Australian Government
Productivity Commission

Modelling protectionist trade policies

Rising Protectionism

Technical Supplement to the Research Paper

July 2017

Preface

This technical report provides details about the modelling that supports the Commission Research Paper *Rising protectionism: challenges, threats and opportunities for Australia.*

The modelling is available on request from the Productivity Commission in the form of zip files that allow the results to be reproduced and analysed in more details.

The technical report was produced by Xiao-guang Zhang, Henry McMillan and Patrick Jomini. The authors are grateful to Lou Will, Miriam Veisman-Apter, Jenny Gordon, John Salerian, Jonathan Coppel and Shiro Armstrong for their valuable comments and guidance throughout the project. Additional input from Laurent Cretegny, who reviewed an early draft of the report, and from participants in three technical workshops, held at the Productivity Commission on 3 February, 28 March and 30 March 2017, is gratefully acknowledged.

Modelling protectionist trade policies

This technical paper supports the Commission's research report, *Rising protectionism: challenges, threats and opportunities for Australia*. It documents the modelling undertaken to illustrate the economic effects of potential changes in the trade environment facing Australia.

The paper has three sections. Section 1 outlines the modelled scenarios. Section 2 summarises the features of the models used for the project, and explains how the choice of closure assumptions can affect model results. Section 3 contains an analysis of the scenarios modelled.

1 Scenarios modelled

The scenarios considered in this project are described in the research report. They are designed in light of recent public statements and developments in trade policies. This technical paper contains results for the simulations listed in table 1, which are based on the scenarios. The simulations include:

- a range of simulations with unilateral increases in tariffs on US imports from China and Mexico, and responses by China and Mexico to those increases
- simulations to clarify the possible effects of the United States implementing border adjustments as part of moving from the current origin-based corporate income tax to a destination-based cash flow tax
- a range of simulations with global increases in tariffs (global contagion) and possible responses by Australia and other countries that might consider liberalisation as a response to widespread increases in protectionism.

2 Modelling framework

The modelling framework consists of two models.

The main model used is PC Global. It is derived from the GTAP model and database developed at the Global Trade Analysis Project. The GTAP model has been widely used to analyse the national and global effects of policy changes, with a particular focus on international trade, and the GTAP database has become a standard input into global policy analyses. Like GTAP, PC Global is a multi-region computable general equilibrium (CGE)

model designed to analyse global trade policy.[1] Unlike GTAP, PC Global accounts for changes to capital allocations on a bilateral basis.

Table 1 **Scenarios modelled**[a]

Simulations	*Shock applied*	*Abbreviation*
US tariffs		
US tariff on imports from China	US increases tariffs to 45 per cent on all imports from China	CHN45
US tariff on imports from Mexico	US increases tariffs to 35 per cent on all imports from Mexico	MEX35
US tariffs on imports from China and Mexico	US increases tariffs to 45 per cent on all imports from China and to 35 per cent on all imports from Mexico	CHNMEX
Reciprocal US and China tariffs	US and China increase tariffs to 45 per cent on imports from each other	CHNUS
Reciprocal US and Mexico tariffs	US and Mexico increase tariffs to 35 per cent on imports from each other	MEXUS
Reciprocal US and China and US and Mexico tariffs	US increases tariffs on imports from China and from Mexico as above and both retaliate	CHNMEXR
US border adjustments		
US border adjustments	Uniform 20 per cent tax on imports and uniform 20 per cent subsidy on exports in the US	BA2020
Global contagion		
Global contagion	All countries increase tariffs by 15 percentage points	G1
Global contagion without Australia	All countries excluding Australia increase tariffs by 15 percentage points	G2
Global contagion without RCEP countries	All countries excluding RCEP members increase tariffs by 15 percentage points	G3
Global contagion with RCEP members liberalising NTBs and barriers to services	All countries excluding RCEP members increase tariffs by 15 percentage points; RCEP members reduce non-tariff barriers and barriers to trade in services.	G4
Global contagion with RCEP members abolishing tariffs, and liberalising NTBs and barriers to services	All countries excluding RCEP members increase tariffs by 15 percentage points; RCEP members abolish tariffs (MFN) and reduce non-tariff barriers and barriers to trade in services	G5

a RCEP — Regional Comprehensive Economic Partnership; NTBs — non-tariff barriers; MFN — most favoured nation.

1 The structure of PC Global is similar to that of the Australia–New Zealand Economic Analysis (ANZEA) model that was used for the report *Strengthening Economic Relations between Australia and New Zealand* (PC and NZPC 2012). Like the database for the ANZEA model, the PC Global database identifies Australia and 24 other economies separately (appendix 1). Its base year is 2011.

The distributional impacts on household income within Australia are also analysed for some simulations. The Commission's CGE model of the Australian economy, PC National, is used for this work.[2] A limited number of results from PC Global are used to shock PC National so that PC National emulates the results obtained for Australia in PC Global.

Development of PC Global

PC Global was developed as a streamlined and more transparent version of the GTAP model. The design of PC Global starts with the minimum number of equations required to solve the general equilibrium problem (Zhang 2013). Therefore, PC Global 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.[3] Despite these simplifications, PC Global contains the same behavioural assumptions as the GTAP model, and additional assumptions about how capital is allocated across the world.

All CGE modelling involves altering or extending a base model to meet the specific demands of a project. The simplified structure of the PC Global core model makes it easier to make such alterations 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. In addition, PC Global's streamlined structure allows it to be solved more quickly than the GTAP model. This facilitates efficient:

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

PC Global accounts for bilateral capital flows, illustrating how capital owned by a region is allocated across all regions, including its own (box 1). The purpose of this extension is to account not just for the reallocation of trade flows and of resources within each country, but also for the effects of trade policies on the global reallocation of capital. The bilateral capital structure allows the model to be used to analyse the effects of policies that affect foreign investment — with additional data about foreign direct investment (FDI) this facilitates the analysis of policies that affect commercial presence of services, and FDI more broadly.

2 The model and its household extension are described in Zhang (2015).

3 PC Global consists of approximately 150 equations, of which 35 are core equations. In contrast, GTAP consists of approximately 300 equations.

Box 1 The bilateral capital extension in PC Global

The PC Global model accounts for bilateral capital ownership. This means that GDP and GNP can change differently as capital moves towards economies with higher returns to capital. This facility was introduced to:

- account for changes in real income (real GNP) rather than just changes in production capacity (real GDP)
- investigate the possible effects of constraining capital flows on a bilateral basis.

The capital extension involves adding two new matrixes to the original GTAP database:

- a matrix of capital stocks, where each cell describes the amount of capital owned by region *s* that is used by region *h*. The row total represents the amount of capital owned by region *s*, whose returns contribute to GNP in region *s*. The row totals are calibrated with international investment position data and data derived for the GDyn model (see below). The column total represents the amount of capital used in region *h*, whose returns contribute to GDP in region *h,* and the column totals are calibrated to the capital stocks in the GTAP database
- a matrix of savings and investment, where each cell describes the amount of savings from region *s* that is invested in region *h.* The row total represents total savings in region *s*, and the column total represents total investment in region *h*. The column totals are calibrated to the demand for investment and the row totals are calibrated to savings in the GTAP data.

The matrixes are based on data from various sources:

- the IMF *Balance of Payments and International Investment Position Statistics*, which describe bilateral inward and outward investment flows and foreign capital assets and liabilities, and are used to determine row and column totals
- a set of domestic/foreign capital shares derived for the GDyn model (Ianchovichina and Walmsley (2012)), which are used to allocate ownership between local and foreign owners
- a foreign direct investment (FDI) database produced by Gouel et al. (2012), which provides a bilateral FDI structure by industry. These data are used to determine the structure of all bilateral capital flows and are updated from their original year (2004) to 2011, using the IMF data as control totals.

The international capital data account for foreigners' claims on a country's productive capital. Therefore foreign capital stocks consist of FDI (which is associated with some form of control over operations) and portfolio stocks, but the two are not distinguished. The system is consistent with global and bilateral macroeconomic relationships, linking trade in goods and services with investment, savings and capital income flows.[a]

In this structure, capital is assumed to be differentiated: it has characteristics that are specific to the source region. For example, US capital is assumed to be different in some way from Chinese capital. Capital from different sources is therefore assumed to be imperfectly substitutable.[b]

[a] This does not mean that all items in the balance of payments are accounted for. For example, unrequited remittances, including foreign aid and payments by migrants, are omitted. To the extent that wages change in a region, payments made by migrants abroad would affect the relevant elements of the balance of payments. That said, these effects are likely to be small, except maybe for economies such as the Philippines and Bangladesh. [b] Capital is the implicit quantity of capital, measured as its value, with any real changes calculated as the change in its value, deflated by any change in its price.

