of the iceberg approach

There are useful critiques of use of the iceberg approach that arise from the assumption that the change in import costs is a result of exogenous efficiency change. These are instructive rather than destructive.

Productivity shock critique

Walmsley and Minor (2016) question whether the assumption of an efficiency shock is relevant for households and governments:

> *From a firm's perspective, the increased quantity of goods imported is equivalent to a technological change to the importing firm, akin to a reduction in the production costs. While this explanation may find some basis in a firm's supply chain, the role of a productivity shock for households and government is difficult to reconcile. It's important to note here that an often-used explanation for the productivity shock on government and households is that it can be interpreted as a change in quality. However, this explanation is inconsistent with the impacts on real GDP that the productivity shock creates and is not consistent with standard definitions of real GDP.* (Walmsley and Minor 2016)

GDP impact critique

Walmsley and Minor (2016) conclude that the iceberg method attributes a significantly larger increase in real GDP due to productivity gains than would be obtained with other approaches. They comment that the assumed technology change is assumed to be pervasive throughout the economy of the importing country. They report that in global models based on the GTAP database (Narayanan, Aguiar and McDougall 2012), all firms will receive the import-augmenting technological change shock.

Efficiency effect critique

Fugazza and Maur (2008) conclude that the iceberg method overstates efficiency gains in the economies concerned. They argue that the impact of falls in import prices from removal of NTMs will not entirely be translated into efficiency gains:

> *The efficiency assumption implies that the price differential calculated by the AVEs [ad valorem equivalents] is entirely explained by the efficiency losses due to the presence of NTBs. That is unlikely to be the case, and conceptually it is not completely clear whether trade liberalization related to technical regulations is best represented by a reduction in efficiency impediments.* (Fugazza and Maur 2008)

Consumer welfare effect critique

Hertel (2012) cautions that the inherent framework of the GTAP model can introduce excessive terms of trade effects that can influence consumer welfare effects. This is due to the transmission mechanism for terms of trade effects. This is the Armington structure (refer Appendix A.4.1 below) – a GTAP model feature derived from the work of Armington (1969).

The Armington structure of the GTAP model can influence estimates of welfare, for example. This is because change in the relative prices of exports and imports influence the inter-regional distributions of goods and services. Terms of trade effects therefore influence welfare because of the high Armington elasticities used. The terms of trade impact on welfare can be reduced by using low Armington elasticities. Hertel (2012) explains the economic mechanisms underlying the terms of trade (ToT) influences.

> *The underlying economic mechanism driving the large ToT effects in GTAP is quite straight forward: tariff reductions lead to increased imports; assuming little change in the country's trade balance, exports are required to increase; in order to increase exports, prices must fall; this increase in international competitiveness is achieved via a real depreciation which, in turn lowers the prices of all exports, and raises import costs, sufficiently to restore external balance.* (Hertel 2012)

A.3.4 Overview

In summary, the GTAP iceberg approach is a theoretical device used in the context of a theoretical model. Like many theoretical assumptions it abstracts from the real world in ways that affect its outputs.

It contains a stylised effect of a technology change that is:

- not necessarily meaningful to the conventional GDP contributions of households and government, who are not producers
- likely to overestimate GDP increases
- likely to overestimate efficiency gains for economies
- likely to overestimate terms of trade effects countervailing to increases of GDP and efficiency.

Acknowledging these shortcomings, the iceberg method is nevertheless a reasonable and computationally tractable approach for our purposes. This is because we are concerned with small changes in import costs at the border.

A.4 Interpreting our GTAP results

A.4.1 Armington structure of GTAP can influence terms of trade effects

Zhang (2006) describes how the Armington structure plays a crucial role in determining the response of trade flows and consumption patterns to changes in productivity parameters and trade costs.

The Armington specification of GTAP ensures that production of final commodities in each country uses both domestic and foreign intermediate inputs and that consumers consume both domestically produced and imported commodities.

Typically input-output data for domestic production cannot distinguish between countries of origin on an industry-use basis.

The Armington structure circumvents this problem by assuming aggregation of each good from all countries takes place at the border.

