E Economy-wide modelling of economic integration

This supplementary paper documents modelling undertaken to illustrate the effects of various aspects of integration on the Australian and New Zealand economies. The Australia–New Zealand Economic Analysis (ANZEA) model was developed specifically for this study, and was based on the Global Trade Analysis Project (GTAP) model. It is a global general equilibrium model, which identifies separately Australia and New Zealand and 23 other economies (appendix A).

Section E.1 outlines the five scenarios which are modelled. The following section (E.2) summarises the features of the model, while section E.3 contains details and results of the scenarios examined. Due to a lack of information about the possible effects investigated, some of the simulations are based on an arbitrary 1 or 10 percent change (that is shocks). Results from these types of simulations can therefore be interpreted as 'reaction elasticities' of the economies to the shocks modelled.

Section E.4 presents a sensitivity analysis based on varying assumptions about key parameters. The ranges of effects on aggregate incomes are summarised in table E.14 to facilitate comparisons across simulations.

E.1 Scenarios

This paper contains simulation results and sensitivity analysis for five scenarios.

- *Eliminating Australian and New Zealand tariffs on imports from all sources* — which has the potential to provide gains from reallocating resources across industries in Australia and New Zealand. (Tariffs between Australia and New Zealand have already been all but eliminated, thus modelling a reduction in trans-Tasman tariffs or related impediments to goods trade would not produce any noticeable benefits other than for the industries immediately affected. Likewise, given the small numbers of items and corresponding volumes of trade subject to a tariff of exceeding 5 percent, modelling a reduction of tariffs to 5 percent does not produce noticeable benefits at the aggregate level.)

- *Productivity improvements in Australia and New Zealand* — which increase incomes and demand for imports from the partner country and simultaneously improve competitiveness, which reduces the partner country's exports.
- *Economic growth in Asia* — which produces gains for both Australia and New Zealand.
- *Migration from New Zealand to Australia* — which increases gross national product (GNP) in Australia and reduces it in New Zealand, and increases GNP per person in New Zealand and reduces it in Australia. Workers who move increase their wage, while the wage differential between Australia and New Zealand decreases.
- *Liberalising trade in services via commercial presence (by reducing barriers to trans-Tasman foreign direct investment (FDI) in services)* — which provides benefits to both countries. Only removing barriers to telecommunications trans-Tasman FDI provides small gains, which are increased if both countries remove barriers to all foreign communications.

There are numerous caveats to the results presented in this paper. For example:

- the modelling does not include dynamic effects that might result from the scenarios
- the results also abstract from scale effects. Accounting for these effects would require substantial adjustments. In practice, scale effects are likely to be relatively small at the economy-wide level and are more likely to appear in reaction to large changes in economic environment.

E.2 Modelling framework

The ANZEA model is a multi-region computable general equilibrium (CGE) model of the global economy. It has been developed for the purpose of this study.

Model development

The ANZEA model is derived from the GTAP model and database. The GTAP model has been widely used to analyse the national and global effects of policy changes, with a particular focus on international trade.

The ANZEA model was developed as a simpler and more transparent version of the GTAP model. Its structure allows it to be solved more quickly than the GTAP model.

This facilitates a greater focus on:

- alternative model formulations and specifications for individual scenarios
- database calibration
- error checking
- sensitivity testing.

The ANZEA model differs from the GTAP model in two key respects.

First, the structure of the ANZEA model is relatively simple compared to that of the GTAP model. Specifically, the design of the ANZEA model starts from the minimum number of equations that is required to solve the general equilibrium problem. It therefore has fewer equations than the GTAP model and fewer indicator variables, such as those that aggregate quantity and price variables to national and industry levels.

All CGE modelling projects involve altering or extending a base model to meet the specific demands of the project. The simple structure of the ANZEA model makes it easier to make such alterations. This is because each component of the core system of equations is clearly defined and can be easily replaced by an alternative component or linked with an extension.

Second, the ANZEA model accounts for bilateral capital flows. In the GTAP model, national savings are collected in a global bank; global savings are then reallocated across the world to finance national investments. The ANZEA model accounts for capital in three dimensions: that is, capital used by industry *j* in host country *h* is owned by households in source country *s*. The productive capacity is attributed to the sector in the host country, while post-tax capital incomes are returned to residents in the source region. Bilateral capital flows are sourced from a database created by Lakatos and Walmsley (2011).

The bilateral capital structure allows the model to be used to analyse the effects of initiatives that affect the commercial presence of services and FDI more broadly.

Model structure and theory

The ANZEA model is a ‘bottom-up’ model, which includes a range of industries, commodities and labour types. Each country’s economy is modelled separately, with bilateral trade linkages to all other countries. The model includes:

- 57 industries and commodities in each economy (appendix A)

- 25 separate economies with Australia, New Zealand and the world's major economies identified separately (appendix A)
- region-specific skilled and unskilled labour markets
- region-specific sources of final demands (including consumption, investment, government and export demands)
- region-specific household sectors, which supply production factors, consume privately and publically supplied goods and services, and pay income and commodity taxes
- bilateral trade flows between all regions
- capital flows, identified by source and host country, as well as the industry destination of the capital.

Important elements of the behavioural structure of the ANZEA model (most of which are shared with the GTAP model and other global trade models) include:

- households change their consumption bundles in response to changes in their incomes and in relative prices, using the Constant Difference Elasticity (CDE) functional form (McDougall, 2003) and subject to a budget constraint that is defined by the relevant factor income
- producers adapt their output and their use of intermediate inputs and primary factors in response to changes in relative prices, using a 'constant-returns-to-scale' production technology
- productivity improvements can be modelled as a reduction in the amount of resources required per unit of output
- final demands in a region substitute between domestic and imported sources of goods and services based on relative prices
- firms substitute between domestic and foreign sourced capital based on relative prices.

The theory in the ANZEA model is summarised in appendix B.

The comparative static version of the model is used to illustrate the long-run impacts of the scenarios. The results are presented in terms of percentage changes relative to the base, and are best interpreted as how the economy would differ if the agents faced the environment reflected in the modelled shocks, rather than the one that is reflected in the base data.

The following closure was used for the majority of the simulations.

- Labour and land are fixed at the country level, but can move between industries.
- Capital can move between industries and countries; the capital owned by each country is fixed. Each country allocates its capital in such a way that each additional unit of capital earns the same return.
- Tax rates on consumption, income, production, exports and imports are all fixed.

In the trans-Tasman migration simulation, capital was held fixed to isolate the effects of labour migration from the effects of any capital movement that may occur.

E.3 Scenarios and results

Five scenarios were modelled to illustrate the effects of:

- removing remaining most-favoured-nation (MFN) tariffs
- productivity improvements in Australia and New Zealand
- Asian economic growth (box 3.11, chapter 3 in the discussion draft)
- trans-Tasman migration (box 4.6, chapter 4 in the discussion draft)
- reducing barriers to commercial presence bilaterally and multilaterally.

Results are presented both as percentage changes from base and as changes in 2004 US$ (box E.1).

Box E.1 **Presentation of results**

Results presented in this paper are 'comparative static'. Comparative static results show how different the economies would be if the policy environment were different, holding everything else constant. The percentage changes indicate the difference the simulated shocks make, relative to the base.

The model is supported by the GTAP version 7 database (Narayanan et al 2008). The base year of the data is 2004. The data are assembled from a wide variety of sources and are a reasonable representation of the global economy around that time. The experiments conducted in the simulations are assumed to occur in 2012 or sometime thereafter. For these illustrations it is therefore assumed that the database is a reasonable representation of the current and future global economy.

Results in this paper are presented in 2004 US$, consistent with the database. It is possible to convert these results into 2010 A$ and NZ$ by using the conversion factors in the table below.

Table **Conversion factors, Australia and New Zealand[a]**

		Data		*Conversion factors[a]*	
Year	*Units*	*Australia*	*New Zealand*	*Australia*	*New Zealand*
		Billions	Billions		
2004	US$ 2004	612	88	na	na
2010	US$ 2010	1 220	138	2.0	1.6
2010	A$ 2010	1 365	154	2.2	1.8
2010	NZ$ 2010	1 715	194	2.8	2.2

[a] These factors can be applied to 2004 US$ amounts reported in this paper to obtain orders of magnitude in national currencies. Conversion factors are derived from GDP data from the IMF's World Economic Outlook Database and exchange rate data from the UN Comtrade database.

Sources: GTAP database; World Economic Outlook Database (2012); UN Comtrade database (2012).

Removing most-favoured-nation (MFN) tariffs

As a result of the Australia–New Zealand Closer Economic Relations Trade Agreement, tariffs and quantitative restrictions on trans-Tasman trade have been all but eliminated (supplementary paper A). Only a few products are subject to a tariff greater than 5 percent (table E.1). For this reason modelling any reduction in tariffs to 5 percent does not provide any significant gains.

Table E.1 **Comparison of current Australian and New Zealand tariffs**
HS-8 nomenclature

Tariff rate grouping	*Australia*		*New Zealand*	
	No.	%	No.	%
Zero rate	2944	47.6	4314	57.4
4 percent	11	0.2	0	0
5 percent	2987	48.3	2638	35.1
10 percent	226	3.7	417	5.6
Specific tariff rate[a]	17	0.3	141	1.9
Total	**6185**	**100.0**	**7510**	**100.0**

[a] Some specific tariff rate items for New Zealand relate to excise tariffs.

Sources: Australian Customs Service and New Zealand Customs Service.

Shocks

Tariffs still exist on many imports from other countries. Eliminating these tariffs has the potential to produce economic gains as resources are reallocated within a country, and imports are sourced from the most cost-effective international supplier.

This simulation sets all MFN tariffs — and therefore the average tariffs — to zero in Australia and New Zealand to illustrate the size of these economic gains. For most industries, the tariffs used in the simulation are based on the 2004 GTAP database. However, textiles, clothing and footwear, and automotive tariffs have been lowered in both Australia and New Zealand since 2004. Tariffs for 2010 sourced from the World Bank's World Integrated Tariff Solutions (WITS) were therefore used for these industries. As a result of different import patterns, imports from different countries are subject to different average tariffs (table E.2).

Table E.2 **Sample of average tariffs, Australia and New Zealand, 2010**

Source of imports	*Australia*	*New Zealand*
	%	%
China	3.7	3.6
Japan	3.3	4.3
Republic of Korea	2.9	2.7

Sources: GTAP database; WITS.

Results

Setting tariff rates to zero for both Australia and New Zealand leads to an increase in imports for commodities where tariffs previously existed (such as textiles and clothing) and a contraction in the corresponding domestic industries (table E.3). For example, the wearing apparel industry in Australia is no longer protected by an 8 percent tariff. Removing the tariff leads to a 13 percent increase in imports of wearing apparel into Australia, and a reduction in Australian production of 6 percent.