Sources: Zhang (2013); IMF (2015); Gouel et al. (2012); Ianchovichina and Walmsley (2012).

In the comparative static version of PC Global, the mechanisms by which capital stocks are reallocated across countries are similar to those used to reallocate capital across industries in a national model — or in the GTAP model for that matter. Although the capital reallocation mechanism is not explicit, it is *assumed* to take place through investment and depreciation — this would be modelled explicitly in a dynamic model.[4] While no explicit time frame can be assigned to simulations conducted with PC Global, it is implicit that sufficient time must lapse to enable the modelled capital reallocation and adaptation in the level of capital in each country to occur, similar to what is implicit in any other comparative static model in which capital is allowed to be reallocated across industries, for example.

PC Global accounts for capital in three dimensions: capital used by industry j in host region h is owned by households in source region s. Capital is allocated to the industry in the host region, while post-tax capital incomes are returned to residents in the source region. The reallocation across regions and industries occurs once a global level of capital has been determined (see closure section below).

PC Global — structure and theory

PC Global includes a range of industries, commodities and labour types. Each country's economy is modelled separately, with bilateral trade and investment linkages to all other countries. The theory underpinning PC Global is summarised in appendix 2. The model includes:

- 25 separate economies,[5] with Australia, Southeast Asia and the world's major economies identified separately and the European Union represented as a single economy (the economies are listed in appendix 1)
- 57 industries and commodities in each region (listed in appendix 1)
- region-specific skilled and unskilled labour markets
- region-specific sources of final demands (including private consumption, government consumption, private and government investment and export demands)
- region-specific household sectors, which supply capital, labour and land, consume privately and publicly supplied goods and services, and pay income and commodity taxes
- bilateral trade flows between all regions
- global capital allocation, identified by source and host country, as well as the industry using the capital.

4 Capital mobility can also occur through accelerated depreciation or by transfer of ownership.

5 The economies include individual countries, such as Australia and the United States, and regions such as 'the rest of Africa'. The expressions 'economy' and 'region' are used variously to refer to any of the types of geographical and political entities.

Important elements of the behavioural structure of PC Global (all of which are shared with the GTAP model) include:

- households change their consumption bundles in response to changes in their incomes and in relative prices, using the Constant Difference Elasticity functional form (McDougall 2003)
- producers optimise output and use of intermediate inputs, labour, capital and land in response to changes in relative prices, under constant returns to scale
- barriers to trade are typically modelled as tariff equivalents, with any revenues assumed to accrue to the government; some barriers give rise to additional resource costs instead and are modelled as changes in the quantity of resources required to produce a unit of the relevant output; this report concentrates on the latter type of effects[6,7]
- regions substitute between domestic and imported sources of goods and services based on relative prices
- tax rates on consumption, income, production, exports and imports are all fixed (except when taxes or subsidies on imports or exports are shocked)
- household savings and consumption are fixed as a share of income.

In contrast with the GTAP model, firms in PC Global substitute between domestic and foreign sourced capital based on relative costs. This supply of capital module assumes that households in each country own capital, which they allocate domestically and across all other economies, based on relative returns. Any changes in relative returns will change the allocation. Residents in each country allocate the capital they own in such a way that each additional unit of capital earns the same return across all destination economies.

Each source of capital is assumed to embody unique characteristics, and the initial proportion of domestic and foreign capital in the capital used by a country (a determinant of value added and GDP in that country) is specified in the database. The degree to which industries substitute between domestic and foreign-sourced capital is determined by a constant elasticity of substitution function.[8]

In the context of this report, PC Global is a comparative static model.[9] The results are presented in terms of percentage changes relative to the base as represented in GTAP

6 See the section on non-tariff barriers and barriers to trade in services below.

7 Any changes in protection are assumed to be passed on entirely to users — 'full pass through'. Iapadre and Pace (2016), for example, show that incomplete pass through of tariff reductions is likely where competition in the distribution chain in the destination country is weak.

8 This is similar to the Armington function that determines the choice between domestically-produced and imported goods. Demanders of capital can substitute between capital from different sources relatively easily with an elasticity of substitution of 5, implying that assumed differences between capital from different sources are not large.

9 As mentioned above, PC Global is run in comparative-static mode for this project. Although dynamic investment and capital mechanisms exist in PC Global, they have not been parameterised to date. They are turned off in the context of this report in the interest of simplicity, and to facilitate quick solution

database version 9. Results are best interpreted as indicators of how the global economy changes from its representation in the database after industries, consumers, governments, workers and capital owners have fully adjusted to changes in the trade environment, as reflected in the shocks and model closure (the concept and specifications of which are explained next).

Closure options

Model closures specify which variables are not explained by the model (the exogenous variables) and key assumptions about them. The choice of closure can have a significant impact on model results (box 2).

PC Global does not explain labour supply behaviour or the investment processes underlying changes in capital stocks. Therefore, in this report, employment is assumed to be fixed in each region, or unaffected by the types of experiments being run.[10] Practically, this means that if a policy increases the demand for labour in an economy, this translates into an increase in real wages. Conversely, a decrease in the demand for labour translates into a decrease in real wages. Although employment is assumed to be fixed, a decrease in real wages can be interpreted as an indication that unemployment would increase if it were modelled.[11]

Modelling capital is fraught with difficulties in a comparative static model, especially if one is interested in the allocative effects of an experiment.[12] There are two main issues to consider:

- the links between capital stocks and returns to capital (and rates of return)
- the links between investment (and depreciation), savings and capital stocks.[13]

times, given the large number of simulations. Parameterising dynamics, including the development of a forecast or of a reference case over time for each economy, would be required to run PC Global in dynamic mode.

10 As in GTAP, PC Global recognises skilled and unskilled labour in each economy. The supply of each type of labour is assumed to be fixed. Therefore, wages for each type of labour adjust independently.

11 That is, real wages would decrease less and unemployment would increase. Allowing for unemployment or a decrease in employment would translate into larger declines in real GDP, real GNP and real Gross National Absorption (defined in box 5) than are reported.

12 There are allocative and growth effects. Growth effects (the rate at which capital is accumulated) are likely to be smaller than allocative effects (where capital owners choose to allocate their capital stocks).

13 PC Global does not link investment and capital (with steady state calibration). This is because the national accounts data on which PC Global is based are incompatible with capital stocks data and a steady-state. The database would have to be modified (and depart from national accounts) to enforce the consistency required in a model that explained investment behaviour in a steady-state. Murray and Salerian (2016) make such adjustments in a model of the Australian economy; these would be more complex in the context of a global model.

Box 2 The effects of closure choice on modelling results

In the table below, the simulation 'US applies a 45 per cent tariff on imports from China' is used to illustrate how the choice of assumptions about how capital stocks and rates of return to capital adjust affect the results for real GDP and rates of return.

Changes in real GDP and rates of return to capital under three closures

US applies a 45 per cent tariff on imports from China. Percentage changes

	GDP				*Rates of return*			
	US	*China*	*Mexico*	*World*	*US*	*China*	*Mexico*	*World*
Closure 1	-0.39	-0.39	0.06	-0.11	-1.60	-2.12	1.77	-0.21
Closure 2	-0.61	-0.60	1.09	-0.11	-0.10	-1.62	0.86	-0.09
Closure 3	-0.63	-1.27	2.34	-0.12	0	0	0	0

Data source: Commission estimates generated using the PC Global model.

Under closure 1, the most restrictive, the amount of capital used in each economy does not adjust and, to achieve this, there are relatively large changes in rates of return — commensurate with the constraint on changes in capital. For the United States, this limits changes in GDP to efficiency losses arising the misallocation of resources. For China, income losses from reduced exports are limited by the requirement that the stock of capital be used, since it is fixed (so the price of their exports contributes more to the adjustment than the volume). For Mexico, potential income gains from increased exports are limited by its inability to expand its stock of capital.

Under closure 2, capital owners reallocate their capital from the United States and China to other economies. This is reflected in greater contractions in GDP for the United States and China than under closure 1. This pure reallocation effect results in returns to capital declining in contracting economies. The largest contraction is in China, consistent with a larger decline in rates of return.

In closure 3, capital owners are assumed to maintain the rates of return that they require from firms (change is zero). This means that the supply of capital from each country is perfectly elastic relative to the rate of return and the equilibrium amount of capital in each country is determined solely by the decline in the demand for capital in that country. There is no capital reallocation mechanism across economies, but there are large effects on GDP.

