Economic benefits of MRAs for authorised economic operators

Part 2: Quantitative modelling report

NZIER report to New Zealand Customs Service

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Key points

The New Zealand Customs Service (NZCS) is interested in an assessment of the potential economic benefits from New Zealand's mutual recognition agreements for authorised economic operators (MRA-AEOs).

The results of this study should be interpreted as indicative, looking toward further research on the impacts of specific bilateral MRA-AEOs.

Consumer Wellbeing

New Zealand has six bilateral MRA-AEOs. One of the benefits they provide is an increase in consumer wellbeing for all our MRA-AEO partners: Australia (USD102 million); China (USD51 million); Japan (USD48 million); Korea (USD22 million); the United States (USD42 million); and Hong Kong (USD3 million).

EU MRA-AEO benefits consumers in both NZ and the EU. If New Zealand were to add an MRA-AEO with the European Union, the change in consumer wellbeing benefits from the present case of six MRA-AEOs would be:

- increases for New Zealand, the European Union and Hong Kong
- decreases for Australia, China, Japan, Korea and the United States.

Abolishing the US MRA-AEO makes consumers in both countries worse off. If New Zealand were to cease its MRA-AEO with the United States, the change in consumer wellbeing benefits from the present case of six MRA-AEOs would be:

- decreases for New Zealand, the United States and Hong Kong
- increases for Australia, China, Japan and Korea.

Impacts on Third Parties. The consumer wellbeing results accord with our understanding that New Zealand's MRA-AEOs produce benefits for New Zealand as well as each MRA-AEO bilateral partner. Benefits increase for New Zealand and the European Union under the hypothetical MRA-AEO (decrease for the case of abolishing the US MRA-AEO). The decrease for third party countries in the EU case (and the increase in the US case) reflect a legitimate form of trade diversion. In a sense, each partnership is a form of trade pact that, by lowering costs between partners, switches trade away from outsiders.

Trade balance

As shown in Table 1, New Zealand's six MRA-AEOs in the long run produce annual trade balance increases for New Zealand (USD86 million), Australia (USD19 million) and Korea (USD1 million). By comparison, there are decreases for China (-USD26 million), Japan (-USD0.3 million), the United States (-USD0.7 million) and Hong Kong (-USD0.07 million).

The decreases for the large economies are unexpected and we cannot explain them from the present investigation. More research is warranted to understand this effect.

EU MRA-AEO improves the trade balance for both the NZ and the EU. If New Zealand were to add an MRA-AEO with the European Union, the change in trade balance from the six MRA-AEO cases would be:

- increases for New Zealand, the European Union and the United States
- decreases for Australia, China, and Japan.

Abolishing US MRA-AEO reduces the trade balance for NZ. If New Zealand were to cease its MRA-AEO with the United States, the change in trade balance from the six MRA-AEO cases would be:

- decreases for New Zealand and Hong Kong
- increases for Australia, China, Japan, Korea and the United States.

The results indicate that New Zealand derives trade benefits from its MRA-AEO with the United States. The small benefits for the United States on abolishing the MRA-AEO cannot be explained in the present study.

Impacts on Third Parties. The generally contrariwise impacts on other MRA-AEO bilateral partners following the hypothetical bilateral changes are explained by the influence of trade diversion (above).

Table 1 Consumer wellbeing and trade balance benefits from current six MRA-AEOs (scenario 1) and impacts on changing to scenarios 2 and 3

Country	Consumer wellbeing (USD m)			Trade balance (USD m)		
	Scenario 1: Current six MRA-AEOs	Change to scenario 2: Current six plus NZ-EU	Change to scenario 3: Current six less NZ-US	Scenario 1: Current six MRA-AEOs	Change to scenario 2: Current six plus NZ-EU	Change to scenario 3: Current six less NZ-US
Australia	101.6	-13.83	6.99	19.45	-1.86	3.94
New Zealand	448.04	99.23	-65.1	86.1	20.88	-12.19
China	50.76	-0.89	7.89	-25.82	-8.15	0.97
Japan	48.31	-1.55	6.90	-0.32	-0.41	0.21
Korea	22.17	-0.22	3.05	1.25	-0.49	0.78
United States	41.87	-7.45	-70.22	-0.73	0.04	3.32
Hong Kong	3.43	0.06	-0.28	-0.07	0	-0.02
European Union	-44.61	98.17	11.43	-14.37	2.58	-0.13

Source: NZIER

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1. Introduction

New Zealand has six bilateral mutual recognition agreements for authorised economic operators (MRA-AEOs). One of their benefits is a reduction in Customs clearance times for AEO enterprises in respective member territories – a kind of trade facilitation. This occurs because the AEO enterprise is trusted to observe compliance, and this obviates the need for Customs inspection. This time saving has an economic value, and it affects the whole economy.