The reduction in output in these formerly protected industries frees up labour and capital to be employed in industries where they can be used more productively (especially metals and minerals in Australia, and livestock in New Zealand). This leads to an expansion in the more productive industries and an increase in gross domestic product (GDP) of 0.3 percent for Australia and 0.4 percent for New Zealand (table E.4).[1] Also, returns to Australian and New Zealand capital increase which attracts additional capital from abroad. This additional capital increases Australian and New Zealand GDP; it is remunerated through remittances to foreigners, which account for the smaller increase in GNP than in GDP in table E.4.

Detailed industry results are presented in table E.18 in appendix C.

These results abstract from the potential gains associated with eliminating the rules of origin (discussed in supplementary paper A), which can range between 1.5 and 8 percent of the value of imports (PC 2010). Such cost savings add to the reallocation gains that are reported in table E.4.

Table E.3 **Effects of removing MFN tariffs on contracting industries**

	Australia			*New Zealand*		
	Size of tariff removed	*Increase in imports*	*Change in output*	*Size of tariff removed*	*Increase in imports*	*Change in output*
	%	% changes	% changes	%	% changes	% changes
Textiles	4.4	4.1	-3.3	2.3	2.3	-3.0
Wearing apparel	7.6	13.4	-6.2	7.1	18.7	-8.0
Motor vehicles and parts	3.5	2.9	-1.0	4.3	6.8	-3.0

Source: Australian Commission estimates.

1 These results abstract from any dynamic gains that might arise from tariff reductions, including from expansions in global capital availability. Such gains were included in the modelling conducted in PC (2010).

Table E.4 **Effects of removing MFN tariffs on GDP, GNP and industry value-added**

	Australia		*New Zealand*	
	% changes	*US$m*[a]	*% changes*	*US$m*[a]
GDP	0.3	1 598	0.4	397
GNP	0.1	814	0.2	158
Industry results				
Minerals (e.g. iron ore, uranium)	1.2	153	0.8	–
Food products	0.5	220	1.2	156
Textiles, wearing apparel and leather	-4.4	-343	-4.5	-89
Motor vehicle and parts	-1.0	-139	-3.0	-40
Metals (e.g. steel, iron, aluminium)	4.0	620	3.0	30
Other manufacturing	-0.4	-171	-0.3	-22
Services	0.2	1 262	0.5	335

[a] Results are in 2004 US$. – less than 0.5.

Source: Australian Commission estimates.

Productivity improvements in Australia and New Zealand

Domestic reforms and technological improvements can improve the way in which resources are organised and reduce costs, thus improving productivity. To illustrate the effects of productivity improvements on each trans-Tasman partner, an improvement in factor augmenting technical change of 1 percent for all factor inputs in each economy was modelled.

In the ANZEA model, productivity improvements in one country (country A) affect output in its trading partner (country B) in three ways.

- They increase the relative competitiveness of country A, expanding its global market share and output, and decrease that of country B, decreasing its output.
- They increase returns to factors and incomes in country A, which increases demand for imports from country B and its aggregate output.
- An increase in returns in country A causes factors to shift from country B to country A. This contributes to decreasing aggregate output in country B.

The results stem from two separate simulations in which:

- shocks were applied separately for Australia and New Zealand
- capital can move between all countries, but other primary factors are fixed.

Results

A 1 percent productivity improvement in all factors translates into a 1 percent increase in GDP for the country in which the improvement occurs, when factors are fixed at the country level. When factors are free to move across countries, a 1 percent productivity improvement in all factors translates into a greater than 1 percent increase in GDP, as internationally-owned capital shifts to the country experiencing the productivity improvement in response to improved rates of return (table E.5).

Productivity improvements in New Zealand

Productivity improvements in New Zealand have little measurable effect on Australian aggregates. That said,

- growth in New Zealand incomes leads to increased consumption, and a 1.1 percent increase in New Zealand's demand for Australian exports (table E.6)
- there is some substitution in favour of New Zealand sourced production in global markets (in particular, in agriculture and food manufacturing), which contributes to an increase in New Zealand production and reduces Australian exports to these markets by 0.05 percent.

Increased incomes arising from an increase in Australian exports would in isolation lead to an increase in the consumption of domestically produced goods. However, an increase in the consumption of domestically produced goods is not observed in the results. This is in part due to a 0.01 percent movement of Australian capital to New Zealand (where it could be used more productively), which reduces the productivity of labour and thus incomes in Australia. Also, there is a substitution towards cheaper New Zealand imports (an increase of 0.04 percent) from the consumption of domestically produced goods.

Table E.5 **Effects of productivity improvements on GDP, Australia and New Zealand**

	Effect on GDP	
Productivity improvement in:	*Australia*	*New Zealand*
	% changes	% changes
Australia	1.327	-0.025
New Zealand	-0.003	1.407

Source: Australian Commission estimates.

Table E.6 **Effects on the Australian economy from productivity improvements in New Zealand**

	Effect on Australian aggregates	
	% changes	US$m
Domestic consumption	0.00	0
Total exports	0.02	27
Trans-Tasman exports	1.14	73
Other exports	-0.05	-46
Imports	0.04	44
GDP	0.00	-17

Source: Australian Commission estimates.

Thus, the increase in Australian exports is offset by an increase in imports and a decrease in domestic consumption (table E.6). Effects on industry outputs are presented in table E.19 in appendix C.

Productivity improvements in Australia

A similar story can be told when productivity improves in Australia. An increase in Australian consumption leads to an increase in Australia's demand for New Zealand exports, most notably food and other manufacturing (table E.7).

Australian demand accounts for 22 percent of New Zealand's total exports, and exports account for a third of New Zealand's GDP (Statistics New Zealand 2012a, 2012b). If these proportions remained the same and Australian gross domestic absorption increased by 1 percent, New Zealand's exports and GDP would increase by approximately 0.22 percent and 0.07 percent, respectively.

Table E.7 **Effects on New Zealand of productivity improvements in Australia**

	Effect on New Zealand aggregates	
	% changes	US$m
Domestic consumption	-0.01	-14
Total exports	0.04	11
Trans-Tasman exports	0.84	43
Other exports	-0.15	-32
Imports	0.08	21
GDP	-0.02	-24

Source: Australian Commission estimates.

This simple input-output calculation does not account for the effects of behavioural responses to price changes, or capacity constraints in either economy, which will reduce this effect. Furthermore, this effect is offset by a 0.15 percent export contraction that New Zealand firms experience in other foreign markets as a result of improved Australian competitiveness. Also, New Zealand consumption decreases by 0.01 percent as the productivity of its labour (and thus labour income) decreases as a result of the capital movement from New Zealand to Australia (a 0.08 percent reduction in capital located in New Zealand). Overall, a 1 percent increase in Australia's productivity contributes to a 0.02 percent reduction in New Zealand GDP.

Asian economic growth

Shocks

The ANZEA model was used to illustrate the effects on Australia and New Zealand of a 10 percent increase in economic growth for all Asian economies. In 2011, China and India grew by approximately 9.1 and 6.9 percent respectively (Word Economic Outlook Database 2012). This expansion was modelled as a uniform expansion in labour and capital (and therefore their corresponding incomes) in all Asian economies.

Results

A 10 percent increase in the size of Asian economies has two main effects on the Australian and New Zealand economies:

- First, as Asian incomes rise, Asian economies increase their demand for Australian and New Zealand (and other) exports. Australian and New Zealand exports to Asia increase by 3.1 and 3.4 percent respectively.
- Second, the increase in Asian primary factors leads to a reduction in production costs in Asian economies, which in turn crowds out Australian and New Zealand exports on global markets. Accordingly, Australian and New Zealand exports to non-Asian countries decrease by 3.0 and 1.7 percent. Asian growth also crowds out Australian and New Zealand exports to Asian markets (counteracting the first effect mentioned above).

The combination of these two effects translates into small increases in Australian and New Zealand exports (0.6 and 0.3 percent, respectively). Exports represent approximately 20 percent of GDP for Australia and 30 percent of GDP for New

Zealand. This means that the effect on GDP for both countries is in the order of 0.1 percent (table E.8).

At the industry level, growth in the Asian construction sectors (especially in China) translates into increased demand for Australian mining output (table E.9). Also, growth in Asian consumer demand (especially in the Association of South East Asian Nations (ASEAN)) translates into increased demand for agricultural goods, especially dairy and meat products from New Zealand. In both Australia and New Zealand, manufacturing industries contract as a result of crowding out by Asian exports. Factors from the manufacturing industries move to the service industries (and the expanding export industries mentioned above), which expand as Australian and New Zealand incomes increase. More detailed industry results are presented in table E.20 in appendix C.

Table E.8 **Effects of a 10 percent increase in Asian economies on trade and GDP in Australia and New Zealand**

	Australia		*New Zealand*	
	% changes	*US$m*	*% changes*	*US$m*
Exports to Asia	3.1	2 001	3.4	361
Other exports	-3.0	-1347	-1.7	-285
Total exports	0.6	654	0.3	75
GDP	0.1	906	0.1	137

Source: Australian Commission estimates.

Table E.9 **Effects of a 10 percent increase in Asian economies on GDP, industry outputs and exports in Australia and New Zealand**

	Australia		*New Zealand*	
	% changes	*US$m*	*% changes*	*US$m*
Output				
Agriculture[a]	0.1	62	0.1	24
Mining	1.5	385	0.6	1
Manufacturing	-1.0	-816	-0.8	-126
Services	0.2	1 076	0.2	174
Exports				
Agriculture[a]	0.3	74	0.4	42
Mining[b]	3.0	685	3.0	5
Manufacturing	-0.6	-241	-0.8	-70
Services	0.5	135	1.3	97

[a] Includes food processing. [b] Mining accounts for only 0.64 percent of New Zealand exports. Thus even a large percentage change in mining production contributes only a small change in New Zealand output. In contrast, mining accounts for more than 21 percent of Australian exports, and contributes significantly to output.

Source: Australian Commission estimates.

Trans-Tasman migration

The purpose of this simulation is to illustrate the mechanisms that are at work in trans-Tasman migration. Since the 1970s, the flow of migrants has been mainly from New Zealand to Australia.

Migration is positively related to the expected benefit from migrating. These net benefits are composed of any additional income that might arise from migrating, including additional income from higher remuneration less any costs of migration. Abstracting from any differences in welfare benefits, and for a given level of costs, migration can be expected to occur as long as there are large enough differences in wages between Australia and New Zealand. Migration from New Zealand to Australia reduces this wage differential, as labour supply increases in the host country, and decreases in the source country.

Shocks and assumptions

To illustrate the effects of trans-Tasman labour migration, a 1 percent increase in the supply of New Zealand labour in Australia was modelled. This translates into a movement of approximately 3000 workers and is equivalent to a 0.13 percent decrease in the supply of labour in New Zealand and a 0.02 percent increase in the supply of labour in Australia.