In the case of capital, because PC Global describes who owns the capital stock and how this stock is allocated across regions, there are three main options for setting the capital closure:

- Closure 1: The stock of global capital is fixed, as is the stock of capital in each economy. Capital cannot be reallocated across economies. In the event of a policy change that increases the demand for capital in an economy, the rates of return on the capital used in that economy increase. This is equivalent to the standard GTAP closure that is used in many GTAP applications.
- Closure 2: The stock of global capital is fixed but capital owners can allocate their stock across economies. In the event of a policy change that increases returns to capital in an economy, owners reallocate capital toward that economy until changes in rates of return are equalised across the world (owners maintain initial relativities). The global rate of return increases if the global demand for capital increases.

- Closure 3: The stock of global capital is not fixed, but can increase (or decrease) if the global demand for capital increases (decreases). In the event of a policy change, the capital stock increases (or decreases) up to the point where rates of return resume their original levels. Under closure 3, capital owners are assumed to be able to supply as much capital as is demanded by each host region at the original target rates of return. Changes in the capital stock used in each region are determined solely by changes in the demand for capital from each region, within that region.

Closure choice

None of these closures is likely to be an accurate description of how the supply of capital and target returns to capital would react in response to the types of scenarios modelled. The choice of closure is made on the basis of how reasonable the assumptions are and how these assumptions summarise mechanisms that are not modelled explicitly. In the case of capital, traditional choices are to assume that either capital is fixed or rates of return are fixed. Neither of these choices allows for the global capital reallocation effects that one might expect in the types of scenarios modelled.

A dynamic representation of capital and investment interactions would account for capital stock in one year being a function of the capital stock in the previous year and of investment less depreciation. Over time, capital is therefore the sum of net investments made in previous years. Net investment is a function of savings, which in turn depend on income net of expenditures, and are influenced by preferences between current and future consumption and returns on investment. Thus changes in income are liable to affect future capital stocks. It is unlikely that the global supply of capital would not be affected by changes in income (as assumed in closures 1 and 2), or that an investor's target rate of return not would be affected by changes in economic conditions (as assumed in closure 3).

Theory of the dynamics of investment and preferences between consumption and savings suggests that the actual outcome would lie somewhere between the two extremes represented by closures 2 and 3.

The results presented in this paper are based on a hybrid of closures 2 and 3. Closure 3 provides information about the maximum potential response of the demand for capital in each country, assuming that rates of return do not change. Closure 2 provides information about the maximum potential response of the rates of return when the supply of capital is assumed to be fixed in each region. Between these two extremes any change in capital stock is possible. Instead of introducing a mechanism to project how the capital stock might change over time, the focus is on the effects of reallocating a given capital stock. The information from closure 3 is used to determine an equilibrium level of the global capital stock so that the responses of regional and world economies to such a change in capital stocks can be analysed using closure 2 (box 3).

Box 3 Implementing the closure

A three-step process is used to model changes in the capital stock and rates of return that lies between the extremes represented by closures 2 and 3:

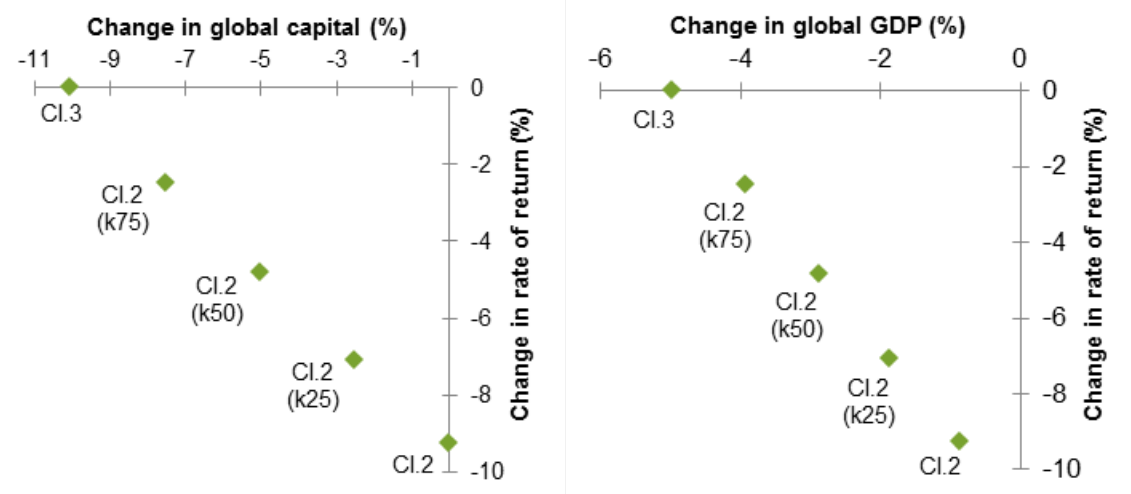
1. a simulation is run assuming that the target rate of return does not change in response to the policy change (as per closure 3), thus obtaining the change in the amount of capital demanded in each economy under this condition
2. the target rate of return is assumed to decline by an amount consistent with *a proportion* of the decline in capital demanded observed in step 1
3. the simulation is re-run with the closure 2 setting and the change in the demand for capital set as in step 2 to obtain how the global economy reorganises the use of the stock of capital owned.

This approach requires a decision about the proportion of the change observed in step 1 that is used at step 2. To inform this decision, PC Global was used to test the effects of setting the proportion at 25, 50 or 75 per cent. As illustrated in the figure below, the results lie between the extremes represented by closures 2 and 3. The effects of the closure choice are most noticeable in the case of shocks that affect a large number of economies so the tests were run using the global contagion scenario.

In this report, the proportion is set at 50 per cent of the change in capital observed using closure 3 alone (that is, 50 per cent of approximately -10, or about -5 per cent), the consistent change in the rates of return is about -4.8 per cent (left panel of the figure). Changes in the capital stock and rates of return of that magnitude are reflected in a 2.9 per cent decline in global GDP (right panel of the figure).

Effect of closure on capital used and GDP, depending on assumptions about target rates of return[a]

Simulation G1



[a] Cl.3 and Cl.2 refer to closures 3 and 2; k25 to k75 refer to proportional decreases in capital stocks — k50 represents 50 per cent of the reduction in the amount of capital used as observed in Cl.3, and so on.

Data source: Commission estimates generated using the PC Global model.

The bilateral reallocation of capital as modelled in PC Global means that once the amount of capital demanded in each economy is known, investors allocate the capital that they own across economies according to changes in returns, which depend in turn on the effects of the modelled policy changes.

For example, increases in protection reduce returns to capital in the country imposing the tariff and in the country whose exports are targeted. This reduction is larger where initial tariffs are larger, because the efficiency losses are a quadratic function of tariff levels.[14] The differing reductions in returns to capital across countries produce a reallocation of capital across the world and across industries — investors allocate their capital so that they earn the same marginal return across all the destination economies in which they invest.[15] The outcomes in terms of changes in capital stock in the destination economies and in terms of their real GDP depend on the extent to which investors adjust the target rate of return that they require. In turn, the reallocation of capital affects GNP in the destination countries, which have to pay returns to the foreign owners of capital, and GNP in countries in which the capital is owned, which receive returns to capital from abroad.

The effect of varying the proportion of the original change in demand for capital on real GDP in the main countries of interest to this project is illustrated in figure 1. The effects when the proportion is set at 50 per cent for example, are represented by the green triangles.