The New Zealand Customs Service (NZCS) is interested in highlighting the potential economic benefits from New Zealand's MRA-AEOs. New Zealand has an AEO programme for New Zealand exporters only – the Secure Export Scheme (SES). SES enterprises are recognised by Customs agencies in partner MRA economies through MRA-AEOs signed with Australia, China, the United States, Japan, the Republic of Korea and Hong Kong.

This report presents the findings of a general equilibrium modelling analysis. The aim was to estimate the economic benefit of the trade facilitation brought about by New Zealand's MRA-AEOs. This is measured in terms of the potential change in selected economic characteristics of the New Zealand economy and other economies. The impact is a result of transit time saving (assuming all merchandise trade is covered by the set of MRA-AEOs.)

Three scenarios of MRAs were investigated:

1. The current set of six MRA-AEOs.
2. Seven MRA-AEOs obtained by adding an NZ-EU MRA-AEO.
3. Five MRA-AEOs obtained by excluding the NZ-US MRA-AEO.

We assessed the impact of the MRA-AEO sets in terms of selected variables: real (inflation adjusted) gross domestic product (GDP), trade balance (export value less import value at world prices) and consumer wellbeing (price level of consumer goods).

Our method consisted of two parts. We expressed the value of time saving brought about by the MRA-AEOs as a change in price of the good using the approach of Hummels (2001, 2007). We then used the Global Trade Analysis Project (GTAP) framework to estimate responses of global economies to the presence of the time saving.

This report is Part 2 of a two-part set. Part 1 is a scan of selected global literature on the origins of AEOs, their benefits and the enhanced benefits provided by MRAs associated with them.

In this report:

- section 2 describes our methodology and the data used
- section 3 presents our results.

We provide a list of references in section 4. Appendix A describes the methods used to estimate the value of time saving and to include it in a global trade model. Appendix B provides specifications for the GTAP framework.

2. Methodology

2.1. Expressing time saving as a price effect

Improvements in trade facilitation through streamlining of Customs procedures, inspections or security requirements are valuable in themselves and as part of a wider economy. Slower movement through the border increases inventory holding costs as well as costs from reduced quality and tardiness of delivery. This is illustrated in the case of fresh high-value vegetables demanded by retailers by a specific market day. Delay results in spoilage, and tardiness results in lost market days. Both produce a loss in revenue. These costs are effectively tariffs on the merchandise, and they raise the average cost of the cargo. The costs differ by commodity type and country of origin.

International studies, such as by Moïsé, Orliac and Minor (2011) find that trade facilitation measures that aim to streamline Customs procedures (single windows, pre-arrival processing, physical inspections, post-clearance audits, separation of release from clearance and authorised traders) have the potential to reduce these effective tariffs by 5.4 percent.

While we do not know what proportion these costs make of total import costs for each commodity, we expect, however, that the trade facilitation achieved by the MRA-AEOs will produce some of the reduction in trade costs addressed by Moïsé et al. We further assume that the reduction in costs so produced can be expressed as a percentage of the total import cost of the commodity.

We therefore express trade cost reductions in this study of MRA-AEO benefits as a percentage of the total import cost. Non-MRA-AEO effects on the total cost of imports such as from faster shipping or cheaper production could be similarly modelled. In this sense, MRA-AEO impacts are merely one of a wider group of cost-reducing effects.

2.2. Time saving in a global trade model

We assume the presence of an MRA-AEO reduces time in transit by 1 day for all merchandise traded between New Zealand and our MRA-AEO partners for 1 year.

To translate this time effect into a price effect, we attach a value of time saving to each merchandise good. Such values are not precisely known and vary considerably by type of good and location of trade. Therefore, we follow Hummels (2001, 2007) and others who derived ad valorem equivalents for the value of 1 day of time delay in trade. Hummels expressed these ad valorem equivalents as a percentage of the total value of merchandise by detailed commodity type, for a specific bilateral trade pair. These ad valorem values represent the reduction in the costs of the import due to time saving. Appendix A provides further details for this methodology.