The Armington aggregator, which combines commodity exports from each source country into a single commodity aggregate, is a constant elasticity of substitution (CES) consumption function:

$$y_{ik} = \theta_{\rho_i} \left[\sum_{k=1}^{n} a_{ijk} y_{ijk}^{\rho_i} \right]^{1/\rho_i}$$

where,

y_{ik} is the aggregate demand for imported commodity i in country k.

y_{ijk} is the imports by country k of commodity i from country j

a_{ijk} are non-negative parameters that govern the relative shares for each commodity i for trade between j and k.

θ_{ρ_i} is the productivity effect of commodity i

$1/(1-\rho_i)$ is the elasticity of this CES function, referred to as the Armington elasticity. It determines the degree of substitutability across origin countries for commodity i.

As noted by Zhang (2006) the choice of the Armington assumption is an important one as it impacts on the outcomes of policy shocks introduced to CGE models. This is due to both the Armington structure itself and the size of the substitution elasticities, which can have a large effect on the terms of trade.

Zhang (2006) describes how the Armington structure plays a crucial role in determining the response of trade flows and consumption patterns to changes in productivity parameters and trade costs.

Zhang (2006) observes that:

> *Two consequences of introducing the Armington assumption are that:*
>
> - *every country in a CGE model has market power in every market in which it buys and sells*
> - *comparative advantage in production does not exist.*
>
> *The first consequence means that when one country reduces its tariff rates, the model results tend to display large negative terms of trade effects. The second means that any resource reallocation across industries is small relative to what might occur in a non-Armington model. Both factors reduce the gains from trade liberalisation in simulations that use a CGE model. As a consequence, any benefits from reducing tariffs tend to be small, and occasionally negative. This is especially the case when the initial tariffs are small*. (Zhang 2006)

A.4.2 GDP effects via cost of capital effects

In this study we are concerned with removal of an NTM of the 'protection' type (A 2.2 above). A reduction of border clearance time lowers import costs. The impact on welfare is similar to the removal of a tariff and can be estimated as an ad valorem measure. Removal of a tariff and removal of an NTM have similar effects in improving welfare and allocative efficiency, but not necessarily by the same amount to the same people. The removal of a tariff is a cost to some entities, such as a government and a benefit to others, such as a firm. To the extent that removal of a 'protection' NTM is similar to a tariff measure,

because it increases welfare and allocative efficiency in an economy, we can draw lessons for GDP impacts of the removal of NTMs from the case for the removal of tariff measures.

Adams (2003) describes three main mechanisms through which tariff cuts can affect the real cost of capital (the nominal cost of capital adjusted for GDP price inflation).

> *The first is via a change in the global rate of return on capital – essentially the rate of return required on the global market for capital. The second is via the direct effects of the tariff cuts on the duty-paid prices of imported inputs to investment. The third is via changes in the terms-of-trade that affect the average c.i.f. price of imported capital goods relative to the GDP deflator.* (Adams 2003)

We can conclude that higher investment demand for production will raise the rate of return on capital, thereby tending to reduce GDP. The second will tend to reduce the costs of imported inputs to production, thereby tending to raise GDP. The third will tend to lower the costs of production, because imported inputs to production will be less expensive.

A.5 Consumer welfare

We measure welfare of households in terms of 'utility' – an economic term for satisfaction gained from consuming things. We assume that the more goods and services a household can purchase, the better off they are.

Changes in consumer welfare of households due to perturbations is explicitly modelled in the GTAP model. Consumer welfare is measured in terms of utility of households.

According to Hertel (2012), it is important to have a unique measure of regional welfare in the GTAP model because the GTAP model is designed to assess the inter-regional incidence of economic policies.

Hence, the GTAP model specifies 'regional households' that maximise welfare from current consumption, future consumption and the provision of public goods:

> *The GTAP model incorporates private consumption, government spending and savings directly into the regional household's utility function. Therefore, regional welfare might fall, even when private consumption rises, if government consumption and/or savings are adversely affected by a given policy. In short, in the standard closure, private spending, government spending and savings are all determined as part of a single utility maximization problem undertaken by the regional household.* (Hertel 2012)

Both prices and incomes affect our purchasing power. Both prices and household incomes change following a perturbation to global economies. We use equivalent variation as a measure of the combined impact of changes in prices and changes in incomes on utility.