As tariffs increase, the demand for capital declines and:

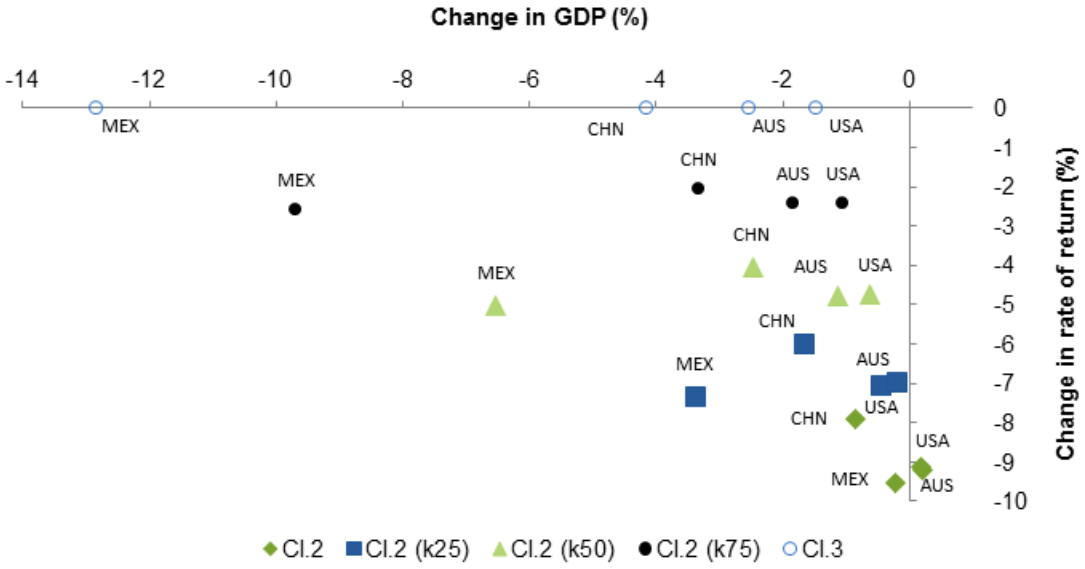
- in closure 2 (with fixed global capital), rates of return decline to employ all capital. As global capital is fixed, this results in relatively small changes in real GDP
- in closure 3 (with fixed target rates of return), the global capital stock declines, determined only by the demand in each economy. These declines in capital stocks in each economy are reflected in large declines in real GDP
- in the closures between closure 2 and closure 3 (as the target rate of return is assumed to decline in response to declining capital demand), the supply of global capital declines less than under closure 3 and owners of capital allocate their holdings across the different economies, based on changes in relative rates of return. The declines in capital stocks are reflected in smaller declines in GDP than under closure 3.

[14] Efficiency losses from tariffs are quadratic when demand and supply are linear (Mankiw 2008). A tariff increases the price linearly, but it also decreases imports (the amount depends on elasticities of demand and supply). The losses are the multiplication of price and quantity effects, that is, an area. For example, increasing a tariff might increase the price two-fold and decrease imports two-fold, but would increase deadweight losses four-fold.

[15] Returns to capital differ across economies in recognition of different risk premia. This is reflected in the database. Simulations are assumed not to affect these risk premia.

Figure 1 **Effects of closure assumptions on real GDP, selected countries[a,b]**

Simulation G1, selected countries



[a] Cl.3 and Cl.2 refer to closures 3 and 2; k25 to k75 refer to proportional decreases in capital stocks; k75 represents 75 per cent of the reduction in capital used as observed in Cl.3, and so on. [b] The equivalent figure with all regions is found in appendix 4.

Data source: Commission estimates generated using the PC Global model.

The central results that are the basis for most of the analysis presented in the report assume that reactions in global capital markets are about half way between the extremes represented by closures 2 or 3. That is, the proportion is set at 50 per cent.

Other relevant modelling

Dixon (2017) and Kawasaki (2017) have modelled the effects of the US increasing tariffs to 45 per cent on imports from China. Although they use fundamentally the same database and model as this report, some of the results are quite different due to differences in assumptions (box 4). The results from the Dixon simulation are close to those obtained from PC Global with a similar closure.[16] The results reported in Kawasaki are larger because of differences in assumptions about the closure and the assumption that tariffs might be associated with some inefficiencies (Kawasaki 2014 and pers. com. 2017).

[16] Dixon (2017, p. 4) assumes that 'aggregate employment in each region responds weakly to wages […] Good or bad economic news is mainly reflected in changes to wage rates commensurate with maintaining the employment rate (broadly defined as the ratio of employment to population) at close to its initial level.' This is very similar to the assumption used for PC Global.

Box 4 **Other modelling of increased protectionism**

Although modelling the same scenario — the US imposes a 45 per cent tariff on imports from China — Dixon (2017), Kawasaki (2017) and the Commission arrive at different results. There are several possible reasons for the differences between the results for the United States, including the country aggregation and assumptions about labour and capital.

Dixon uses a 4-region aggregation; Kawasaki, 13 regions; the Commission, 25 regions. Greater aggregation means that there are fewer opportunities for substitution (which mitigate the effects of tariffs), and produces larger decreases in GDP. This is part of the reason for the smaller declines in the PC Global column.

As discussed in box 2, assumptions about whether capital is fixed at the country level (closure 1) or globally endogenous (closure 3) can produce dramatically different results. The first two lines of the table below repeat this message. When capital is constrained from adjusting, losses in real GDP are smaller than when global capital is allowed to adjust.

The third line presents Kawasaki's results that account for dynamic effects on investment as per the approach in Francois, McDonald and Nordstrom (1996). The initial decline in GDP is assumed to be magnified by further investment effects.

The fourth line presents results obtained by Kawasaki when it is assumed that increases in tariffs lead to 'anti-competitive productivity effects'. Kawasaki assumes that protection from imports leads protected industries to suffer additional costs. These additional costs are calibrated as the amount by which the tariff increases prices for domestically produced goods. This effect adds to the losses due to allocative inefficiency that are part of the other results.

The settings adopted for PC Global can be thought of as conservative relative to those underlying some of the other published results.

Changes in US real GDP — US applies a 45 per cent tariff on imports from China

Percentage change, various studies

Assumptions	*Kawasaki (2017)*	*Dixon (2016)*	*PC Global*
Capital fixed in each economy (cl.1)	-0.42		-0.39
Endogenous capital (cl.3)		-0.53	-0.61
Endogenous capital[a]	-0.93		
Productivity effects	-1.72		

[a] Includes dynamic effects as designed in Francois, McDonald and Nordstrom (1996).

Sources: Dixon (2017), Kawasaki (2017), Commission estimates generated using the PC Global model.

Non-tariff barriers on goods and barriers to trade on services

Two of the scenarios consider the potential impacts of a coalition of economies pursuing a liberalisation agenda. This group of economies, including Australia, is assumed to respond to the global contagion scenario by pursuing a liberalisation agenda on a most favoured nation (MFN) basis, through combinations of tariff freezes or removal, and reductions in

non-tariff barriers (NTBs) on goods and barriers to trade in services (BTS). This section explains how estimates of these barriers were calculated.

For both goods and services, these barriers result largely from regulations that have a variety of objectives — and that can impose a range of costs on local and foreign firms.

- Regulations might be designed to protect a domestic industry. For example, some regulations that limit the number of operators in a sector, prohibit an import or some technical barriers can be used for this purpose. In these cases, regulations could be modified to increase competition from foreign suppliers, which could decrease local prices.
- Regulations might impose unnecessary costs and could be redesigned to reduce costs for local and foreign suppliers — for example, harmonisation or mutual recognition could reduce the cost of regulations; obsolete regulation could be modified or abandoned.

In some cases, it is a matter of 'liberalising' or 'deregulating', in others it is rather a matter of 're-regulating'. The modelling does not provide an indication of what type of action is implied by the modelled price reductions. It simply assumes that barriers translate into price effects and makes further assumptions about how much liberalisation can reduce these price effects. The price effects are based on estimates of NTBs and BTS, which are briefly explained in the next sections.

Estimates of NTBs and of BTS

In order to estimate the broader impacts of liberalisation on international trade, this project uses estimates of NTBs and BTS that are based on recent work by other researchers.

- Kee et al. (2009) use a gravity approach to estimate the effects of non-tariff *measures* (NTMs) on bilateral trade flows of goods.[17] These are the effects of all the measures included, irrespective of whether they are actionable non-tariff *barriers*. Kee et al. (2009) include variables to account for four types of restrictions: price control measures, quantity restrictions, monopolistic measures and technical regulation. To the extent that other measures are correlated with these four measures, the estimation also accounts for their influence on traded quantities.
- Fontagné et al. (2016) also use a gravity approach to estimate the effects of regulation on services trade. The authors stress that the 'tariff equivalents of services NTMs' that they present are likely to include the effects of any frictions that might affect service trade flows, beyond those that might be attributable to regulations. The authors do not include any regulatory measures explicitly. The effects of regulation are estimated with a destination 'country fixed effect' variable (hence the likelihood that the estimates

[17] They also identify the effects of domestic support for certain agricultural commodities. These estimates are not used in this report.

account for many possible trade frictions, other than those accounted for in the traditional gravity variables).

Nature of the effects of barriers

Both sets of authors present estimates of the effects of regulations on prices. While these are often referred to as ad valorem equivalents in that they are measures of the price increases that are attributed to the measures, there is no indication as to whether they are more likely to increase prices by giving rise to rents or require the use of resources.