We then use the GTAP framework (refer Appendix B). This is a multiregional general equilibrium model of global trade. Under different scenarios, we estimate the following economic characteristics of global economies: real (inflation adjusted) gross domestic product (GDP); consumer wellbeing (price level of consumer goods); and trade balance (export value less import value). We start with the case where New

Zealand has no MRA-AEOs. This is our base case. We then estimate the economic characteristics for each of the following scenarios:

1. The current set of six MRA-AEOs.
2. Seven MRA-AEOs, including a hypothetical NZ-EU MRA-AEO.
3. Five MRAs excluding the NZ-US MRA-AEO.

The differences in economic characteristics for the scenarios from the base case represents the impact of them, respectively, for 1 year.

Changes in real GDP and trade balances are measured in USD million. Consumer wellbeing impacts are measured in terms of equivalent variation, due to price changes for consumers, in USD million.

The GTAP framework was chosen because:

- it has a detailed trade specification – and so it accounts precisely for changes in unique trade items
- it is a general equilibrium model, which means it accounts for the series of ripple effects of a 'shock' to the initial state of equilibrium
- it is designed to handle the shock we apply to the model, which is the price change of merchandise at the border caused by MRA-AEOs.

The GTAP model is very reliable in modelling the change in incomes of nations for precisely these types of shocks. As an equilibrium model, it works in a series of iterations until the ripple effects from the detailed price changes are fully accounted for in the economy of each nation.

2.3. Ad valorem equivalent of time database

We used the value of time in trade database of Minor (2013) and Hummels and Schaur (2013) who estimated the ad valorem equivalent of time in a global framework following Hummels (2001, 2007). In the case of dairy products, we used an estimate of the ad valorem equivalent, which, in our view, better represented the transit times. NZIER used Hummels' (2001, 2007) methodology for the estimation. We used the GTAP 9 database (Aguiar, Narayanan and McDougall 2016) to populate the GTAP framework. The full database contains information that simulates the annual macroeconomic and trade characteristics for 140 regions and 57 commodities. It has base years of 2004, 2007 and 2011. In the database we used, the New Zealand data is 2007 data. For the present study, the detailed results of the simulations were aggregated and reported for 20 regions and 57 commodities (Appendix B).

In the present study, we are modelling differences in the global economy produced by including sets of MRA-AEOs for New Zealand.

The changes in magnitude of economic characteristics we observe due to the introduction of a shock from a set of MRA-AEOs to 2007 data are likely to be similar to those changes we would observe using current period data.

3. Results

This section presents the results of the GTAP modelling of the impact of the three scenarios of various New Zealand MRA-AEOs compared to the base case (no New Zealand MRA-AEOs.)

3.1. Precision of results

Overall, the results reported here should be taken as indicative. In addition to the use of historical data, and of course the simplification in the model, a serious uncertainty in the results arises from the ad valorem estimates of the value of time saving for each good. Accuracy can be improved by using actual estimates of time saving by AEO enterprises themselves. This is a huge task but is viable for focused studies concerned with an individual industry or commodity. In this broad study, however, we are estimating the impact across many goods.

Similar ad valorem estimates are accepted by many as a reasonable first approximation (for example, refer de Soyres et al. 2018.). We consider our estimates to be reasonable first approximations because the GTAP framework is widely accepted to produce reliable outputs, as far as income goes. Thus, GDP and consumer wellbeing results seem acceptable.

We model a long-run state of the world where the current account balance is explicitly fixed and the global level of capital stock is free to adjust. This is achieved by imposing a technical device in the model called a closure condition. We impose a long-run closure condition because we are interested in the potential long-run impact of the MRA-AEOs. In such a long-run state, we expect the long-run estimates of the trade balance to be reasonable as first approximation estimates.

In summary, we can expect the long-run impacts on real GDP, consumer wellbeing and the trade balance impacts to be reasonable first approximations of the actual trade facilitation impacts of MRA-AEOs from time saving.