The simulation concentrates on the effects of the movement of labour and abstracts from so-called 'government-transfer shopping' (supplementary paper D). It does not attribute the modelled migration flow to any factor, but assumes that it reduces the trans-Tasman wage differential, which is allowed to adjust in response to this movement. The migrants are assumed to share the same average characteristics as Australians. They are assumed to (i) have similar qualifications and skills as Australians (and New Zealanders who remain in New Zealand), and (ii) be accompanied by a typical family (the structure of families in Australia and New Zealand are similar). The new demand for goods and services (for example, education and health) generated by the migrants is assumed to be similar to that generated by Australians. The analysis abstracts from foreign remittances as these have historically been a small fraction of income earned by New Zealanders abroad.[2] It is assumed that capital cannot move between countries. This

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2 Based on the number of New Zealand citizens working abroad (Statistics New Zealand 2012c) and current New Zealand remittance data (Migration and Remittances Database 2012), the average remittances paid back to New Zealand per person is just under $1 700 per year.

assumption isolates the effects of labour migration from the effects of any capital movement that may occur.

Results

An increase in the supply of labour in Australia increases output and income in Australia, while the reverse occurs in New Zealand (table E.10). Given that labour income represents approximately 60 percent of GDP in Australia and 50 percent of GDP in New Zealand, the effect on GDP for both countries is in the order of half the modelled change in labour supply. Output per worker in Australia declines as more workers are spread across the existing capital stock, while the converse occurs in New Zealand.

Workers who migrate are better off as a result of the move. Applying model results to wage data for 2008 (OECD 2012) suggests that on average, workers who leave New Zealand increase their wage by approximately 26 percent.[3] With greater numbers of migrants (a greater shock), the average wage increase becomes smaller, and the wage gap between the two countries is reduced further.

The assumed migration behaviour is highly stylised and does not, for example account for lifestyle preferences and other determinants of migration. Also, migrant labour is assumed to substitute for incumbent labour. To the extent that New Zealand workers complement incumbent workers in Australia, the projected increase in Australian GNP could be increased and the projected reduction in Australian GNP per worker could be reduced.

Table E.10 **Illustrative effects of trans-Tasman migration[a,b]**
Percentage changes relative to base

	Australia	*New Zealand*
Change in employment	0.02	-0.13
GNP	0.01	-0.08
GNP per worker	-0.01	0.06

a 1 percent increase in New Zealand labour in Australia. **b** Sensitivity analysis did not produce ranges that are significantly different from the results reported.

Source: Australian Commission estimates.

3 Given the small shock modelled, this is equivalent to the initial gap between Australian and New Zealand wages, as reported by OECD (2012).

Reducing barriers to commercial presence

The purpose of these simulations is to illustrate the effects of barriers to trade in services in the form of barriers to commercial presence. These barriers can be barriers to establishment or barriers to ongoing operations. There are other barriers to trade in services (in particular, barriers that increase the cost of cross-border trade) but they are not considered here.

The barriers are assumed to apply only to FDI capital. FDI capital is assumed to be imperfectly substitutable and to earn different returns by industry and country.

Shocks

The shocks for these scenarios are derived from a Centre for International Economics (CIE 2010) report on *Quantifying the benefits of services trade liberalisation* (box E.2). CIE (2010) examined the economic impact of reducing global barriers to services trade, by reducing barriers to cross-border trade in direct service provision (mode 1) and foreign commercial presence in service industries (mode 3).

The shocks used for this project are a subset of the CIE's shocks: a reduction in barriers to commercial presence (mode 3) in Australia and New Zealand on trans-Tasman investment and on a non-discriminatory basis. These barriers are represented by two wedges between efficient cost of provision and market price:

- *Rent-creating barriers faced by foreign firms*. Rent-creating barriers impose costs of entry for new foreign firms, allowing incumbent foreign firms to earn rents. Barriers such as screening requirements increase the cost for new foreign firms to enter the market, without increasing the marginal cost for foreign firms. Ex ante, foreign firms must anticipate that once they have entered the market their ongoing costs will be sufficiently below the expected domestic price to enable them to earn a return on their total investment (including the entry cost). Once a foreign firm has entered the market, its entry costs are sunk. If it prices at its marginal cost (that is, if it does not recover its sunk cost), consumers benefit from lower prices, and established firms lose the rent they were previously earning. If the firm prices above marginal cost (given the barrier to entry still faced by any new entrants), the wedge between their marginal cost and the market price accrues to them as a rent.[4] The removal of

[4] These barriers could also create rents for domestic firms. However, domestic firms have never had to overcome the barrier to foreign investment; it is therefore likely that their operating costs are close to the market price. Further, given the lack of barriers

these barriers was modelled as a *reduction* in a rent in excess of normal returns to foreign-owned capital, all of which accrues to investors.

Box E.2 CIE calculation of barriers

The CIE used FDI Regulatory Restrictiveness Index (FRRI) data collected by the OECD to calculated its shocks. The FRRI attempts to quantify the level of restrictions placed on FDI investment by sector for different countries. Four types of measures are covered by the FRRI (see table below). The highest score for a measure is 1 (the measure fully restricts foreign investment in the sector) and the lowest is 0 (there are no regulatory impediments to FDI in the sector). The total FRRI score for each sector is obtained by adding the scores for all four types of measures.

Table Coefficients on FDI restrictions

	Scores
Foreign equity limits	
No foreign equity allowed	1
1 -19 % foreign equity allowed	0.6
20-34% foreign equity allowed	0.4
35-49 % foreign equity allowed	0.3
50-74% foreign equity allowed	0.2
75-99% foreign equity allowed	0.1
Screening and Approval	
Investor must show economic benefits	0.2
Approval unless contrary to national interest	0.1
Notification	0.05
Other Restrictions	
Board of directors/Managers	
majority must be nationals or residents	0.1
at least 1 must be national or resident	0.05
must be locally licensed	0.025
Movement of people	
no entry	0.1
less than one year	0.075
one to two years	0.05
three to four years	0.025
Input and Operational Restrictions	
domestic content must be more than 50%	0.1
other	0.05
Total[a]	**Between 0 and 1**

[a] If foreign equity is banned, then the other criteria become irrelevant, so that the Index is at 1.0. The Index is also capped at 1.0.

(Continued next page)

limiting the shift of investment between domestic sectors (such as from manufacturing to services) any rents would be likely to be bid away.

Box E.2 (continued)

The CIE calculated its barriers by:

- statistically estimating the relationship between the FDI to GDP ratio and each element of the FRRI
- using this estimate to determine how each country's FDI stock will change if its barriers were removed (FRRI set to zero)
- converting these changes in FDI stock to a price equivalent using price elasticities of capital derived from historical data.

Screening barriers were modelled as rent-creating barriers, while equity and operational restrictions were modelled as cost-escalating barriers.

Sources: OECD (2006); CIE (2010).

- *Cost-escalating barriers.* Cost-escalating barriers — such as a reporting requirement imposed on foreign firms — increase the ongoing costs of operation for (part- or wholly-owned) foreign firms. This blocks potentially lower-cost foreign entrants (who may have lower marginal costs than domestic producers, but for the cost-escalating barrier), protecting higher-cost domestic suppliers. The removal of these barriers was modelled as capital augmenting technical change on foreign-owned capital, which is equivalent to an *increase* in the productivity of capital.

Three different scenarios that reduced the barriers to commercial presence were modelled to illustrate the effects of reducing barriers on services.

- A reduction in trans-Tasman barriers to FDI in all services industries.
- A reduction in trans-Tasman barriers to FDI in communications industries.
- A reduction in the barriers to FDI in communications industries irrespective of where the FDI originates.

A reduction in the barriers to commercial presence in the communications industry was modelled separately as an example of the magnitude of gains in a sector that provides services to households as well as intermediate input services to businesses. The barriers that were removed are summarised in table E.11.

Table E.11 **Estimated barriers to commercial presence**

	Rents on foreign capital		*Cost-increasing effects*	
	Australia	*New Zealand*	*Australia*	*New Zealand*
	% of the return to foreign capital	% of the return to foreign capital	%	%
Trans-Tasman barriers				
Barriers to services[a]	18.5	15.4	2.4	0.9
Barriers to communications	6.9	6.2	4.5	3.1
Barriers with all partners				
Barriers to communications[b]	1.7	2.5	1.1	1.2

[a] Weighted average of barriers for all services industries. [b] The weighted average of barriers for all foreign countries in the communications sector is smaller than the equivalent trans-Tasman barriers because relatively low barriers are assumed to apply to capital owned by USA and Europe in both Australia and New Zealand.

Source: CIE (2010).

Barriers to services

Removing the barriers to Australian commercial presence in New Zealand services, reduces the rental rate of capital. The reduction in the cost of this source of capital leads to an increase in its level, an increase in the total amount of capital located in New Zealand, and an increase in New Zealand GDP.

The same mechanism applies when barriers to New Zealand commercial presence in Australia are reduced. However, even though the Australian barriers are larger than New Zealand's, the effects are much smaller because Australia's share of New Zealand's capital stock is much larger than New Zealand's share of Australia's capital stock (5.2 percent compared to 0.2 percent).

The net effect of removing trans-Tasman barriers to commercial presence is a relatively large increase in capital in New Zealand and a relatively small decrease in capital in Australia. This results in an increase in New Zealand GDP of 1.2 percent and a decrease in Australian GDP of 0.05 percent (table E.12).

When the increase in returns to Australian capital in New Zealand are considered, Australian GNP (which includes income from Australian-owned capital) increases by 0.04 percent. Similarly, for New Zealand, the change in GNP is smaller than it is for GDP because of the increased capital stock owned by Australia and related returns paid to Australian capital owners. New Zealand GNP also grows because labour incomes in New Zealand increase with a greater capital stock.

Table E.12 **Effects on GDP and GNP of eliminating barriers to commercial presence**

	Australia	*New Zealand*
	% changes	% changes
GDP		
Preferential		
Remove trans-Tasman barriers to FDI — all services	-0.05	1.23
Remove trans-Tasman barriers to FDI — communications	0.0	0.03
Non-preferential		
Remove barriers to FDI all countries — communications	0.03	0.08
GNP		
Preferential		
Remove trans-Tasman barriers to FDI — all services	0.04	0.72
Remove trans-Tasman barriers to FDI — communications	0.00	0.01
Non-preferential		
Remove barriers to FDI all countries — communications	0.01	0.03

Source: Australian Commission estimates.

Barriers to Communications

The New Zealand economy gains more strongly than Australia's as a result of removing of trans-Tasman barriers to FDI in communications. The share of communications capital in Australia and New Zealand are relatively similar (4.4 and 5.3 percent respectively), but Australia contributes a much larger share of New Zealand's foreign-owned capital (17.1 compared with 0.7 percent). Reducing the cost for incumbent foreign capital by removing cost-escalating barriers (and attracting more capital by removing rent-creating barriers) creates proportionately larger gains for New Zealand.

Trans-Tasman telecommunications FDI is a small share of the total capital stock for both Australia and New Zealand (less than 0.2 percent). However, the total stock of foreign owned telecommunications capital is 1.2 percent for New Zealand, and 1.0 percent for Australia. Given the much larger base of foreign-owned capital, reductions in barriers to telecommunications FDI from all sources has the potential to provide larger economy-wide gains.