- If they are considered to give rise to rents, they are traditionally thought to give rise to Harberger triangles and to resource misallocation. They are thought of in the same way as tariffs; for example:
  - Kee et al. (2009) derive an Overall Trade Restrictiveness Index as the cumulative effects of tariffs and NTBs
  - Kawasaki (2017) models NTBs as if they were tariffs (and allocates any implied revenue to governments[18]).
- If they are considered to require resources, they are referred to as 'cost-increasing barriers', and freeing up the resources is akin to changing the production process in that each unit of output requires less inputs. This is similar to a productivity improvement.
  - Petri and Plummer (2016, p. 27) assume that the cost-increasing effects and the rent effects each contribute half of the barriers on goods and on services trade.

Little is known about the contribution of each effect to estimated ad valorem equivalents. That said, while both effects influence allocative efficiency, the cost-increasing part is likely to have larger effects than the rent part.[19]

Implementation

As with all economic research, the two estimation studies referenced above have limitations. That said, they use reasonable methods to produce the estimates. Both sets of authors present estimates in the form of tariff equivalents that are aggregated to GTAP commodity level. Some values exceed 100 per cent, implying that the values of the measured trade flows include large price wedges (the implication in these cases is that the prices are estimated to be more than twice as large as they would be otherwise). Such

[18] This could be a reasonable representation if any revenue implied from the tariff equivalents is captured, for example, in a government-sponsored auction.

[19] Even rents are associated with changes in 'production technology' that are not accounted for in a simple tariff simulation. Rents are typically captured by some part of the production process, whether through lobbying, weaker wage negotiations or higher executive remuneration. All of these form part of the cost structure and, therefore, of the 'production technology', and contribute to cost increases that can be represented by increased input requirements.

estimates imply that the cost of purchasing these goods or services could be reduced to less than half their current level.

Further, all measures that might affect trade are not appropriate in the circumstances of this report. Petri and Plummer (2016, p. 9) argue that '[s]ome regulations that have legitimate, welfare-increasing objectives (for example, product safety standards) may be included in estimates of [NTMs] … but they should not be counted as barriers'. The authors assume that only 75 per cent of the measures are 'subject to reduction'. Of these, they assume that 50 per cent are 'actionable'.

Therefore, the shocks implemented in this study are much smaller than the estimates presented in the estimation papers. This report only applies a portion of the reported estimates of NTMs and BTS as a shock. This portion reflects:

- the subset of NTMs and BTS which do not relate to regulations necessary to address safety or risk concerns and similar regulations
- the subset of NTMs and BTS which can be actioned
- the subset of NTMs and BTS that discriminate between domestic and imported goods.

This report concentrates on the likely effects of the cost-increasing component of NTBs and BTS (that is, 'productivity improvements'), the part that is likely to have the largest effects on trade. It uses a small portion of the published estimates: 20 per cent of the estimates of NTMs on goods and 10 per cent of the estimates of BTS, where both proportions are thought to be conservative. Further, NTBs on agricultural trade are assumed to be legitimate sanitary and phytosanitary regulations and assumed not to be 'actionable' in a trade setting; they are therefore not implemented.

Both types of barriers are applied to the import flows. The rationale for this is that the estimates are based on the way in which the barriers affect import flows (then converted to effects on the corresponding prices), not on the prices of domestic production.[20]

PC National

PC National with a household extension is used to analyse the distributional impacts of some policy changes introduced in PC Global.

PC National is a single-region CGE model based on the 2012-13 input–output table of the Australian economy. Its structure is similar to that of other models of the Australian economy that are based on ABS input–output table data, such as those developed by the

[20] For services especially, the import flows (cross-border trade, that is, mode 1) are small relative to the size of the domestic sectors. Thus, effects can be expected to be smaller than if they were applied to the much larger services sectors themselves. Further work would be required to use the estimates used as a starting point to design shocks that could be applied to the corresponding domestic industry.

Centre of Policy Studies. Unlike other Australian models, however, the version of PC National used in this study extends the single representative household into a detailed module of the household sector, using the ABS 2009-10 *Household Expenditure Survey and Survey of Income and Housing* as the data source. In PC National, the household sector (private expenditure and income sources) is represented by a weighted sample of over 9700 households.

As PC National uses a different database, no attempt has been made to integrate it with PC Global.[21] Instead, PC National is used to emulate the effects produced by PC Global. In other words, results from PC Global are used to inform the modelling done in PC National.

A number of exogenous variables in PC National are shocked with the simulation results from PC Global. These include changes in the world (cost, insurance and freight (CIF)) prices of Australian imports, the world demands for Australian exports, the tariffs on Australian imports, Australia's capital stock endowment and the real net inflow of foreign investment (trade deficit). In addition, the Armington elasticities of substitution between domestically produced and imported goods in PC National are adjusted to be consistent with those used in PC Global so that the two models have similar demand responses.

Each household in PC National corresponds to a sample household in the survey. It has a full household budget. On the income side, its members (up to six members for each household) receive income from various sources: labour (eight different occupations), capital and government benefits (23 different types of benefits), and pay income taxes. On the expenditure side, each household spends their income on 114 goods and services. The difference between incomes and expenditures as reported in the household data is assumed to be savings. Sample incomes and expenditures are expanded to the population level with population weights and scaled so that the aggregate income and expenditure amounts are consistent with the data in the input–output table.

A household's real income is defined as its nominal income divided by the household's specific price index. Each household has a given set of factor endowments (occupational labour, which is assumed to be fixed,[22] and capital, which declines if the stock of owned capital declines) and a given consumption pattern. As factors are assumed to be perfectly mobile between industries, there is only one equilibrium rental price for capital and each occupation. Therefore, all factor owners earn the same returns (rental price of capital and occupation-specific wages). Similarly, all households face the same set of goods and service prices. As households have different factor endowments and consumption patterns, the same changes in factor and goods prices can result in different changes in nominal income and in household specific price indexes, which generate different impacts on household real incomes.

[21] Although integrating the databases fully is desirable, this approach was not taken due to the time constraints in the project.

[22] Since the supply of each occupation is fixed, occupational wage changes are larger than if the supplies were assumed to be flexible.

3 Results

PC Global was used to model 12 main scenarios (table 1), and the results are presented in charts, to facilitate comparisons. Tables summarising the main macroeconomic results and the results for changes in bilateral trade flows are presented in appendix 3. The results from the various scenarios are aggregated to 10 regions to facilitate the analysis, although the simulations were carried out at the 25–region aggregation. That said, results in this section are often presented for a selection of countries (mainly Australia, China, the United States and Mexico). In the main, results are presented as percentage changes in real GDP, GNP and GNA (box 5). Any results in dollar terms are expressed in terms of changes in 2016 US$.[23]

To illustrate the principles underlying the simulations, the simulation 'US increases tariffs on imports from China to 45 per cent' is analysed in the most detail. The others are analysed with reference to this simulation.

US increases tariffs on Chinese imports — CHN45

From an Australian perspective, the aggregate effects of this simulation are small, though there are some structural changes. These results are analysed later in this section. The analysis is best conducted by starting with the shocks and what they affect directly — that is, the US tariffs on its imports from China and the corresponding trade flows.

Most US tariffs are currently less than 5 per cent. Therefore, the increase in US tariffs on imports from China exceeds 40 percentage points for almost all goods — a very large increase. The primary effect of this is to substantially increase the price of Chinese exports to US consumers[24] relative to the price of imports from all other origins.

US consumers are expected to substitute away from Chinese imports in favour of local production (to some extent) and imports from other sources (largely). Therefore, the demand for Chinese exports is expected to decline, reducing the world prices for these exports. The reduced world prices mean that Chinese exports crowd out other exporters in non-US markets, including Mexico. In addition, Mexican exports to the US increase. This increase dwarfs the effect of increased US demand for Canadian exports, because Mexico and China compete in very similar US markets (that is, certain manufactured goods) but Canada does not.

[23] Model input and output data are in US 2011 dollars. Results have been scaled to 2016 dollars assuming a cumulative inflation rate of 6.7 per cent.

[24] Consumers include firms as users of intermediate goods and investment goods as well as consumers of final private and public goods.

Box 5 Measuring real changes in activity, incomes and purchasing power

Most aggregate results from computable general equilibrium (CGE) simulations are presented in terms of changes in real GDP, a measure of the change in activity within borders. If all capital used in a country is assumed to be owned by residents (the assumption made in most CGE modelling applications using the GTAP model), this is equivalent to the change in real GNP. If alternatively, as in PC Global, some capital is supplied from abroad and some domestically owned capital is used in other countries, then GNP and GDP measures differ by the net foreign capital income received from abroad.