Equivalent variation measures the income required to maintain the initial level of utility after a perturbation.

In the case of a price fall (rise) due to a perturbation, a household is better (worse) off. The change in utility is measured as the amount of income that would purchase the utility change prior to the shock occurring.

Applying the findings of Fugazza and Maur (2008) to the present MRA study, we should expect welfare effects (see below) to be unambiguously positive for all MRA economies.

In the GTAP framework, efficiency shocks lower the price of imports, and this leads to an increase in demand for them at the expense of domestic goods:

> *Because in GTAP this efficiency gain applies nondiscriminatorily to all imports there are no trade diversion effects at work. This should thus result in unambiguous positive welfare effects for all countries.* (Fugazza and Maur 2008)

A.6 Sensitivity analysis

In most economic models, results are very dependent on the value of variables that are exogenous to the model. These exogenous variables can be either parameters of the model or shocks implemented for a specific experiment.

Sometimes the value of exogenous variables is not known precisely because they are econometrically estimated or involve errors for parameters or shocks, and we would like to know the variations of the model (CGE) results with respect to small changes of asumed parameters or shocks.

Therefore, we usually test the model by imposing a range of change in exogenous parameters to find the sensitivity of the model to the value of parameters or shocks.

In this study, we used systematic sensitivity analysis (SSA) (Hertel et al. 2001), and we selected the change in the value of time in trade estimated (Minor and Hummels 2013) as the exogenous variable of interest to perform an SSA.

We follow the Gaussian 'quadratures' technique for the GTAP model to calculate means and standard deviations for the results, which give us an indication of the sensitivity of the model to shock value and the degree of confidence associated to any result. We use a triangular distribution in which central values are the time value for each commodity, with 10 percent minimum and maximum values for lower and upper levels respectively. Hertel (2012) describes this methodology:

> *…it is clear that we are unlikely to have access to a fully validated, global CGE model in the near future. A more modest goal is to provide sufficient robustness checks to assure policy makers that key findings are not simply a function of certain arbitrary (or worse yet, carefully selected) parameter settings. This leads to the topic of Systematic Sensitivity Analysis (SSA), a tool which has been widely employed in the GTAP community to explore the sensitivity of model results to parametric uncertainty. The basic idea is to sample from a set of parameter distributions, each time resolving the model and saving the results. After completion of the SSA, the user can compute standard statistics – most commonly the mean and variance of model results, thereupon providing model consumers with appropriately constructed confidence intervals. Thus, it should be possible to say, for example: "Given the overall structure of the GTAP model, we are 95% confident that this policy will improve regional welfare".* (Hertel 2012)

Hertel (2012) notes that a:

> *more common approach to SSA is to simply specify a uniform or a triangular distribution with a lower endpoint of zero (for nonnegative elasticity values). This reassures the reader that the author is being suitable conservative by specifying a generous variance in the underlying distribution.* (Hertel 2012)

However, Hertel (2012) concludes, that none of this is satisfactory and it would be far preferable to actually estimate the relevant parameters and the associated distributions and use these directly in the SSA.

In summary for this analysis, we have used a conservative approach in specifying a triangular distribution for sampling with central values being the value of time saving for each commodity time value with 10 percent upper and lower bounds. This accords with Hertel's description above. It is likely to be superior to assigning arbitrary error margins for time saving for each commodity.

Appendix B GTAP modelling results

This appendix presents GTAP model results for MRA impacts on imports and exports. We regard these as illustrative. This is because the absolute values of the results are small. Hence the main assumption of the iceberg method, that a change in import cost can be modelled as a productivity change, is likely to have a sizeable influence on them.

B.1 Merchandise imports change

New Zealand experiences percentage increases of 0.17 percent for Scenario 4 in merchandise imports (Table 7). Meanwhile Australia sees a 0.01 percent increase.

Import value increases are positive (or zero from rounding) for all MRA economies, except for Canada, Hong Kong and the United States. Increases are conceptualised as due to the price substitution effect dominating the expansion effect in the iceberg method (Appendix A.3.2).

Increases are sizeable for New Zealand. Results for other MRA partners are at least an order of magnitude less.