E.4 Sensitivity analysis

Sensitivity analysis is used to examine the sensitivity of model results to changes in parameters (such as elasticities and cost shares). Varying combinations of parameters shows the likely range of results. When a number of parameters need to be varied, comprehensive sensitivity analysis can be time consuming, as it requires a large number of simulations.

One of the key reasons for using the ANZEA model in the current study was the relative ease with which sensitivity analysis could be performed. CGE models are typically large and take a long time to solve. The ease of solving the ANZEA model, its simplified and more transparent structure, and its easily modified core make the process of performing sensitivity analysis more straightforward than comparable models (such as, for example, GTAP and G-Cubed).[5] Reduced simulation times allow more detailed sensitivity analyses to be conducted within reasonable timeframes. For the version of the ANZEA model used, a simulation takes less than half the time required to solve a comparable GTAP simulation.

A comprehensive sensitivity analysis examining a range of input parameters simultaneously (for example, via Monte Carlo simulation) would require several thousand simulations for each scenario, which is impractical. As an alternative, the Commissions have used a technique called Gaussian Quadrature (box E.3), which reduces the number of simulations required.

Central values and ranges of the model parameters varied in the sensitivity analysis are presented in table E.13. The parameters chosen were those whose estimates are judged to be most uncertain or judged most likely to affect results.[6] The parameters of interest are varied by +/- 50 percent, assuming both a uniform and a triangular distribution (box E.4). Any of the assumptions underlying the Gaussian Quadrature analysis can be varied for further modelling.

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5 G-Cubed is a multi-region, multi-sector, dynamic CGE model that incorporates the financial sectors.

6 These parameters do not affect migration results much. Other parameters (including database values) are likely to affect these results more. This latter factor has not been investigated in the context of the study.

Box E.3 **Gaussian Quadrature for sensitivity analysis**

CGE results are sensitive to a range of parameters (such as elasticities and cost shares). A lot of uncertainty characterises the levels of these parameters. Varying key parameters can provide insights into the robustness and range of results. Gaussian Quadrature (GQ) is one approach for conducting sensitivity analysis.

The GQ approach treats key parameters as random variables with associated distributions. Based on distributions assumed for the parameters, the GQ approach produces estimates of means and standard deviations of model results. These means and standard deviations can then be used to derive confidence intervals.

The mean and standard deviation of a known probability distribution can be calculated from first principles if the distribution takes a simple form. If the distribution is unknown or takes a complicated form, then an approximation may be required. The distributions of CGE model results are generally unknown and would be complex if they were known. For the ranges presented in the study, a uniform distribution was chosen to reflect the lack of knowledge about the properties of the parameter values; this produces larger ranges in model results than alternative assumptions, such as triangular or normal distributions. Sensitivity analysis using the triangular distribution was also undertaken and is presented in table E.14.

The 'low' and 'high' results presented in this section represent a 95 percent confidence interval of the model results. This is conditional on all other assumptions incorporated in the model, and does not reflect uncertainty regarding the functional forms in the model, model closure, other parameter values, or the specifications of shocks and scenarios.

The GQ approach has been used in various CGE applications (Beckman and Hertel 2009; Hertel et al. 2003; Piet 2002). A more detailed explanation of the GQ approach is presented in Arndt (1996).

Source: Arndt (1996).

Table E.13 **Parameters varied in the sensitivity analysis**

Substitution elasticity	*Number of parameters*	*Mean value*[a]	*Range examined*
Armington[b]	57	2.51	+/- 1.26
Factor substitution[c]	25	1.27	+/- 0.64
Capital source[d]	25	5.00	+/- 2.50

[a] Parameters in the database vary by a number of dimensions (such as commodity, source region and destination region). Values presented in this table reflect weighted averages across all indices. [b] Import-domestic substitution. Elasticities of substitution across different sources are parameterised as twice the value of the import-domestic elasticities. [c] Substitution between labour, capital and land (for primary industries). [d] Substitution between capital sourced from different countries.

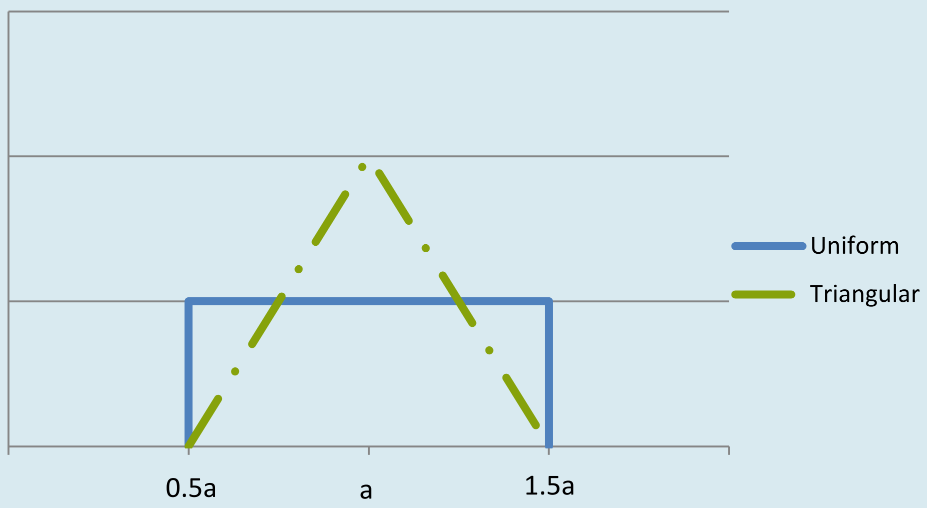
Box E.4 **Uniform and triangular probability distributions**

Parameters were varied using both a uniform and triangular distribution. For both distributions, the lower and upper bounds were set equal to +/- 50 percent of the parameter's database value (described as the point 'a' in the figure below).

With a uniform distribution, the probabilities associated with each possible value between the lower and upper bounds are all equal (see figure below). With a triangular distribution, the probabilities associated with values close to the mean (the original database value) are higher than values that are relatively close to the lower or upper bounds.

Assuming a uniform distribution produces wider ranges in results than assuming a triangular distribution.

Figure **Uniform and triangular probability distributions**



The sensitivity of model results is presented in table E.14. For the majority of simulations, the signs of the results do not change as parameter values are varied. (The New Zealand GNP result under the Asian growth simulation assuming a uniform distribution is the only exception.)

Table E.14 **Sensitivity analysis: effects on aggregate incomes**

Percentage changes relative to base

	Australia			*New Zealand*		
	Low	*Mid*	*High*	*Low*	*Mid*	*High*
Uniform distribution	%	%	%	%	%	%
Effects on GNP						
Multilateral tariff removal[a]	0.076	0.133	0.190	0.097	0.179	0.260
Asian growth[b]	0.013	0.081	0.150	-0.009	0.078	0.164
Increase in migration[c]	0.011	0.012	0.012	-0.076	-0.076	-0.075
Remove barriers to FDI						
Trans-Tasman — all services[d]	0.014	0.035	0.057	0.401	0.725	1.048
Trans-Tasman — telecommunications[e]	-0.001	0.000	0.000	0.011	0.014	0.018
Multilateral — telecommunications[f]	0.010	0.015	0.020	0.020	0.030	0.039
Effects on GDP						
Australian productivity improvement[g]	1.194	1.327	1.459	-0.049	-0.025	0.000
New Zealand productivity improvement[h]	-0.006	-0.003	0.000	1.239	1.407	1.574
Triangular distribution						
Effects on GNP						
Multilateral tariff removal[a]	0.095	0.135	0.175	0.124	0.181	0.239
Asian growth[b]	0.031	0.076	0.121	0.016	0.071	0.125
Increase in migration[c]	0.011	0.012	0.012	-0.076	-0.076	-0.075
Remove barriers to FDI						
Trans-Tasman — all services[d]	0.021	0.036	0.051	0.499	0.727	0.955
Trans-Tasman — telecommunications[e]	-0.001	0.000	0.000	0.011	0.014	0.018
Multilateral — telecommunications[f]	0.012	0.015	0.018	0.023	0.030	0.036
Effects on GDP						
Australian productivity improvement[g]	1.241	1.334	1.427	-0.043	-0.026	-0.009
New Zealand productivity improvement[h]	-0.005	-0.003	-0.001	1.303	1.419	1.536

[a] Reduction in all Australian and New Zealand tariff rates to zero. [b] 10 percent growth in Asian economies. [c] 0.13 percent decrease in the supply of labour in New Zealand and a 0.02 percent increase in the supply of labour in Australia. [d] Removal of trans-Tasman barriers to commercial presence for all services as defined in CIE (2010). [e] Removal of trans-Tasman barriers to commercial presence in telecommunications. [f] Removal of all Australian and New Zealand barriers to commercial presence in telecommunications. [g] 1 percent improvement in primary factor productivity in Australia. [h] 1 percent improvement in primary factor productivity in New Zealand.

Source: Australian Commission estimates.

Table E.15 suggests that varying parameters by +/- 50 percent leads to a more than a +/- 50 percent change in the results of the ‘Asian growth’ and ‘productivity improvement’ simulations — changing parameters can double some of the mid-point results. The lowest proportional change occurs in the ‘trans-Tasman migration’ simulation, indicating that this simulation is not sensitive to the parameters chosen — it is likely to be more sensitive to varying parts of the database.

Table E.15 **Difference between low/high results and medium results[a]**

Changes as a proportion of the medium result

	Australia	*New Zealand*
Uniform distribution	%	%
Effects on GNP		
Multilateral tariff removal	43.0	45.9
Asian growth	84.4	111.1
Increase in migration	1.9	0.5
Remove barriers to FDI		
Trans-Tasman — all services	53.1	26.1
Trans-Tasman — telecommunications	31.5	31.9
Multilateral — telecommunications	43.0	45.9
Effects on GDP		
Australian productivity improvement	10.0	99.1
New Zealand productivity improvement	112.1	11.9
Triangular distribution		
Effects on GNP		
Multilateral tariff removal	29.6	31.6
Asian growth	59.1	77.1
Increase in migration	2.0	0.5
Remove barriers to FDI		
Trans-Tasman — all services	42.3	31.3
Trans-Tasman — telecommunications	53.7	26.1
Multilateral — telecommunications	21.5	21.9
Effects on GDP		
Australian productivity improvement	7.0	66.4
New Zealand productivity improvement	73.4	8.2

a The difference between the low and medium result, and the difference between the high and medium result are the same.

Source: Australian Commission estimates.

As would be expected, results obtained using the triangular distribution are less spread out than the results obtained using the uniform distribution.

Aside from the labour migration simulation results which do not vary as parameters change, the GNP and GDP results for simulations are noticeably different when parameters are varied. Of the three parameters in the sensitivity analysis, the Armington and the capital source elasticities contribute most to the changes in results. The relative importance of these two elasticities differs across simulations.