Both measures are termed 'real' in that the values of these aggregates are deflated by the appropriate price indexes. These price indexes are calculated as the weighted average of changes in the prices of the components of the aggregates.

To capture the effect of changes in income on living standards, a measure of economic welfare, that is, the purchasing power of income, could be derived by deflating changes in income by changes in the price index of a basket of goods that might be purchased. Alternatively, one might deflate the value of expenditure by the relevant index of prices.

This report uses real Gross Domestic Absorption adjusted for expenditure on foreign investment as measure of purchasing power. This is termed real Gross National Absorption (GNA). In contrast to real GDP, real GNA accounts for changes in the terms of trade by excluding the effect of export prices (which residents do not consume) in the deflator and including the effect of import prices (which residents do consume).

Real GNA accounts for expenditure made by residents on private and public consumption and on investment goods. This is in effect a basket of expenditure. Any change in its value can be deflated by an index of the changes in the prices of its components.

Just like real GDP and real GNP, real GNA has the property that changes in the country indexes add up to changes in global real GDP. This is important in that it means that it is consistent across countries and that it provides an accurate view of how global income is distributed in real terms.

In the US, the prices of imports (and those of import-competing products) increase, raising production costs. With increasing costs, demand for US output (and exports) declines. Output contracts because, although domestic demand for domestically produced output increases, this increase does not compensate for the fall in exports. The reallocation of resources toward import-competing sectors results in a decrease in efficiency, which contributes to the decrease in real GDP. That said, the reallocation of resources toward domestic production is relatively small, since the United States substitutes imports from other sources such as Korea and Japan. But this substitution comes at a cost, as imports from those sources become more expensive.

With output falling, demand for labour and capital falls. Real wages decrease and rates of return decline. As a result of the latter, US investors increase their holdings of capital abroad and foreign investors withdraw their capital from the United States. The combined effect of this is to reduce the amount of capital located in the US, which contributes to the reduction in real GDP (figure 2). Real income (real GNP) declines less than real GDP as:

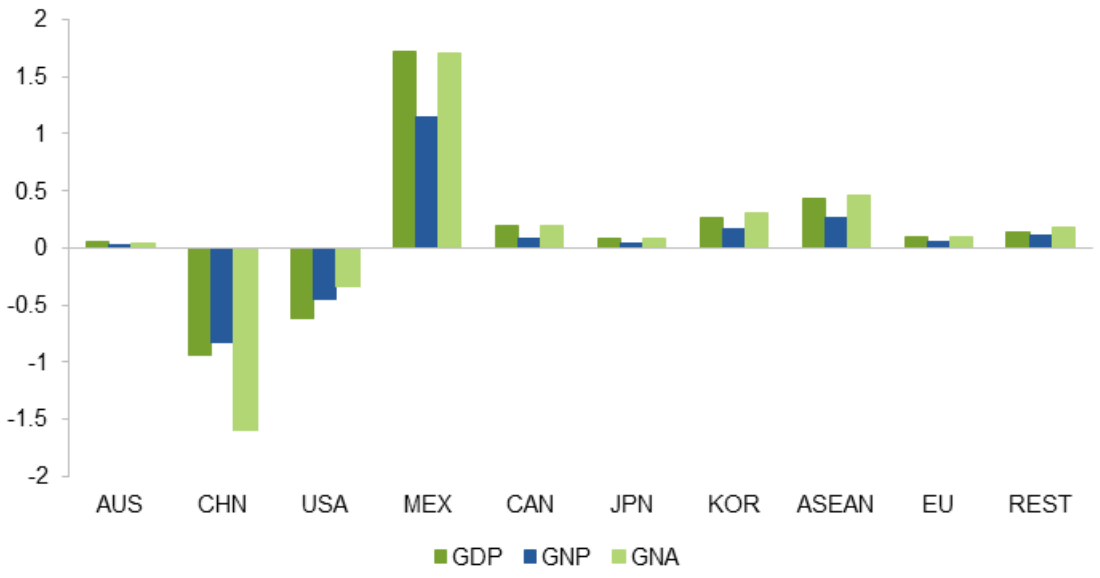
- the income owed to foreign owners of capital declines
- US capital owners receive more income from their increased holdings abroad.

In turn, real GNA declines less than GNP because, as it increases its tariffs, the United States experiences an improvement in its terms of trade, which increases the purchasing power of US income.

In China, the decline in US demand for Chinese exports produces large decreases in exports and incomes. The decline in demand for Chinese goods decreases demand for labour and capital, reducing real wages and rates of return.

Faced with lower rates of return in China, foreign investors decrease their holdings in China. Chinese investors increase their holdings abroad.[25] The decline in capital used in China and in output shows as a reduction in real GDP.

Figure 2 **Changes in real GDP, GNP and GNA — CHN45**
Percentage change



Data source: Commission estimates generated using the PC Global model.

The decline in foreign capital in China reduces payments to foreigners and the increase in capital outflows increases payments to Chinese investors, which explains the smaller decrease in Chinese real GNP compared with the decline in real GDP. The decline in

[25] This will result even without an open Chinese capital account since the capital controls are known to be relatively porous (The Economist 2015).

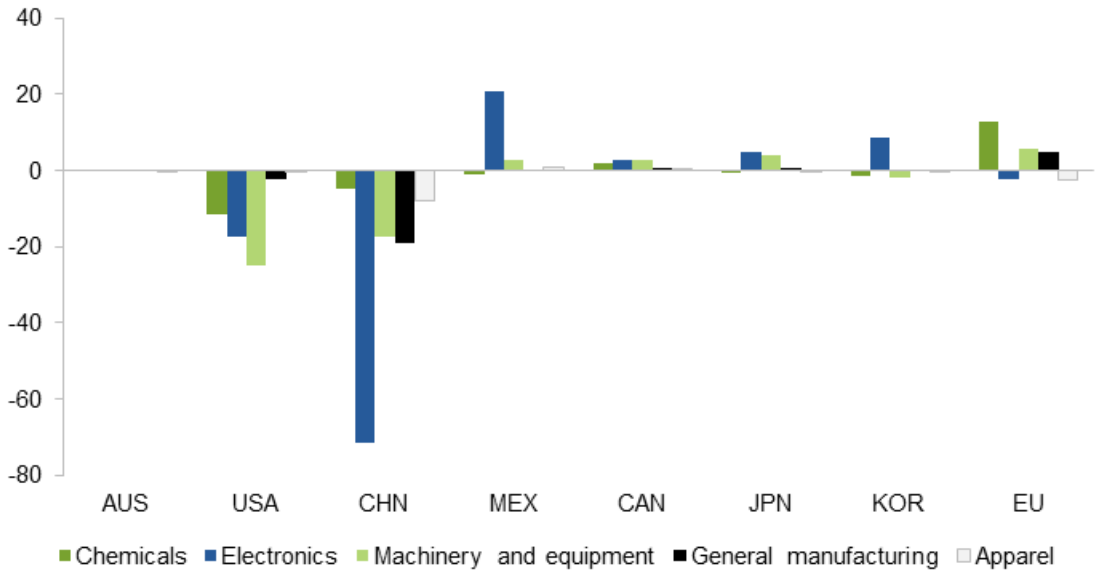
prices received for Chinese exports accounts for the decline in China's terms of trade and the larger decline in real GNA.

Global trade reorganisation

The increased US tariff on Chinese imports causes a large decline in US imports of manufactures and a significant reorganisation of remaining imports into the US (figure 3). Chief among this reorganisation is the shift from China toward Mexico and Korea for imports of electronics in particular, and toward the European Union for other large changes in manufactures.

As the main substitute for China as a source of inputs into US production, and given the large share of trade in its economy, Mexican GDP increases most, followed by Canada, Korea and the Association of South East Asian Nations (ASEAN) as they increase their contributions to US imports (figure 2). For these economies, increased real GDP means that they have attracted capital that has been shed, mainly from China. This in turns means that their real GNP increases, but not as much as real GDP, because returns to foreign owners must increase. The decrease in Chinese export prices decreases the cost of their imports, resulting in a terms of trade gain, which translates into a larger increase in real GNA.

Figure 3 **Changes in export volumes by sector and exporter in CHN45**
2016 $US billion



Data source: Commission estimates generated using the PC Global model.

Effects on Australia

Despite its close commercial ties with China and the United States, Australia experiences small effects in aggregate. Declines in incomes in the United States and China decrease demand for Australian exports, but several price effects compensate for this.