3.2. Real GDP impact of MRA-AEOs

The impact of New Zealand's MRA-AEOs on the real GDP of New Zealand and Australia is shown in Table 2 for the three scenarios under the long-run state of the world. We do not report other economies, because the impacts on them are approximately zero in percentage terms. This reflects the relative importance of trans-Tasman trade for both countries and the relatively minor impact of New Zealand's trade changes on the income of other economies.

The impact is positive for New Zealand in all scenarios. The impacts in percentage terms are smaller for Australia but still positive.

To appreciate the size of the impact, we see that, in scenario 1, the long-run annual impact on GDP from the current six MRA-AEOs of 0.18 percent compares to the annual growth rate in real GDP of about 3.1 percent for the year to June 2018 for New Zealand.

Table 2 Real GDP impacts for long-run states

Percentage change compared to base case without MRA-AEOs

	Scenario 1: Current six MRA-AEOs	Scenario 2: Current six plus NZ-EU	Scenario 3: Current six less NZ-US
Australia	0.01%	0.01%	0.01%
New Zealand	0.18%	0.22%	0.15%

Source: NZIER

New Zealand's real GDP in 2017 was about USD206 billion, and for Australia, it was about USD1.32 trillion.[1] These are the latest reported numbers, and we use them to estimate the current value of impacts below.

In scenario 1, the long-run benefit for GDP from New Zealand's six MRA-AEOs compared to the base case was about USD371 million annually for New Zealand and about USD132 million annually for Australia.

In scenario 2, where New Zealand adds an MRA-AEO with the European Union, the real GDP impact over the base case increases to 0.22 percent of current GDP or about USD453 million annually. This amounts to an extra annual increase of about USD82 million over the real GDP benefit for scenario 1.

In scenario 3, where New Zealand has no MRA-AEO with the United States, the real GDP increase over the base case is 0.15 percent of current GDP or about USD309 million annually. This is about USD62 million less than the increase over the base case achieved by scenario 1.

3.3. Consumer wellbeing impact of MRA-AEOs

The consumer wellbeing impact of MRA-AEOs is a measure of the change in spending power of the consumer. It is measured as an equivalent variation (EV) for households. It is expressed in 2011 (base year) USD million. The change in EV can be interpreted as the change in regional household income at constant prices from implementing the MRA-AEOs.

Table 3 shows the consumer wellbeing impact of the three different scenarios.

In scenario 1, consumer wellbeing increases with the presence of the six MRA-AEOs for New Zealand as well as for all of New Zealand's six MRA-AEO partners. Consumer wellbeing decreases for other economies.

In scenario 2, consumer wellbeing increases with the six MRA-AEOs plus the new NZ-EU MRA-AEO. This increase is achieved by New Zealand, all of New Zealand's six MRA-AEO partners and the new EU partner. As for scenario 1, consumer wellbeing decreases for other economies.

New Zealand and its new EU partner both improve their consumer wellbeing by the addition of the NZ-EU MRA-AEO. By comparison, the consumer wellbeing of all other MRA-AEO partners falls with the addition of the NZ-EU MRA-AEO compared with the

[1] https://data.worldbank.org/indicator/ny.gdp.mktp.cd

six-partner arrangement of scenario 1. We can interpret this as the result of a legitimate form of trade diversion. In a sense each partnership is a form of trade pact, which by lowering costs between partners, switches trade away from outsiders.

In scenario 3 (removal of the NZ-US MRA-AEO), consumer wellbeing is below the six-partner MRA-AEO scenario 1 for New Zealand, the United States and Hong Kong. It rises for all other MRA-AEO partners.

Table 3 Consumer wellbeing impact of MRAs for long-run states for selected economies and groups

USD million (refer to Appendix B for lists of country groups)

Country	Scenario 1: Current six MRA-AEOs	Scenario 2: Current six plus NZ-EU	Scenario 3: Current six less NZ-US
Australia	101.6	87.77	108.59
New Zealand	448.07	547.27	382.94
China	50.76	49.87	58.65
Japan	48.31	46.76	55.21
Korea	22.17	21.95	25.22
US	41.87	34.42	-28.35
UK	-17.31	-22.94	-14.62
East Asia	-5.76	-6.36	-4.71
Hong Kong	3.43	3.49	3.15
South East Asia	-34.46	-39.81	-31.44
South Asia	-4.67	-4.96	-3.58
Latin America	-9.07	-14.91	-8.23
Europe (EU countries)	-44.61	53.56	-33.18
Europe (Non-EU)	-2.22	-4.11	-1.76
Russia and Eastern block	-4.72	-6.76	-4.42

Source: NZIER

3.4. Trade balance impact of MRA-AEOs

The results in Table 4 show the changes in the balance of trade (the value of exports at world prices less the value of imports at world prices) in USD million.