The capital source elasticities contribute most to the range of results for the ‘reducing barriers to commercial presence’ and the ‘productivity improvement’ simulations.

- In the ‘commercial presence’ simulation, when capital from different sources is assumed to be highly substitutable, more foreign capital flows into the country where the barriers are removed and GDP and GNP increases (the latter through increased labour incomes).
- For the ‘productivity improvement’ simulation, increasing the substitutability between capital from different sources leads to more capital flowing to the country experiencing the productivity improvement from the trans-Tasman partner. This increases the GDP result for the more productive country and decreases the GDP result for the trans-Tasman partner.

The Armington elasticities contribute most to the range of results for the ‘multilateral tariff removal’ and ‘Asian growth’ simulations.

- For the ‘multilateral tariff removal’ simulation, assuming a relatively high level of substitutability between imports and domestically produced goods results in countries purchasing relatively more imports when tariff barriers are removed. This allows additional resources to be diverted to more productive uses, increasing GNP.
- For the ‘Asian growth’ simulations, assuming a relatively high level of substitutability between imports and domestic production leads to smaller changes in GNP for Australia and New Zealand. This is because Asian countries crowd Australian and New Zealand exports out of international markets to a greater extent, reducing the positive effect of Asian growth on Australian and New Zealand GDP. Indeed, the change in New Zealand GDP becomes negative with a large enough Armington elasticity.

Appendix A: Industries and regions

Table E.16 **Industries in the ANZEA model database**[a]

Number	*Industry*	*Number*	*Industry*
1	Paddy rice	30	Wood products
2	Wheat	31	Paper products, publishing
3	Cereal grains nec	32	Petroleum, coal products
4	Vegetables, fruit, nuts	33	Chemical, rubber, plastic products
5	Oil seeds	34	Mineral products nec
6	Sugar cane, sugar beet	35	Ferrous metals
7	Plant-based fibres	36	Metals nec
8	Crops nec	37	Metal products
9	Cattle, sheep and goats, horses	38	Motor vehicles and parts
10	Animal products nec	39	Transport equipment nec
11	Raw milk	40	Electronic Equipment
12	Wool, silk-worm cocoons	41	Machinery and equipment nec
13	Forestry	42	Manufactures nec
14	Fishing	43	Electricity
15	Coal	44	Gas manufacture, distribution
16	Oil	45	Water
17	Gas	46	Construction
18	Minerals nec	47	Trade
19	Bovine meat products	48	Transport nec
20	Meat products nec	49	Water transport
21	Vegetable oils and fats	50	Air transport
22	Dairy products	51	Communication
23	Processed rice	52	Financial services nec
24	Sugar	53	Insurance
25	Food products nec	54	Business services nec
26	Beverages and tobacco products	55	Recreational and other services
27	Textiles	56	Pub Admin, Defence, Educ., Health
28	Wearing apparel	57	Dwellings
29	Leather products		

a Industries 1 to 14 form the agricultural sector, 15 to 18 the mining sector, 19 to 42 the manufacturing sector, and 43 to 57 the services sector.

Table E.17 **Regions in the ANZEA database**

Number	*Region*	*Number*	*Region*
1	Australia	14	India
2	New Zealand	15	Rest of Asia
3	China	16	Canada
4	Hong Kong	17	USA
5	Japan	18	Mexico
6	Korea	19	Brazil
7	Taiwan	20	Rest of America
8	Indonesia	21	European Union
9	Malaysia	22	Russia
10	Philippines	23	Rest of Europe
11	Singapore	24	South Africa
12	Thailand	25	Rest of Africa
13	Bangladesh		

Appendix B: The ANZEA model and database

This appendix outlines the model's database structure and describes the model's core equation system. This model is an extension of a global model developed for policy analysis. The exposition is technical, but allows a referee to form a clear view of differences between the approach used in developing the ANZEA model and the approach used in other global CGE models such as the GTAP model.

The model is described in levels in this paper but is implemented in percentage changes using GEMPACK software. The appendix first presents some notation conventions, before detailing the model database. The third section of the appendix presents the core equations that are required to solve for the equilibrium.

Conventions

The following sets are used in the description of the model and database.

- COM(1,…,*m*): Commodities (indexed by *i* or *j*)
- REG(1,…,*n*): Regions (indexed by *r* or *s*)
- USER(COM,hou,gov,inv): Users (indexed by *u*)
- SRC(dom,imp): Sources (indexed by *s*)
- FAC(lab,cap,land): Factors of production (indexed by *f*)
- NCF(lab,land): Non-capital factors (indexed by *f*)
- MCOM(1,…,*h*): Margin commodities (indexed by *j* or *m*)
- NCOM(1,…,*k*): Non-margin commodities (NCOM=COM–MCOM)

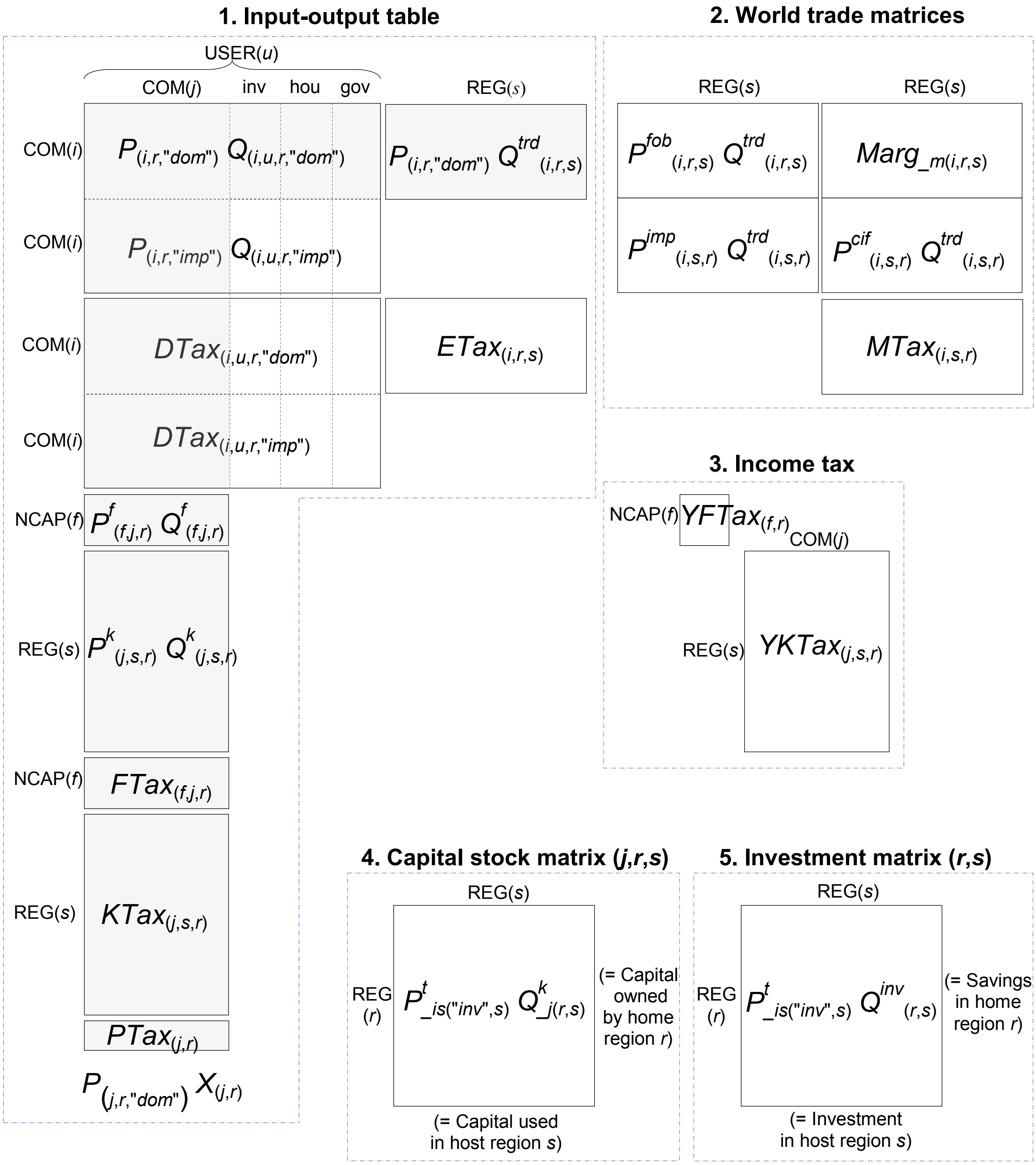
Database

The basic structure of the model's database is illustrated in Figure E.1, which shows the database for a representative region *r*. It has five components: a national input-output table; bilateral trade matrices; factor income tax tables; a bilateral capital stock matrix at the industrial level; and an investment matrix at the national level.

The input-output, world trade and factor income tax data are taken from the GTAP version 7 database. The bilateral capital stock and investment matrices are compiled with additional data from various sources.[7]

[7] The additional data used include *Balance of Payments Statistics 2005* (IMF 2005); GDyn database (Ianchovichina and Walmsley 2012) and Lakatos and Walmsley (2011).

Figure E.1 **Database structure for a representative region (*r*)**



Each component of the database consists of a number of boxes, representing matrices or vectors. The elements in these matrices and vectors are values, expressed in US dollars, representing certain economic activities portrayed in the model. To link the database with the model structure, these values are expressed in terms of the relevant variables in the core model. In most cases, these values can be presented as the product of a price variable and a quantity variable, which are defined in the model's core equation system.

Input-output table

This component consists of the following eight matrices and one vector:

- the purchases of domestically produced and imported goods by domestic users at basic prices ($P_{(i,r,s)}Q_{(i,u,r,s)}$)
- indirect taxes/subsidies on these purchases ($DTax_{(i,u,r,s)}$)
- the exports of goods to each destination region ($P_{(i,r,\text{"dom"})}Q^{trd}_{(i,r,s)}$)
- taxes/subsidies on exports ($ETax_{(i,u,r,s)}$)
- the purchases of non-capital factors of production at basic prices ($P^{f}_{(f,j,r)}Q^{f}_{(f,j,r)}$)
- the purchases of capital at basic prices ($P^{k}_{(j,s,r)}Q^{k}_{(j,s,r)}$)
- taxes on non-capital factor purchases ($FTax_{(i,u,r,s)}$)
- taxes on capital purchases ($KTax_{(i,u,r,s)}$).

The row vector is the production tax on industry's outputs ($PTax_{(i,u,r,s)}$).

Unlike the standard GTAP database, this database incorporates bilateral foreign capital stocks. Therefore, the capital income part of the input-output table is extended to include a capital owner dimension. Capital income, generated in a region, is received by owners of capital across the world. This allows factor taxes to be levied on each region's owned capital stock.