Results for non-MRA regions (Table 14) show falls in import values. This is explained as a trade diversion away from non-MRA regions to MRA regions due to falls in costs of imports from MRA regions.

Table 6 Merchandise imports of MRA partners – change[1]

2019 US$ billions

Region	Imports	Change
New Zealand	42	0.12
Australia	222	0.03
Canada	464	0.00
China	2,077	0.04
Hong Kong	578	0.00
Japan	721	0.01
Korea	503	0.01
Singapore	359	0.00
United States	2,568	0.00

1 Base year of change is 2019 for nominal imports. Change is expressed in terms of annual results and occurs over the long term.

Source: World Bank national accounts data, OECD national accounts data files and NZIER modelling

Table 7 Merchandise imports of MRA partners – percentage change[1]

Percent

Region	Change	Standard deviation
New Zealand	0.1712	0.0044
Australia	0.0093	0.0012
Canada	-0.0007	0.0000
China	0.0003	0.0001
Hong Kong	-0.0004	0.0000
Japan	0.0009	0.0002
Korea	0.0005	0.0002
Singapore	0.0004	0.0002
United States	-0.0003	0.0001

1 Percentages are derived from the GTAP model. Change is expressed in terms of total change in annual results occurring over the long term.

Source: World Bank national accounts data, OECD national accounts data files and NZIER modelling

B.2 Merchandise exports of MRA partners – change

Over the long term, China experiences the greatest change in merchandise exports (Table 8) due to the New Zealand network of MRAs, rising US$0.05 billion.

Merchandise export changes are positive or close to zero for other MRA partners.

We can explain these in terms of the impact on each MRA partner due to:

- greater demand for imports due to the efficiency effect of the iceberg approach, thereby creating a demand for increased exports from other MRA partners
- increased competitiveness of exports due to lower costs of imported inputs together with a terms of trade effect (Appendix A.3.4), which raises exports of each partner
- the expansion effect of the iceberg method that tends to lower demand for imports due to increased efficiency of importing firms (Appendix A.3.2).

The aggregate of these effects results in the net effect observed, with price effects being larger than volume effects in most cases.

Non-MRA regions (Table 15) experience falls in export values. This can be explained, in part, as a kind of trade diversion, being a substitution of MRA partners away from them in favour of MRA partners for lower priced imports.

Table 8 Merchandise exports change[1]

2019 US$ billion

Region	Exports	Change
New Zealand	40	0.02
Australia	272	0.03
Canada	447	0.00
China	2,499	0.05
Hong Kong	535	0.00
Japan	706	0.01
Korea	542	0.01
Singapore	391	0.00
United States	1,646	0.02

1 Base year of change is 2019 for nominal exports. Change is expressed in terms of annual results and occurs over the long term.

Source: World Bank national accounts data, OECD national accounts data files and NZIER modelling

Table 9 Merchandise exports – percentage change[1]

Percent

Region	Change	Standard deviation
New Zealand	0.0572	0.0020
Australia	0.0100	0.0008
Canada	0.0001	0.0000
China	0.0021	0.0001
Hong Kong	0.0004	0.0000
Japan	0.0016	0.0001
Korea	0.0010	0.0001
Singapore	0.0005	0.0002
United States	0.0012	0.0001

1 Percentages are derived from the GTAP model. Change is expressed in terms of total change in annual results occurring over the long term.

Source: World Bank national accounts data, OECD national accounts data files and NZIER modelling

B.3 Impact of MRAs on main imports and exports

We investigated changes in bilateral trade with New Zealand arising from the MRAs for the main commodity groups traded with each MRA partner.

The GTAP model calculates the impact of the MRA at the level of commodity group for each bilateral trade partner.

We investigated the change in value of trade produced by each MRA arrangement according to the top ten commodities traded by value. We derived the percentage of the value of trade for the top ten that represents this impact.

We report these MRA percentage impacts for the top ten commodities. For illustration, we also provide the identity of the top four commodities that make up the trade impact for Scenario 4 in Table 10 and Table 11 below.