The results for scenario 1 suggest that New Zealand's trade balance improves in the long run. The results for Australia are similar. In general, all other MRA-AEO partners show small long-run changes for scenario 1 (six partners). The long-run absolute deterioration in trade balance is larger for China than the others.

Inclusion of an NZ-EU MRA-AEO in scenario 2 improves New Zealand's trade balance in the long run compared with scenario 1 (six partners). Exclusion of the NZ-US MRA-

AEO in scenario 3 decreases the trade balance for New Zealand from scenario 1 (six partners).

The decreases for the large economies are unexpected and we cannot explain them from the present investigation. More research is warranted to understand this effect.

Table 4 Trade balance impact of MRAs for long-run states for MRA-AEO partners

USD million

Country	Scenario 1: Current six MRA-AEOs	Scenario 2: Current six plus NZ-EU	Scenario 3: Current six less NZ-US
Australia	19.45	17.59	23.39
New Zealand	86.1	106.98	73.91
China	-25.82	-33.97	-24.85
Japan	-0.32	-0.73	--0.11
Korea	1.25	0.76	2.03
US	-0.73	-0.69	2.59
Hong Kong	-0.07	-0.07	-0.09
EU	-14.37	-11.79	-14.50

Source: NZIER

3.5. Impact on New Zealand's MRA-AEO partners

Table 1 (above) summarises the changes from scenario 1 for New Zealand and its MRA-AEO partners.

In this study, we assess, as a first-order approximation, the trade facilitation impacts from the six bilateral MRA-AEOs. The benefits accrue to New Zealand and to MRA-AEO partners. There are some detriments. We investigate two hypothetical scenarios: (i) including the European Union in a new MRA-AEO and (ii) excluding the United States from the current set. Results indicate that the former creates new benefits for New Zealand and the EU. By comparison, the latter reduces benefits for New Zealand, while the impact for the US is marginally positive. In general, the changes in benefits are shifted across other bilateral MRA-AEO members. The results should be interpreted as indicative, looking toward further research on the impacts of specific bilateral MRA-AEOs.

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Appendix A Methodology

NZIER's methodology has two steps:

- Measuring the ad valorem equivalent of time.
- Representing the ad valorem equivalent of time in a model of the global economy.

A.1 Measuring ad valorem equivalent of time

Econometricians use gravity type regression models to estimate the costs of non-tariff barriers and their trade-restricting impacts. Djankov, Freund and Pham (2006) demonstrate that a 1-day delay in trade reduces trade volumes by a significant amount.

Hummels et al. (2007) observe that gravity models suffer from two weaknesses:

- The equations require the strong assumption that the causal relationship between time-cost variables and trade is known.
- Gravity equations link infrastructure and waiting times to trade volumes but do not reveal the costs of those wait times in monetary terms.

Hummels et al. (2007) describe a three-step methodology for estimating ad valorem tariff equivalents of shipping delays:

- Estimate the value of 1 day saved in transit (the per-day value of time savings) for each product.
- Calculate the per-day value of time savings for each country, based on the goods it trades or might one day trade.
- Calculate tariff equivalents for import and export waiting times by combining each country's per-day value of time savings with its Trading Across Borders data from the World Bank Doing Business database.

Applying his methodology to data on port shipping times, Hummels (2007) provides ad valorem per-day time costs by four-digit Harmonised System (HS) commodity classification for US imports, underscoring that not only does time matter in trade but the importance (value) of time varies by commodity. For example, while time in trade may be modestly important for household appliances, it can be extremely important for replacement equipment for high-value production.

Hummels (2007) combined time delay cost data with the Doing Business Database on time delays for crossing international borders and found that reported time delays in the movement of international cargo are frequently more significant than tariffs. Following this, Minor (2013) calculated value of time equivalents for different cargo using the World Bank Doing Business data for all 134 countries and regions and 57 sectors in a GTAP framework.