World trade matrices

In Part 2 of the database, there are five boxes showing how the values of exports are turned into the values of imports. The first box is a matrix showing the freight on board (FOB) values of exports ($\mathrm{P^{fob}_{(i,r,s)}\ Q^{trd}_{(i,r,s)}}$), which is equal to the domestic basic value of exports ($\mathrm{P_{(i,r,\text{"dom"})}\ Q^{trd}_{(i,r,s)}}$) plus export taxes (ETax). The FOB export matrix plus the export margin matrix ($\mathrm{Marg_{\_m(i,r,s)}}$) gives the cost, insurance and freight (CIF) import matrix ($\mathrm{P^{cif}_{(i,r,s)}\ Q^{trd}_{(i,r,s)}}$). The CIF import matrix plus the import tariff matrix (MTax) gives the domestic basic value import matrix ($\mathrm{P^{imp}_{(i,r,s)}\ Q^{trd}_{(i,r,s)}}$), which can then be purchased by domestic users.

Income tax tables

This part of the database has an income tax vector for non-capital factors ($YFTax_{(f,r)}$) and a capital income tax matrix ($YKTax_{(j,s,r)}$). The former is a region-specific tax while the latter is an industry-specific tax, which is levied on individual owner regions. This extension in income tax data is needed for modelling foreign investment barriers in selected industries.

Capital stock matrix

Unlike the GTAP model in which each region owns the capital it uses, this model introduces foreign capital ownership and extends the capital stock data from a vector to a three dimensional matrix with bilateral capital stock ownership at the industry level. It can be seen in figure E.1 that firms in an industry of each region can source capital from not only their own regions but also from any foreign region in the world. This extension allows an analysis of the type of service trade liberalisation that involves foreign commercial presence with bilateral foreign capital investment in service sectors.

Part 4 of figure E.1 shows only the capital stock matrix from a home-host region dimension. From this dimension, it can be seen that the column total, or the sum of the matrix over home regions (*r*), gives the capital stock used in each host region (*s*). On the other hand, the row total, or the sum of the matrix over host regions (*s*), gives the capital stock owned by each home region (*r*).

Investment matrix

To be consistent with the capital stock data, investment data must also be extended from one vector in the standard GTAP database to a two-dimensional matrix. Its structure, as shown in Part 5 of figure E.1, is a home-host region matrix. This is a matrix of bilateral investment across the world. As world investment must be equal to world saving in equilibrium, this matrix also gives bilateral saving flows. Therefore, it can be shown that the column sum of the matrix over home regions (*r*) should be equal to total investment in host regions, consistent with the investment value in the regional input-output tables, while the row sum of the matrix over host regions (*s*) gives the total savings in home regions (*r*). Moreover, a region’s total investment (column sum), net of its total saving (row sum), gives the value of net foreign investment inflow required by this region in equilibrium.

Core equation system

Included in the core system are only those variables and equations that are essential for solving the model's general equilibrium solution. The core system excludes other non-essential variables, such as price indices and quantity aggregates, which do not affect the model's solution.

The separation of essential from non-essential variables allows the number of equations in the core system to be reduced significantly. Moreover, these equations can be arranged in a simpler and cleaner structure, which is more accessible to model users. Such a structure can also be used as a powerful platform for developing new and more sophisticated extensions or add-on modules. This is because each component of the core system is clearly defined and can be easily replaced by an alternative component or linked with an added extension.

There are 33 equations in the core system, which are organised in four sections: (i) demands for imports and domestic goods, (ii) industrial demands for factors, (iii) regional supplies of factors and (iv) final users' expenditure. Most equations are used to define an endogenous variable. The names of the variables are described by the equation titles and aim to be self-explanatory. The equations specifying optimal behaviour are highlighted by boxes in the series of equations (see below), which are typically followed by a number of equations that define the variables used in those behavioural functions.

Demand for imports and domestic goods (equations 1–8)

The demand for imports in each region is determined in a two-tier Armington function. First, each region purchases imports from source regions in the rest of the world to form an import composite under a lower tier Constant Elasticity of Substitution (CES) demand function (equation 1). The import composite is then allocated to individual domestic users in an upper tier CES demand function, together with domestically produced goods to form another composite good, which is used in production and final consumption (equation 6).

(1) CES demand of region *r* for import *i* from region *s*

$$Q^{trd}_{(i,r,s)} = CES\ (P^{imp}_{(i,r,s)},\ P_{(i,s,"imp")},\ Q_{\_u(i,r,"imp")}) \qquad (i\in \text{COM};\ r,s\in \text{REG})$$

where $P_{(i,s,"imp")}$ is a CES price index for composite import *i* in region *s*

$$P_{(i,s,"imp")} = CES\ (P^{imp}_{(i,r_1,s)},\ \ldots\ ,\ P^{imp}_{(i,r_n,s)}) \qquad (i\in \text{COM};\ r\in \text{REG})$$

(2) The domestic basic prices of import *i* from region *r* to region *s*

$$P^{imp}_{(i,r,s)} = P^{cif}_{(i,r,s)} * (1 + t^{imp}_{(i,r,s)}) \qquad (i \in COM;\ r,s \in REG)$$

where $t^{imp}_{(i,r,s)}$ is the rate of an import tariff.

(3) The *CIF* price of import *i* from region *r* to region *s*

$$P^{cif}_{(i,r,s)} = P^{fob}_{(i,r,s)} + P^{mrg}_{(i,r,s)} \qquad (i \in COM;\ r,s \in REG)$$

where $P^{mrg}_{(i,r,s)}$ is the unit cost of margin service.

(4) The *FOB* price of export *i* from region *r* to region *s*

$$P^{fob}_{(i,r,s)} = P_{(i,r,\text{"dom"})} * (1 + t^{exp}_{(i,r,s)}) \qquad (i \in COM;\ r,s \in REG)$$

(5) Regional user demands for composite import *i*

$$Q_{\_u(i,r,s)} = \sum_{u} Q_{(i,u,r,s)} \qquad (i \in COM;\ r \in REG;\ s \in SRC)$$

(6) CES demand for good *i* from source *s* by user *u* in region *r*

$$Q_{(i,u,r,s)} = CES\ (P^{t}_{(i,u,r,s)}, P^{t}_{\_s(i,u,r)}, Q_{\_s(i,u,r)}) \qquad (i \in COM;\ u \in USER;\ r \in REG;\ s \in SRC)$$

where $P^{t}_{\_s(i,u,r)}$ is a CES price index for composite *i* of a domestically produced good and an import composite for user *u* in region *r*,

$$P^{t}_{\_s(i,u,r)} = CES\ (P^{t}_{(i,u,r,\text{"dom"})}, P^{t}_{(i,u,r,\text{"imp"})}) \qquad (i \in COM;\ r \in REG)$$

(7) Purchasers' price of good *i* from source *s* for user *u* in region *r*

$$P^{t}_{(i,u,r,s)} = P_{(i,r,s)} * (1 + t^{dom}_{(i,u,r,s)}) \qquad (j \in COM;\ u \in USER;\ ;\ r \in REG;\ s \in SRC)$$

where $t^{dom}_{(i,u,r,s)}$ is the rate of an indirect tax.

(8) Demands for composite good *i* by user *u* in region *r*

$$Q_{\_s(i,u,r)} = \begin{cases} Leontief\ (X_{(u,r)}) & (i,\ u \in COM;\ r \in REG) \\ CDE\ (V_{(u,r)}, P^{t}_{\_s(i_1,u,r)}, \ldots, P^{t}_{\_s(i_n,u,r)})^{8} & (i \in COM;\ u = hou;\ r \in REG) \\ f\ (V_{(u,r)}, P^{t}_{\_s(i,u,r)}) & (i \in COM;\ u = gov;\ r \in REG) \\ Leontief\ (V_{(u,r)} / P^{t}_{\_is(u,r)}) & (i \in COM;\ u = inv;\ r \in REG) \end{cases}$$

Industrial demands for factors (equations 9–16)

Firms in a regional industry purchase required intermediate inputs under a Leontief demand function (equation 8) and primary factors of production under a CES demand function (equation 11). In the model, firms in an industry can source their

[8] Following GTAP, regional household demand is a Constant Differences of Elasticity (CDE) function.

capital demands from all regions. This is specified in a second tier CES demand function for capital (equation 13).

With given prices of inputs and factors, firms choose an optimal combination of inputs and factors to minimise the cost of producing a given output. This output is determined by the domestic and foreign demands for the good produced in the industry (equation 9). Under constant return to scale production technology, the basic price of the output in that industry is just the unit cost of all inputs and factor services, used in production, plus a production tax (equation 16).

(9) Output of industry j in region r

$$X_{(j,r)} = \begin{cases} Q_{\_u(j,r,\text{"}dom\text{"})} + \sum_s Q^{trd}_{(j,r,s)} & (j \in \text{NCOM};\ r \in \text{REG}) \\ Q_{\_u(j,r,\text{"}dom\text{"})} + \sum_s Q^{trd}_{(j,r,s)} + Q^{mexp}_{(j,r)} & (j \in \text{MCOM};\ r \in \text{REG}) \end{cases}$$

(10) The export of margin good m from region r

$$Q^{mexp}_{(m,r)} = CES\ (P_{(m_1,r,\text{"}dom\text{"})},\ \ldots\ ,\ P_{(m_h,r,\text{"}dom\text{"})},\ Q^{mexp}_{\_irs\ (m)}) \quad (m \in \text{MCOM};\ r \in \text{REG})$$

(11) CES demand for factor f used in industry j in region r

$$Q^f_{(f,j,r)} = CES\ (P^{tf}_{(f,j,r)},\ P^{tf}_{\_j(j,s)},\ X_{(j,r)}) \quad (f \in \text{FAC};\ j \in \text{COM};\ r \in \text{REG})$$

where $P^{tf}_{\_f(j,s)}$ is CES price index for composite factor in industry j in region s

$$P^{tf}_{\_f(j,s)} = CES\ (P^{tf}_{(\text{"}land\text{"},j,r)},\ P^{tf}_{(\text{"}cap\text{"},j,r)},\ P^{tf}_{(\text{"}lab\text{"},j,r)}) \quad (j \in \text{COM};\ s \in \text{REG})$$

(12) The purchasers' price of non-capital factor f in industry j of region r

$$P^{tf}_{(f,j,r)} = P^f_{(f,j,r)} * (1 + t^f_{(f,j,r)}) \quad (f \in \text{NCF};\ j \in \text{COM};\ r \in \text{REG})$$

where $t^f_{(f,j,r)}$ is the rate of a non-capital factor tax.

(13) CES demand of industry j of host region s for capital from home region r

$$Q^k_{(j,r,s)} = CES\ (P^{tk}_{(j,r,s)},\ P^{tf}_{(\text{"}cap\text{"},j,s)},\ Q^f_{(\text{"}cap\text{"},j,s)}) \quad (j \in \text{COM};\ r,s \in \text{REG})$$

where $P^{tf}_{(\text{"}cap\text{"},j,s)}$ is a CES price index for composite capital stock used in region s,

$$P^{tf}_{(\text{"}cap\text{"},j,s)} = CES\ (P^{tk}_{(j,r_1,s)},\ \ldots,\ P^{tk}_{(j,r_n,s)}) \quad (j \in \text{COM};\ s \in \text{REG})$$

(14) The purchasers' price of capital from region r used in industry j in region s

$$P^{tk}_{(j,r,s)} = P^k_{(j,r,s)} * (1 + t^k_{(j,r,s)}) \quad (j \in \text{COM};\ r,s \in \text{REG})$$

where $t^k_{(j,r,s)}$ is the rate of a factor tax on capital.