- As the cost of Chinese exports to the US increases, US demand for Australian exports increases.
- As the costs of US exports increases, demand for Australian exports by third countries increases.
- As the world price of Chinese exports declines, the cost to Australians of acquiring these imports declines.

Price effects are particularly important to the relatively small effects on Australian exports of iron ore (box 6). These effects are dependent on the values of substitution elasticities between domestic and imported goods (box 7). When Australian exports are assumed to be less substitutable for other sources, the decrease in demand from China means that Australian exports decline more. That said, the experiment shows that aggregate results are not sensitive to the elasticity values chosen.

Box 6 **Iron ore and steel**

The markets for iron ore and for steel illustrate the importance of prices and their effects on substitution across suppliers and users. The main players in these markets include Australia, China, Korea, Japan and the United States. As the cost of Chinese steel in the United States increases, US users substitute toward the other main sources: Korea and Japan (and to some extent, toward US producers of steel). Meanwhile, the world price of Chinese steel decreases, which makes it more competitive in markets other than the United States, and China diverts its exports toward those markets where they crowd out other exporters (Korea and Japan). It also reduces the price of steel exports from these exporters. Australian exports of iron ore toward these traditional exporters of steel decline, but they increase toward non steel-exporting countries who produce steel mainly for domestic purposes. The overall effect leads to a small (-0.18 per cent) decrease in Australian exports of iron ore and a small increase (0.77 per cent) in Australian steel exports.

Source: Commission estimates generated using the PC Global model.

Box 7 Sensitivity to substitution elasticities

Given the importance of China to Australia's export sector, and the deleterious effect on Chinese GDP observed in the CHN45 simulation, one might expect that the Australian economy would experience significant adverse consequences from an increase in US tariffs on imports from China. The main results presented in this section depend on the reorganisation of trade as Australia and other economies adapt to the new tariff environment. Reducing the ability of the world economies to reorganise trade and production changes the trade results, but has little effect on Australia's aggregate results.

The CHN45 simulation was used to test the sensitivity of results to halving the elasticities of substitution between domestically produced and imported goods and between imports from different regions. This is equivalent to assuming that users cannot fully adapt where they source their inputs and consumption from — a possible short-run effect.

Decreasing the Armington elasticities shifts demand from imports toward domestically produced goods. As a result, the overall decreases in world trade and output are smaller. The regional responses are diverse. In the case of Australia, world demand for Australian exports is not as high as it is with higher elasticity values, and world demand for iron ore declines by 0.44 per cent, more than the original 0.18 per cent, because it is not as easy to substitute ore from other sources. There is very little effect on aggregate results. Reducing the value of trade elasticities has some effect on disaggregated trade flows and reorganises economies in terms of their mix of domestically produced and imported goods, but it has little effect on Australia's real GDP and other aggregate indicators. Larger effects are possible with extremely low elasticities which would imply that commodities such as iron ore or steel from different sources are not substitutable, which is not a realistic assumption, even in the short run.

Changes in key variables — US applies a 45 per cent tariff on imports from China

Percentage change

		Original	*Half*[a]
Real exports	World	-0.30	-0.43
Real GDP	World	-0.11	-0.10
Real exports	Australia	0.32	0.25
Iron ore	Australia	-0.18	-0.44
Real GDP	Australia	0.055	0.057
Real GNP	Australia	0.030	0.010
Real GNA	Australia	0.013	0.009

[a] Elasticities of substitution between domestic products and imports and between imports from different sources are half their original values specified in the GTAP model.

Source: Commission estimates generated using the PC Global model.

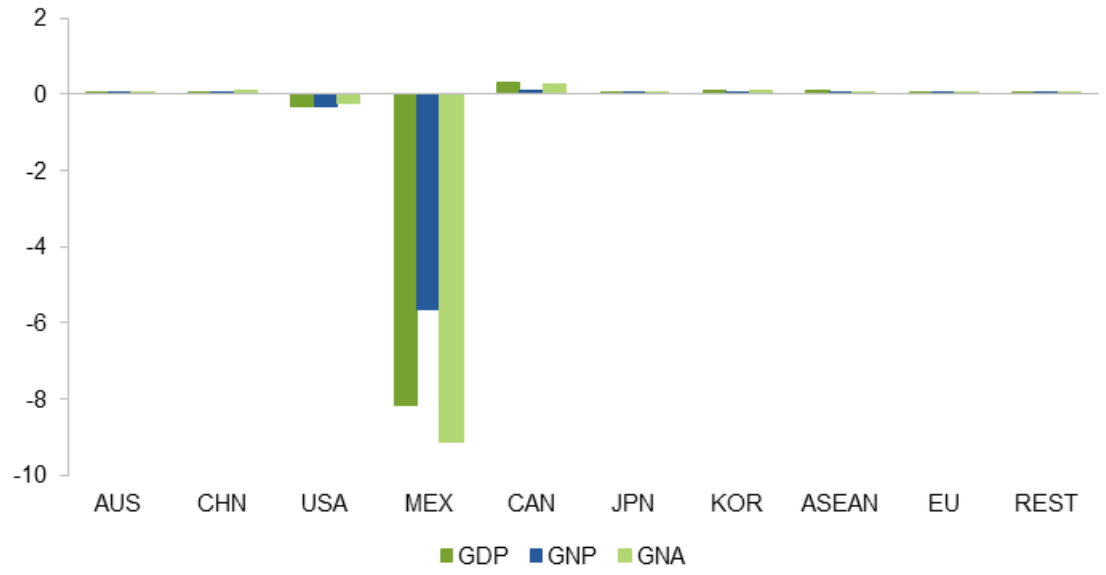
US tariffs on Mexican imports

The United States and Mexico share a strong trade relationship, with imports from Mexico accounting for 13 per cent of US goods imports. The relationship is typically characterised by inputs to manufacturing flowing from the United States to Mexico and final manufactured goods flowing back — the United States relies on Mexico for the final assembly of a large proportion of its consumption.

Increasing tariffs on Mexican imports to 35 per cent puts Mexican manufacturers at a disadvantage relative to other suppliers to the US market. Similar to the simulation on Chinese imports, Mexican exporters divert their products to other markets at the cost of a substantial reduction in Mexico's terms of trade as its export prices decline.

The macroeconomic effects of the MEX35 simulation on Mexico are similar to those shown for China in the CHN45 simulation (figure 4). Because of the greater importance of the United States to the Mexican economy, the effects on Mexico are larger than they are in that simulation.

Figure 4 **Changes in real GDP, GNP and GNA — MEX35**
Percentage change

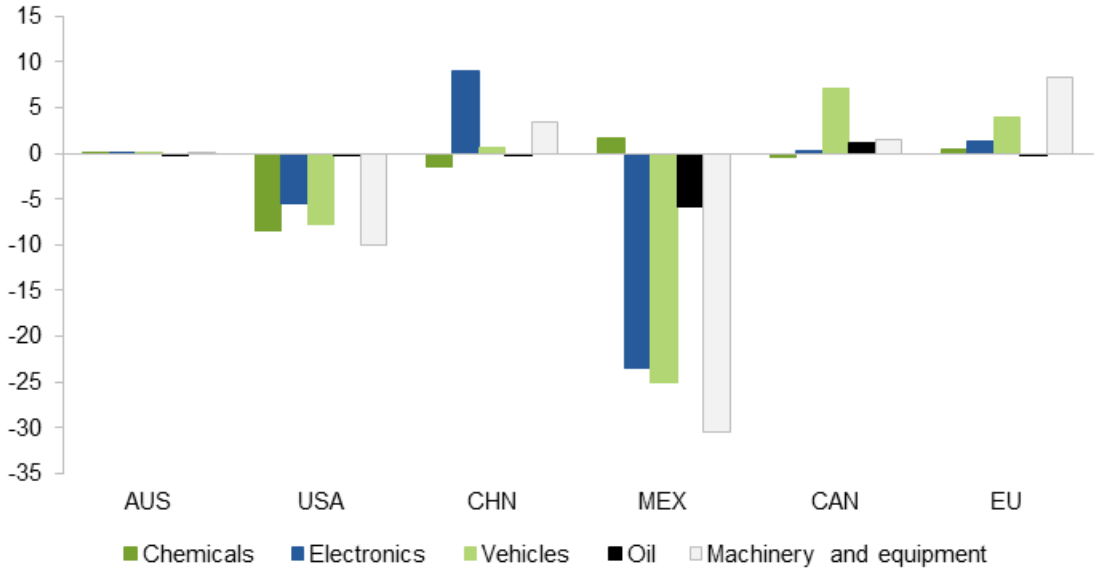


Data source: Commission estimates generated using the PC Global model.