We used the value of time in trade database of Minor (2013) and Hummels and Schaur (2013) who estimated the ad valorem equivalents of time in a global framework following Hummels (2001, 2007). In the case of dairy products, we used an estimate of the ad valorem equivalent, which, in our view, better represented the transit times. NZIER used Hummels' (2001, 2007) methodology for the estimation.

A.2 Representing the tariff equivalent of time in a global trade model

Computable general equilibrium (CGE) models such as GTAP can represent measures of non-tariff barriers and their trade-restricting effects. Traditional barriers to trade, including tariffs and quotas, remain the predominant subject of study in these models when considering trade agreements and trade policy. However, by using a tariff equivalent of time, we can model the impact of time on trade.

Tariff equivalents should be modelled slightly differently from tariffs in the GTAP framework, especially because of the interpretation of total welfare impacts. There is no income to the government by using non-tariff equivalents while the government can benefit from tariffs and therefore there is a redistribution of the income to households.

The GTAP model employs the Armington assumption in the trading sector, which allows the GTAP model to distinguish imports by their origin as well as explain inter-industry trade of similar products. In this way, imported commodities are assumed to be separable from domestically produced goods.

We use the 'AMS' or 'iceberg' approach for modelling trade facilitation in the GTAP model. Walmsley and Minor (2016) describe how this approach has two effects on trade within the Armington structure. It reduces both:

- the importer's price causing substitution towards the good and an increase in quantity demanded
- the amount that needs to be imported to satisfy a given level of demand.

This second effect is interpreted as a productivity shock applied entirely to the importing agents. Importing firms and final consumers reduce their orders with exporters in foreign markets, but still receive the same amount of imports. The argument put forth to explain this direct change in the quantity imported versus the quantity originally exported is that there is potential for less spoilage, theft, breakage or loss in shipment.

Walmsley and Minor note that these two effects work in opposite directions and that the first effect is often larger. They say that the iceberg effect is appropriate to the extent that time delays lead to real costs for the importing firms.

Appendix B GTAP technical specification

B.1 CGE analysis

To capture the economy-wide impact of MRAs, we model the global economy in a computable general equilibrium (CGE) framework. General equilibrium refers to models in which an equilibrium is simultaneously obtained in more than one market. CGE models incorporate data on the structure of production and trade in the economy under consideration.

The starting point for the models is a national input-output table or social accounting matrix (SAM) and a set of trade matrices for multiregional models. This data represents the state of the economy at the base year. Specific functional forms must be employed to define the substitution relationships of a CGE model. Once these are decided, free parameters are obtained (econometric estimation or from the literature.) Profit and utility maximising conditions are then assumed for the base year, allowing the remaining parameters to be determined from the base data through the calibration process.

Simulation in CGE models involves examining comparative static results. Most models consider the role of changes in exogenous parameters (shocks) on the allocation of goods among consumers and of resources among productive activities and the consequences for economic efficiency. The models compare alternative equilibrium states but do not consider the path between the two states. The models thus have no explicit time dimension and instead represent different timeframes by different microeconomic elements of the closure. The results of the static simulations are often interpreted as representing how the economic system in question would have looked had the new policy been in place in the base year after all relevant adjustments had taken place.

B.2 GTAP model

The specific CGE model used in this study is the Global Trade Analysis Project (GTAP) model. This is a multiregional CGE model that has been extensively used in the literature. It has been fully documented in Hertel and Tsigas (1997).

On the demand side, total income is allocated using fixed-value shares across government, household and savings expenditure. The single representative household maximises a constant difference in elasticities (CDE) objective function, which is calibrated to differing income and price elasticities of demand in each region. This allows a rich description of final demand. In each case, consumption is of a constant elasticity of substitution (CES) composite of domestically produced and imported goods.

The production side of the model assumes constant returns to scale technology and perfect competition. Production in each sector in each region is represented by a nested CES function. The model incorporates the Armington assumption, and as such, each firm uses a CES composite of domestically produced and imported intermediate

goods in fixed proportions with a value-added CES composite (based on five endowed factors of production: land; natural resources; unskilled labour; skilled labour; and capital).

We adopt a macroeconomic closure that reflects the choice of the timeframe. It is important to emphasise that the timeframe element cannot be interpreted in terms of calendar years but rather in terms of the adjustment allowed to take place in the transition to a new equilibrium.