(15) The basic rental price of capital, used in industry j of host region s

$$P^f_{(\text{"}cap\text{"},j,r)} = {}_{r}\ s^k_{(j,r,s)}\ P^k_{(j,r,s)} \quad (j \in \text{COM};\ r \in \text{REG})$$

where $s^k_{(j,r,s)}$ is the share of capital from home region r to host region s.

(16) Basic price for the output of industry *j* in region *r* (zero pure profit condition)

$$P_{(j,r,\text{"dom"})} = (\sum_i \alpha_{(i,j,r)} P^{t}_{\_s(i,j,r)} + \sum_f \beta_{(f,j,r)} P^{tf}_{(f,j,r)}) * (1 + t^{p}_{(j,r)}) \qquad (j \in \text{COM}; r \in \text{REG})$$

where $\alpha_{(i,j,r)}$ and $\beta_{(f,j,r)}$ are the cost shares of intermediate inputs and factors. $t^{p}_{(j,r)}$ is the rate of a production tax.

Regional supplies of factors (equations 17–23)

The regional household is the owner of primary factors of production: land, labour and capital. Land is an industry- and region-specific factor. Land supply is determined in a Constant Elasticity of Transformation (CET) supply function, which implies that land can be transformed between different uses to a limited extent (equation 17). Labour is assumed to be mobile across industries but not between regions (equation 18) so that industrial wage rates will be equalised in equilibrium (equation 19).

In a comparative static context, it is assumed that capital stock, owned by a region, can be reallocated in other regions to maximise the rate of return for its owners (equation 20). In equilibrium, the rates of return to a home region's capital stock will be equalised across all host regions (equation 21).

(17) CET supply of land in industry *j* in region *r* (market equilibrium condition (MEC) for industrial land)

$$Q^{f}_{(\text{"land"},j,r)} = CET\,(P^{f}_{(\text{"land"},j,r)}, P^{tf}_{\_j(\text{"land"},s)}, X^{land}_{(r)}) \qquad (j \in \text{COM}; r \in \text{REG})$$

where $X^{land}_{(r)}$ is the exogenously given endowment of land owned by region *r* and $P^{tf}_{\_j(\text{"land"},s)}$ is a CET price index for land in region *s*,

$$P^{tf}_{\_j(\text{"land"},s)} = CET\,(P^{tf}_{(\text{"land"},j_1,s)}, \ldots, P^{tf}_{(\text{"land"},j_m,s)}) \qquad (f \in \text{FAC}; s \in \text{REG})$$

(18) Supply of labour in region *r* (MEC for regional labour)

$$X^{lab}_{(r)} = \sum_j Q^{f}_{(\text{"lab"},j,r)} \qquad (r \in \text{REG})$$

(19) The basic prices of labour equalisation

$$P^{f}_{(\text{"lab"},j,r)} = W_{(r)} \qquad (j \in \text{COM}; r \in \text{REG})$$

where $W_{(r)}$ is equilibrium wage rate in region *r*.

(20) Supply of capital by home region *r* (MEC for regional capital)

$$X^{k}_{(r)} = \sum_s Q^{k}_{\_j(r,s)} = \sum_s \sum_j Q^{k}_{(j,r,s)} \qquad (r \in \text{REG})$$

(21) Rate of return to capital equalisation

$$R_{(j,r,s)} = P^{kt}_{(j,r,s)} / P^{t}_{\_is(\text{"inv"},s)} = R_{\_js(r)} \qquad (j \in \text{COM}; r,s \in \text{REG})$$

where $R_{\_js(r)}$ is the equilibrium rate of return to capital owned by home region *r*.

(22) The rental price of capital, net of income tax

$$P^{kt}_{(j,r,s)} = P^{k}_{(j,r,s)} * (1 - t^{kt}_{(j,r,s)} - t^{fdi}_{(j,r,s)}) \qquad (j \in \text{COM};\ r,s \in \text{REG})$$

where $t^{kt}_{(j,r,s)}$ is the rate of a tax on capital income and $t^{fdi}_{(j,r,s)}$ is introduced as a tax-equivalent of barrier to foreign capital in host regions' service industries.

(23) Purchases' price index for composite goods for user *u* in region *r*

$$P^{t}_{\_is(u,r)} = \sum_{i} s^{t}_{(i,u,r)}\, P^{t}_{\_s(i,u,r)} \qquad (u \in \text{USER};\ r \in \text{REG})$$

where $s^{t}_{(i,u,r)}$ is the share of good *i* in total expenditure of user *u* in region *r.*

Final users' expenditure (equations 24–33)

There are three final users in the model: household, government and investor. Their expenditures are shown in equation 24. Household and government expenditures are equal to their income net of savings. Investment expenditure is equal to total domestic savings plus net foreign investment (NFI) inflow.

It is assumed in the model that regional savings can be invested across all regions, including the home region, to maximise its expected rates of return (equation 31). This optimal behaviour implies that, in equilibrium, all regional expected rates of return will be equalised (equation 32). These bilateral investment flows must be constrained by regional investment (equation 33). This requires the host region's net foreign investment inflow to adjust independently.

(24) Final expenditure of user *u* (*hou*, *gov*, *inv*) in region *r*

$$V_{(u,r)} = \begin{cases} Y^{hou}_{(r)} * (1 - s^{hou}_{(r)}) & (u{=}hou;\ r \in \text{REG}) \\ Y^{gov}_{(r)} * (1 - s^{gov}_{(r)}) & (u{=}gov;\ r \in \text{REG}) \\ V^{sav}_{(r)} + V^{NFI}_{(r)} & (u{=}inv;\ r \in \text{REG}) \end{cases}$$

where $s^{hou}_{(r)}$ and $s^{gov}_{(r)}$ are household and government saving rates; and $V^{NFI}_{(r)}$ is the inflow of net foreign investment (NFI).

(25) Total saving in region *r*

$$V^{sav}_{(r)} = Y^{hou}_{(r)}\, s^{hou}_{(r)} + Y^{gov}_{(r)}\, s^{gov}_{(r)}$$

(26) Post-income tax price for factor *f* in region *r*

$$P^{ft}_{(f,r)} = \begin{cases} P^{f}_{\_j(f,r)} * (1 - t^{ft}_{(f,r)}) & (f \in \text{NCF};\ r \in \text{REG}) \\ \sum_{j} \sum_{s} s^{kt}_{(j,r,s)}\, P^{kt}_{(j,r,s)} & (f{=}cap;\ r \in \text{REG}) \end{cases}$$

where $t^{ft}_{(f,r)}$ is the rate of an income tax on non-capital factor services and $s^{kt}_{(j,r,s)}$ is the rental share of capital from region *r* used in industry *j* of region *s*.

(27) Household disposable income

$$Y^{hou}_{(r)} = \sum_j (P^{ft}_{("land",j,r)} X^{land}_{(j,r)}) + P^{ft}_{\_j("lab",r)} X^{lab}_{(r)} + \sum_s (P^{kt}_{\_j(r,s)} Q^{k}_{\_j(r,s)}) \quad (r \in \text{REG})$$

where $P^{kt}_{\_j(r,s)}$ is the rental price of capital from region r to region s.

(28) Government income from tax revenue

$$Y^{gov}_{(r)} = (\textit{Total Tax Revenue}) \quad (r \in \text{REG})$$

(29) Capital stock at the end of period

$$X^{ke}_{(r,s)} = Q^{k}_{\_j(r,s)} * (1 - r^{dep}_{(s)}) + Q^{inv}_{(r,s)} \quad (r,s \in \text{REG})$$

where $r^{dep}_{(s)}$ is the rate of capital depreciation.

(30) Real investment from region r to region s

$$Q^{inv}_{(r,s)} = V^{inv}_{(r,s)} / P^{t}_{\_is("inv",s)} \quad (r,s \in \text{REG})$$

(31) Market equilibrium condition (MEC) for world savings

$$\sum_r V^{sav}_{(r)} = \sum_r \sum_s V^{inv}_{(r,s)}$$

(32) Expected rates of return equalisation

$$R^{e}_{(r,s)} = R_{(r)} * (X^{ke}_{(r,s)} / Q^{k}_{\_j(r,s)}) \wedge (-\gamma_{(r)}) = R^{e}_{\_rs} \quad (r,s \in \text{REG})$$

where $\gamma_{(r)}$ is a parameter that controls the sensitivity of capital growth to change in the expected rate of return and $R^{e}_{\_rs}$ is the general equilibrium rate of return for the world as a whole.

(33) Market equilibrium condition (MEC) for host region real investment

$$\sum_i Q_{\_s(i,"inv",r)} = \sum_s Q^{inv}_{(s,r)} \quad (r \in \text{REG})$$

Note that $V^{NFI}_{(r)}$ has to adjust to satisfy this constraint.[9]

Among the 33 equations in the core system, five are market equilibrium conditions: equations 17, 18, and 20 for land, labour and capital, and equations 31 and 33 for savings and investment. All remaining 28 equations are used to define 28 endogenous variables. Five endogenous variables are not defined in the core system: three factor prices ($P^{f}_{("land",j,r)}$, $W_{(r)}$ and $R_{\_js(r)}$), the world expected rate of return and regional net foreign investment inflows ($R^{e}_{\_rs}$ and $V^{NFI}_{(r)}$). They must be solved as general equilibrium variables — each of them needs to be independently adjusted to clear a corresponding market listed above.

9 It is worth checking that net foreign investment inflow equals the difference between a region's investment and its savings: $V^{NFI}_{(r)} = \sum_s V^{inv}_{(s,r)} - \sum_s V^{inv}_{(r,s)}$.