Table 10 Impact of MRAs on imports from New Zealand's MRA partners

Percent

Region	Value of MRA impact as percentage of top ten by value	Top four product categories of MRA impact for Scenario 4			
		1	2	3	4
Australia	2.17	Paper products, publishing	Food products nec	Chemical products	Metals nec
Canada	1.78	Machinery and equipment nec	Meat products nec	Chemical products	Wood products
China	2.44	Computer, electronic and optical products	Electrical equipment	Machinery and equipment nec	Rubber and plastic products
Hong Kong	1.64	Electrical equipment	Transport equipment nec	Chemical products	Food products nec
Japan	1.59	Motor vehicles and parts	Petroleum, coal products	Chemical products	Ferrous metals
Korea	2.57	Motor vehicles and parts	Transport equipment nec	Machinery and equipment nec	Chemical products
Singapore	1.04	Petroleum, coal products	Transport equipment nec	Chemical products	Food products nec
United States	0.93	Transport equipment nec	Machinery and equipment nec	Chemical products	Motor vehicles and parts

Source: World Bank national accounts data, OECD national accounts data files and NZIER modelling

Table 11 Impact of MRAs on exports to New Zealand's MRA partners

Percent

Region	Value of MRA impact as percentage of top ten by value	Top four product categories of MRA impact for Scenario 4			
		1	2	3	4
Australia	0.46	Dairy products	Wood products	Food products nec	Vegetables, fruit, nuts
Canada	1.00	Dairy products	Vegetables, fruit, nuts	Manufactures nec	Wood products
China	1.40	Vegetables, fruit, nuts	Dairy products	Chemical products	Manufactures nec
Hong Kong	1.05	Vegetables, fruit, nuts	Dairy products	Bovine meat products	Electrical equipment
Japan	1.34	Vegetables, fruit, nuts	Dairy products	Food products nec	Chemical products
Korea	1.92	Vegetables, fruit, nuts	Dairy products	Chemical products	Paper products, publishing
Singapore	1.19	Dairy products	Vegetables, fruit, nuts	Chemical products	Bovine meat products
United States	1.07	Dairy products	Chemical products	Wood products	Vegetables, fruit, nuts

Source: World Bank national accounts data, OECD national accounts data files and NZIER modelling

Based on the aggregate value (not percentage) for Scenario 4 for the top ten imports (in the HS6 trade classification), key countries for imports affected are Korea, China, Australia and Canada.

The commodities making up the top four for various nations are:

- chemical products for all MRA partners except China
- rubber and plastic products for China
- paper products and publishing for Australia
- machinery and equipment nec for Canada, China, Korea and the United States
- transport equipment nec for Hong Kong, Korea, Singapore and the United States
- electrical equipment for China and Hong Kong
- meat products nec for Canada
- food products nec for Australia, Hong Kong and Singapore
- motor vehicles and parts for Japan, Korea, and the United States
- computer, electronic and optical products for China
- petroleum and coal products for Singapore and Japan
- ferrous metals for Japan
- wood products for Canada
- metals nec for Australia.

Based on the aggregate value (not percentage) for Scenario 4 for the top ten exports (in the HS6 trade classification), key countries for exports affected are China, Japan, and the United States.

The commodities making up the top four for various nations are:

- dairy products for all MRA partners
- vegetables, fruit and nuts for all MRA partners
- wood products for Australia, Canada and the United States
- food products nec for Australia and Japan
- chemical products for China, Japan, Korea, Singapore and the United States
- manufactures nec for Canada and China
- electrical equipment for Hong Kong
- paper products and publishing for Korea
- bovine meat products for Hong Kong and Singapore.

As with our Scenario 3 results (Williams et al. 2021), it is interesting to see the prominence of the commodity group of vegetables, fruit and nuts, consistent with the additional specific number of days of time saving attributed to them.

Appendix C Detailed GTAP modelling results

Table 12 GDP price index – change[1]

Percent

Region	Change
New Zealand	0.0644
Australia	0.0087
Canada	-0.0007
China	0.0000
Hong Kong	-0.0007
Japan	0.0007
Korea	0.0002
Singapore	0.0003
US	-0.0004
Oceania	-0.0019
East Asia	-0.0011
Southeast Asia	-0.0028
South Asia	-0.0011
North America	-0.0013
Latin America	-0.0012
EU	-0.0013
Middle East and North Africa	-0.0012
Sub-Saharan Africa	-0.0010
Rest of World	-0.0010

1 Percentages are derived from the GTAP model. Change is expressed in terms of total change in annual results occurring over the long term.