We considered, but did not subsequently apply, a neoclassical closure.[2] This means fixing the endowments of productive factors and allowing market prices to adjust to maintain full employment. This type of closure is often interpreted as representing the medium run, since it envisages a situation where the existing capital stock is able to move between sectors in response to variations in the rates of return to capital across sectors. However, the period considered is not long enough for new investment to come online as productive capital.

The closure we did apply in this work is a long-run steady-state closure. In this closure, the rate of return to capital is set exogenously, and the level of the capital stock is allowed to adjust. We can interpret the timeframe here as the time required for both the allocation and the level of capital stock to adjust to a given policy change so as to equilibrate rates of return across sectors and to restore rates of return to their initial levels. The changes under this closure approximate the effect of investment expansion following trade liberalisation in a neoclassical model.

The two macroeconomic closures reflect different assumptions about the current account balance. The first closure, which we did not apply, is the standard GTAP model closure. Global investment is assumed to be responsive to changes in the relative rates of return across regions. This does not affect productive capital stocks but does have an impact on savings and thus on the current account balance in each region.

In the second closure, which is applied here, the current account balance is explicitly fixed. This is a conservative closure and can be interpreted as a partial long-run equilibrium with international capital available to achieve full economy balance.

We have used the latest version of the GTAP (GTAP 9) database, which is explained in detail in Aguiar et al. (2016). The full database contains information on 140 regions and 57 commodities and has base years for different nations of 2004, 2007 and 2011.[3] The New Zealand data is 2007 data. The simulations here are based on an aggregated version of the data consisting of 20 countries or regions and 57 commodities. These are set out below.

Geographical countries: Australia; New Zealand; Oceania; China; Japan; Korea; US; UK; East Asia; Hong Kong; South East Asia; South Asia; North America; Latin America; Europe (EU countries); Europe (Non-EU); Russia and Eastern block; Middle East and North Africa; Sub-Saharan Africa; Rest of the world.

[2] Closure in a CGE model refers to selection of the endogenous and exogenous variables in the model and depends on the question asked in the experiment under action.

[3] Input-output data of countries is usually published every few years (for example, New Zealand input-output tables aim at being published every 5 years), therefore in a global database, we don't have the latest input-output data for all countries. However, because of the aggregation level, those input-output tables show the situation of the global economy.

Geographical regions referred in text:

East Asia: Mongolia; Taiwan; Brunei Darussalam; Korea; Democratic People's Republic of Macau

South East Asia: Cambodia; Indonesia; Lao People's Democratic Republic; Malaysia; Philippines; Singapore; Thailand; Vietnam; Myanmar; Timor-Leste

South Asia: Bangladesh; India; Nepal; Pakistan; Sri Lanka; Afghanistan; Bhutan; Maldives

Latin America: Argentina; Bolivia; Brazil; Chile; Colombia; Ecuador; Paraguay; Peru; Uruguay; Venezuela; Rest of Latin America

Europe (EU countries): Austria; Belgium; Cyprus; Czech Republic; Denmark; Estonia; Finland; France; Germany; Greece; Hungary; Ireland; Italy; Latvia; Lithuania; Luxembourg; Malta; Netherlands; Romania; Poland; Portugal; Slovakia; Slovenia; Spain; Sweden: Bulgaria; Croatia

Europe (Non-EU): Switzerland; Norway; Albania; Ukraine; Rest of Europe

Russia and Eastern block: Russia; Tajikistan; Turkmenistan; Uzbekistan

List of sector aggregates for GTAP: Paddy rice; Wheat; Cereal grains; Vegetables, fruit, nuts; Oil seeds; Sugar cane and sugar beet; Plant-based fibres; Other crops; Cattle; Animal products; Raw milk; Wool; Forestry; Fishing; Coal; Oil; Gas; Minerals; Cattle meats; Other meat; Vegetable oils; Dairy products; Processed rice; Sugar; Other food products; Beverage and tobacco; Textiles; Wearing apparel; Leather products; Wood products; Paper products, publishing; Petroleum and coal products; Chemical, rubber and plastic products; Non-metallic minerals; Iron and steel; Non-ferrous metals; Metal products; Motor vehicle and parts; Other transport equipment; Electronic equipment; Other machinery and equipment; Other manufacturing; Electricity; Gas; Water; Construction; Trade (retail and wholesale); Road and rail transport; Water transport; Air transport; Communications; Financial services; Insurance; Other business services; Recreation; Government services; Dwellings.