Appendix C: Industry results

Table E.18 **Effects on value-added of eliminating Australian and New Zealand tariffs, industry results**

	Australia			New Zealand		
	Average tariff	*% changes*	*US$m*[a]	*Average tariff*	*% changes*	*US$m*[a]
Paddy rice	0.0	1.0	–	0.0	1.7	–
Wheat	0.0	0.9	24	0.0	1.3	–
Cereal grains nec	0.0	0.6	4	0.0	1.2	–
Vegetables, fruit, nuts	1.0	0.2	9	0.0	0.8	10
Oil seeds	0.7	0.8	4	0.0	1.4	–
Sugar cane, sugar beet	0.0	0.3	–	0.0	0.3	–
Plant-based fibres	0.0	0.5	5	0.0	0.5	–
Crops nec	0.0	0.7	4	0.2	2.4	3
Cattle, sheep and goats, horses	0.0	0.9	14	0.0	1.7	3
Animal products nec	0.0	0.7	6	0.0	1.1	4
Raw milk	0.0	0.5	2	0.0	1.5	1
Wool, silk-worm cocoons	0.2	0.6	9	0.0	1.1	1
Forestry	0.3	0.0	0	0.1	0.4	3
Fishing	0.1	0.1	2	0.0	0.1	–
Coal	0.0	0.4	37	0.0	0.2	–
Oil	0.0	0.4	9	0.0	0.3	–
Gas	0.0	0.5	8	0.0	0.3	–
Minerals nec	0.1	1.2	153	0.0	0.8	–
Bovine meat products	0.0	1.5	102	0.0	2.0	74
Meat products nec	0.4	0.3	8	0.9	1.4	11
Vegetable oils and fats	0.7	0.6	4	0.3	0.5	2
Dairy products	3.3	0.6	35	1.0	1.6	66
Processed rice	0.0	1.1	4	0.0	2.0	–
Sugar	0.0	1.4	14	0.0	0.2	2
Food products nec	1.7	0.1	17	3.0	0.2	4
Beverages and tobacco products	2.5	0.4	36	4.6	-0.2	-3
Textiles	4.4	-3.3	-101	2.3	-3.0	-29
Wearing apparel	7.5	-6.2	-239	7.1	-8.0	-61
Leather products	4.0	-0.4	-3	2.7	0.2	1
Wood products	3.6	-1.1	-13	3.5	-0.7	-9
Paper products, publishing	2.6	-0.3	-16	0.6	0.1	1
Petroleum, coal products	0.0	0.3	11	2.2	-0.2	-1
Chemical, rubber, plastic products	2.8	-0.6	-62	1.7	-0.1	-2
Mineral products nec	4.0	-0.7	-3	2.6	0.3	–
Ferrous metals	3.1	-0.9	-16	1.5	-0.4	-1
Metals nec	0.8	4.0	620	1.1	3.0	30
Metal products	5.1	-1.6	-37	2.9	-1.8	-10

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Table E.18 (continued)

	Australia			New Zealand		
	Average tariff	*% changes*	*US$m*[a]	*Average tariff*	*% changes*	*US$m*[a]
Motor vehicles and parts	3.5	-1.0	-139	4.3	-3.0	-40
Transport equipment nec	0.8	2.6	42	0.6	5.3	29
Electronic Equipment	0.8	2.8	88	0.4	2.4	29
Machinery and equipment nec	3.2	-1.5	-168	2.6	-1.4	-37
Manufactures nec	2.8	-0.3	-17	6.9	-3.3	-30
Electricity	0.0	0.9	42	0.0	0.5	–
Gas manufacture, distribution	0.0	0.6	1	0.0	0.0	0
Water	0.0	0.3	11	0.0	0.5	–
Construction	0.0	0.6	504	0.0	1.2	100
Trade	0.0	0.1	143	0.0	0.3	54
Transport nec	0.0	0.4	63	0.0	0.9	11
Water transport	0.0	0.7	17	0.0	1.1	10
Air transport	0.0	0.8	88	0.0	1.6	38
Communication	0.0	0.2	21	0.0	0.5	10
Financial services nec	0.0	0.2	33	0.0	0.4	5
Insurance	0.0	0.3	27	0.0	0.4	5
Business services nec	0.0	0.4	83	0.0	0.6	33
Recreational and other services	0.0	0.4	92	0.0	0.5	19
Pub Admin, Defence, Educ., Health	0.0	-0.1	-121	0.0	-0.1	-25
Dwellings	0.0	0.0	12	0.0	0.0	4

[a] Results are in 2004 US$. **–** less than 0.5.

Source: Australian Commission estimates.

Table E.19 **Effects on value-added of productivity improvement in trans-Tasman partner, industry results**

	Australia		New Zealand	
	% changes	*US$m*[a]	*% changes*	*US$m*[a]
Paddy rice	-0.01	–	-0.11	–
Wheat	-0.01	-0.3	-0.18	–
Cereal grains nec	-0.01	-0.1	-0.10	–
Vegetables, fruit, nuts	-0.01	-0.3	-0.05	-0.6
Oil seeds	-0.01	–	-0.06	–
Sugar cane, sugar beet	0.00	0.0	0.00	0.0
Plant-based fibres	-0.01	-0.1	-0.02	–
Crops nec	-0.01	-0.1	-0.06	-0.1
Cattle, sheep and goats, horses	-0.05	-0.7	-0.12	-0.2
Animal products nec	-0.02	-0.1	-0.04	-0.2
Raw milk	-0.06	-0.2	-0.11	–
Wool, silk-worm cocoons	-0.04	-0.6	-0.32	-0.4
Forestry	-0.02	-0.1	-0.03	-0.2
Fishing	0.00	0.0	0.03	–
Coal	-0.01	-0.6	-0.15	-0.2
Oil	0.00	0.1	-0.01	–
Gas	-0.01	-0.1	-0.03	–
Minerals nec	-0.01	-1.5	-0.06	–
Bovine meat products	-0.08	-5.6	-0.17	-6.0
Meat products nec	0.00	-0.1	-0.06	-0.5
Vegetable oils and fats	0.00	0.0	-0.01	-0.1
Dairy products	-0.07	-4.4	-0.11	-4.7
Processed rice	0.00	0.0	-0.31	–
Sugar	-0.01	-0.1	0.01	–
Food products nec	0.00	0.4	0.01	0.2
Beverages and tobacco products	0.00	0.1	0.03	0.4
Textiles	-0.02	-0.5	0.05	0.5
Wearing apparel	0.00	0.1	0.03	0.2
Leather products	-0.02	-0.2	0.05	0.1
Wood products	-0.03	-0.4	0.03	0.4
Paper products, publishing	0.00	-0.2	-0.02	-0.4
Petroleum, coal products	0.01	0.3	0.00	0.0
Chemical, rubber, plastic products	0.01	1.2	-0.02	-0.4
Mineral products nec	0.00	0.0	-0.07	-0.1
Ferrous metals	0.02	0.4	0.05	0.2
Metals nec	-0.04	-5.7	-0.19	-1.9
Metal products	0.00	-0.1	-0.01	–

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Table E.19 (continued)

	Australia		New Zealand	
	% changes	*US$m*[a]	*% changes*	*US$m*[a]
Motor vehicles and parts	0.04	5.4	-0.03	-0.4
Transport equipment nec	0.00	0.0	-0.01	-0.1
Electronic Equipment	0.07	2.1	-0.11	-1.4
Machinery and equipment nec	0.03	3.3	0.13	3.4
Manufactures nec	-0.01	-0.5	-0.03	-0.3
Electricity	-0.01	-0.4	-0.04	-0.4
Gas manufacture, distribution	-0.01	**–**	-0.02	**–**
Water	0.00	-0.1	-0.06	**–**
Construction	-0.01	-6.3	-0.07	-5.9
Trade	0.00	-1.1	-0.01	-1.9
Transport nec	-0.01	-0.9	-0.03	-0.4
Water transport	0.00	-0.1	-0.01	-0.1
Air transport	0.00	-0.5	0.02	0.4
Communication	0.00	-0.3	-0.02	-0.4
Financial services nec	0.00	-0.4	-0.03	-0.4
Insurance	0.00	-0.3	-0.02	-0.3
Business services nec	0.00	-0.7	-0.04	-2.0
Recreational and other services	0.00	-0.2	0.00	-0.1
Pub Admin, Defence, Educ., Health	0.00	-0.6	-0.01	-2.6
Dwellings	0.00	-1.9	-0.01	-1.0

[a] Results are in 2004 US$. **–** less than 0.5.

Source: Australian Commission estimates.

Table E.20 **Effects of Asian growth on value-added, industry results**

	Australia		*New Zealand*	
	% changes	*US$m*[a]	*% changes*	*US$m*[a]
Paddy rice	-4.1	-1	-3.3	–
Wheat	0.1	4	0.2	–
Cereal grains nec	2.1	16	0.2	–
Vegetables, fruit, nuts	-0.7	-29	-1.7	-23
Oil seeds	1.5	7	0.8	–
Sugar cane, sugar beet	0.2	–	0.1	–
Plant-based fibres	0.8	7	0.3	–
Crops nec	-0.9	-5	-2.0	-2
Cattle, sheep and goats, horses	0.3	5	0.1	–
Animal products nec	0.8	7	1.6	6
Raw milk	0.2	–	0.4	–
Wool, silk-worm cocoons	-1.1	-16	-0.8	-1
Forestry	0.2	1	1.5	9
Fishing	0.4	7	0.4	1
Coal	1.0	89	1.2	1
Oil	-1.6	-34	-1.5	-1
Gas	-1.1	-20	0.0	0
Minerals nec	2.7	349	0.6	–
Bovine meat products	0.2	16	0.0	0
Meat products nec	-0.3	-8	-0.3	-2
Vegetable oils and fats	-0.8	-6	0.1	–
Dairy products	0.2	11	0.5	21
Processed rice	-3.0	-10	-5.0	–
Sugar	0.6	7	0.3	2
Food products nec	0.2	23	0.4	8
Beverages and tobacco products	0.3	26	0.3	5
Textiles	-2.4	-73	-2.3	-22
Wearing apparel	-1.2	-45	-1.2	-9
Leather products	-3.2	-29	-3.4	-9
Wood products	-0.6	-6	-0.2	-3
Paper products, publishing	-0.1	-8	0.2	4
Petroleum, coal products	0.7	27	0.9	6
Chemical, rubber, plastic products	-1.1	-125	-0.4	-10
Mineral products nec	-0.2	-1	0.0	0
Ferrous metals	-0.9	-17	-0.7	-2
Metals nec	-0.6	-91	0.0	0
Metal products	-0.5	-12	-0.7	-4

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Table E.20 (continued)

	Australia		New Zealand	
	% changes	*US$m*[a]	*% changes*	*US$m*[a]
Motor vehicles and parts	-0.6	-90	-0.7	-9
Transport equipment nec	-1.2	-19	0.1	–
Electronic Equipment	-3.0	-95	-2.1	-26
Machinery and equipment nec	-1.6	-180	-1.4	-38
Manufactures nec	-0.9	-54	-0.4	-4
Electricity	0.0	2	0.1	1
Gas manufacture, distribution	-0.1	–	-0.1	–
Water	0.2	8	0.2	–
Construction	0.4	296	0.4	30
Trade	0.2	197	0.2	25
Transport nec	0.1	18	0.2	3
Water transport	0.5	13	1.5	14
Air transport	0.3	39	0.9	21
Communication	0.2	14	0.2	3
Financial services nec	0.2	20	0.2	2
Insurance	0.1	12	0.2	3
Business services nec	0.1	18	0.1	7
Recreational and other services	0.3	59	0.3	12
Pub Admin, Defence, Educ., Health	0.1	192	0.2	30
Dwellings	0.3	191	0.3	22

[a] Results are in 2004 US$. **–** less than 0.5.

Source: Australian Commission estimates.

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