Source: NZIER modelling

Table 13 GDP volume index – change[1]

Percent

Region	Change
New Zealand	0.1067
Australia	0.0007
Canada	0.0000
China	0.0003
Hong Kong	0.0003
Japan	0.0003
Korea	0.0003
Singapore	0.0001
US	0.0000
Oceania	-0.0009
East Asia	0.0000
Southeast Asia	-0.0001
South Asia	0.0000
North America	0.0000
Latin America	0.0000
EU	-0.0001
Middle East and North Africa	0.0000
Sub-Saharan Africa	0.0000
Rest of World	0.0000

1 Percentages are derived from the GTAP model. Change is expressed in terms of total change in annual results occurring over the long term.

2. Using detailed GTAP data, the real GDP effects for Canada, the USA and East Asia can be explained as follows:

- For Canada, a near zero change in real GDP arises from small falls in the consumption, investment and government expenditure components of GDP being offset by positive export and import components.
- For the USA, a negative change in real GDP arises from falls in the consumption, investment, government expenditure and import components being offset by a positive export component.
- For East Asia, a near zero change in real GDP arises from falls in consumption, investment, government expenditure and export components being offset by a positive import component.

Source: NZIER modelling

Table 14 Merchandise imports – change[1]

Percent

Region	Change	Standard deviation
New Zealand	0.2925	0.0044
Australia	0.0152	0.0012
Canada	-0.0006	0.0000
China	0.0019	0.0001
Hong Kong	-0.0007	0.0000
Japan	0.0017	0.0002
Korea	0.0010	0.0002
Singapore	0.0004	0.0002
US	0.0000	0.0001
Oceania	-0.0044	0.0001
East Asia	-0.0019	0.0000
Southeast Asia	-0.0034	0.0001
South Asia	-0.0017	0.0000
North America	-0.0011	0.0000
Latin America	-0.0018	0.0000
EU	-0.0016	0.0000
Middle East and North Africa	-0.0018	0.0000
Sub-Saharan Africa	-0.0014	0.0000
Rest of World	-0.0012	0.0000

1 Percentages are derived from the GTAP model. Change is expressed in terms of total change in annual results occurring over the long term.

Source: NZIER modelling

Table 15 Merchandise exports – change[1]

Percent

Region	Change	Standard deviation
New Zealand	0.0572	0.0020
Australia	0.0100	0.0008
Canada	0.0001	0.0000
China	0.0021	0.0001
Hong Kong	-0.0004	0.0000
Japan	0.0016	0.0001
Korea	0.0010	0.0001
Singapore	0.0005	0.0002
US	0.0012	0.0001
Oceania	-0.0030	0.0001
East Asia	-0.0014	0.0000
Southeast Asia	-0.0027	0.0000
South Asia	-0.0009	0.0000
North America	-0.0001	0.0000
Latin America	-0.0007	0.0000
EU	-0.0009	0.0000
Middle East and North Africa	-0.0013	0.0000
Sub-Saharan Africa	-0.0008	0.0000
Rest of World	-0.0007	0.0000

1 Percentages are derived from the GTAP model. Change is expressed in terms of total change in annual results occurring over the long term.

Source: NZIER modelling

Table 16 Consumer welfare – change

Equivalent variation in 2014 U$S million

Region	Change	Standard deviation
New Zealand	249.1889	3.8467
Australia	21.785	1.6338
Canada	-0.4231	0.1969
China	38.6344	2.1539
Hong Kong	0.518	0.0467
Japan	21.3224	1.0458
Korea	6.3421	0.4545
Singapore	1.7228	0.1532
US	11.8523	1.2525
Oceania	-1.1942	0.0179
East Asia	-2.2938	0.0411
Southeast Asia	-19.4254	0.3105
South Asia	-2.6646	0.0841
North America	-3.2905	0.0629
Latin America	-5.5585	0.1371
EU	-38.5527	0.6033
Middle East and North Africa	-13.3281	0.2229
Sub-Saharan Africa	-2.5181	0.0918
Rest of World	-4.9496	0.1324

Source: NZIER modelling