Mexican exports of manufactured goods are particularly affected by the higher tariffs. The combined decline in Mexican exports of motor vehicles, general machinery/equipment and electronics adds up to over US$80 billion (figure 5). Other sources of these imports substitute for Mexican exports, but there is a decline in the volume of all imports by the

United States. Further, the resulting increase in the costs of production in the United States reduces its exports of key manufactures by more than US$30 billion.

Figure 5 **Changes in key export volumes — MEX35**
2016 US$ billion, by sector



Data source: Commission estimates generated using the PC Global model.

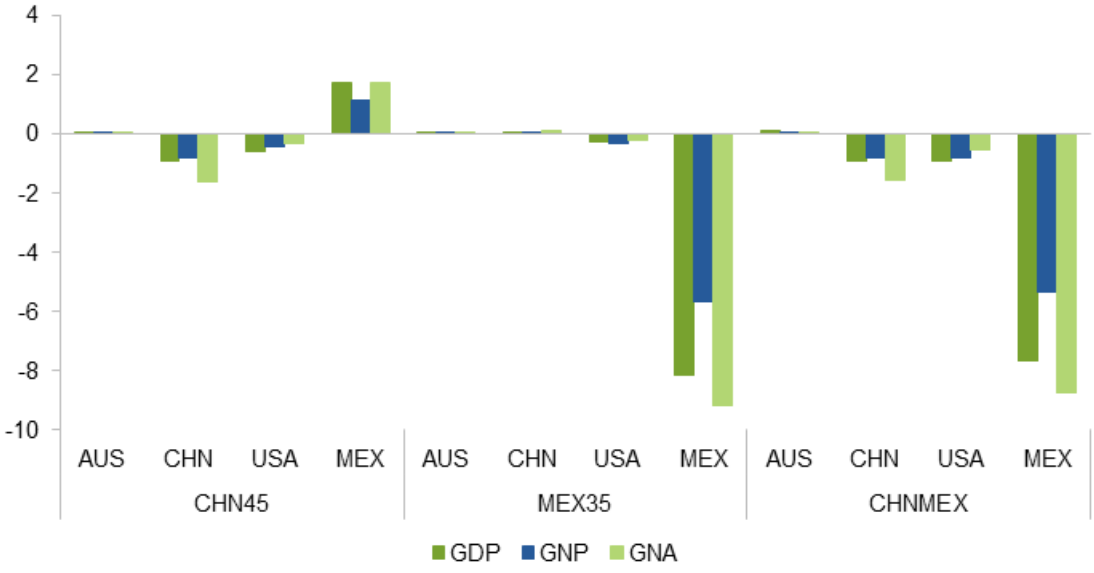
US tariffs on Chinese and Mexican imports

In the previous scenarios, Chinese and Mexican exports to the United States substituted for each other to the extent that both countries supplied into the same US markets (an effect particularly evident for electronics). When tariffs are increased on both Chinese and Mexican exports, the United States substitutes toward exports from other sources. The shift is particularly damaging to the Chinese and Mexican manufactured goods sectors — the main sources of their exports to the United States.

In the United States, GDP declines further (figure 6) as imports from two key trading partners are replaced by domestic production and imports from other (higher price) exporters (figure 7).

Figure 6 **Changes in real GDP, GNP and GNA — CHN45, MEX35 and CHNMEX**

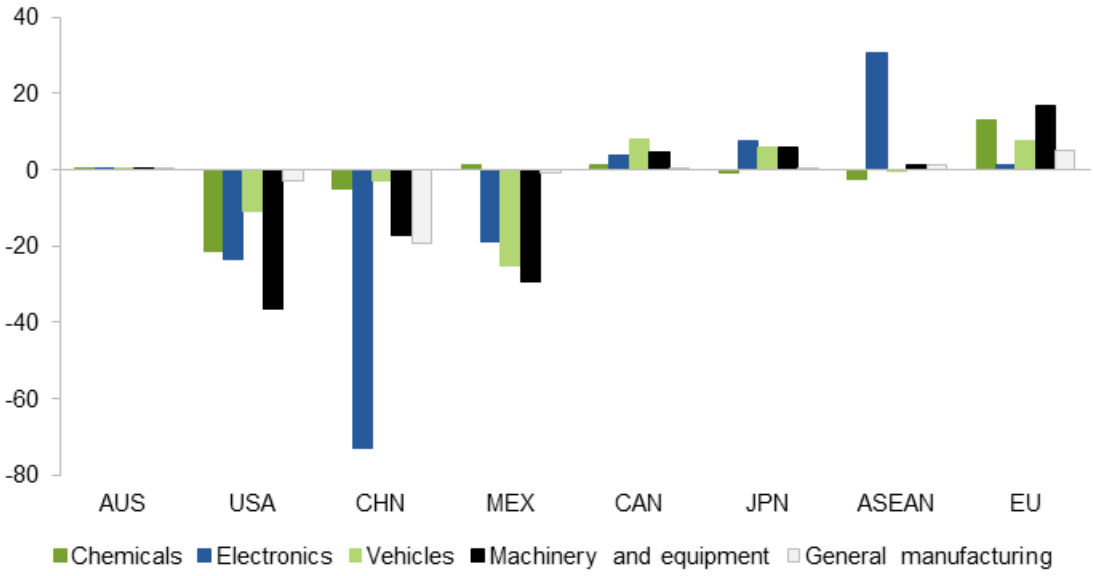
Percentage change



Data source: Commission estimates generated using the PC Global model.

Figure 7 **Changes in key exports — CHNMEX**

US$ billion change in export volumes, by sector and exporting nation



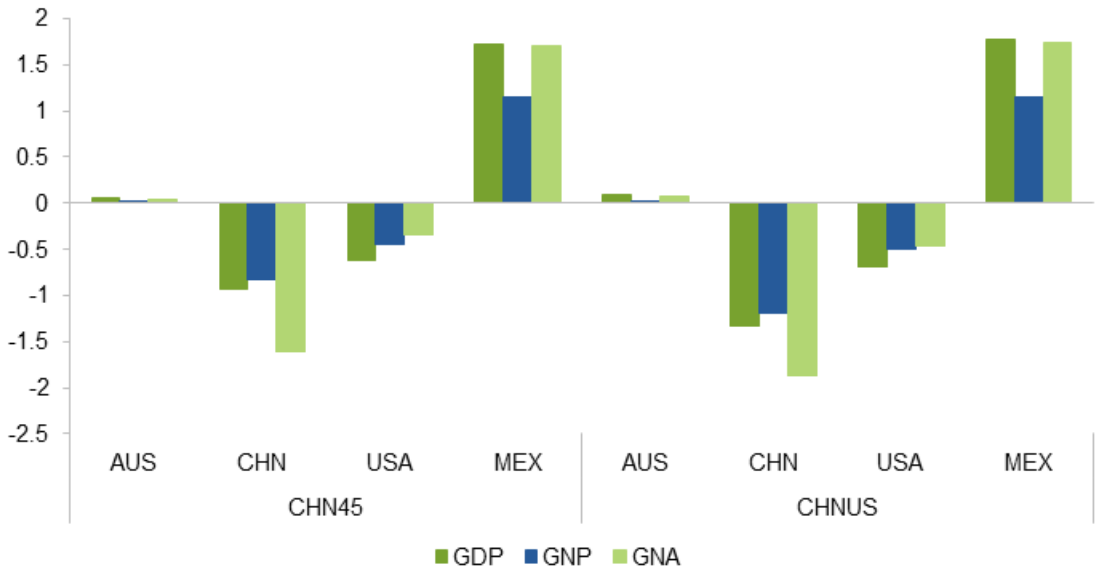
Data source: Commission estimates generated using the PC Global model.

Reciprocal tariff increases by China and Mexico

When the United States increases tariffs on imports from China or Mexico, those countries experience substantial decreases in their terms of trade as they reduce export prices to divert their exports to other markets. The following two simulations illustrate what occurs when either country is assumed to retaliate with an increase in tariffs on US exports.

In 2015, China imported US$151b worth of goods from the United States (9 per cent of its imports) whereas the United States imported US$504b from China (21 per cent of its imports) (UN 2017). Due to this imbalance between China and the United States, a retaliatory 45 per cent Chinese tariff on imports from the United States does not have the same effect as the increase in US tariffs on Chinese imports. China bears greater proportional losses from retaliation, with larger declines in GDP and real income than in the unilateral increase in US tariffs (figure 8).

Figure 8 **Changes in real GDP, GNP and GNA — CHN45 and CHNUS**
Percentage change

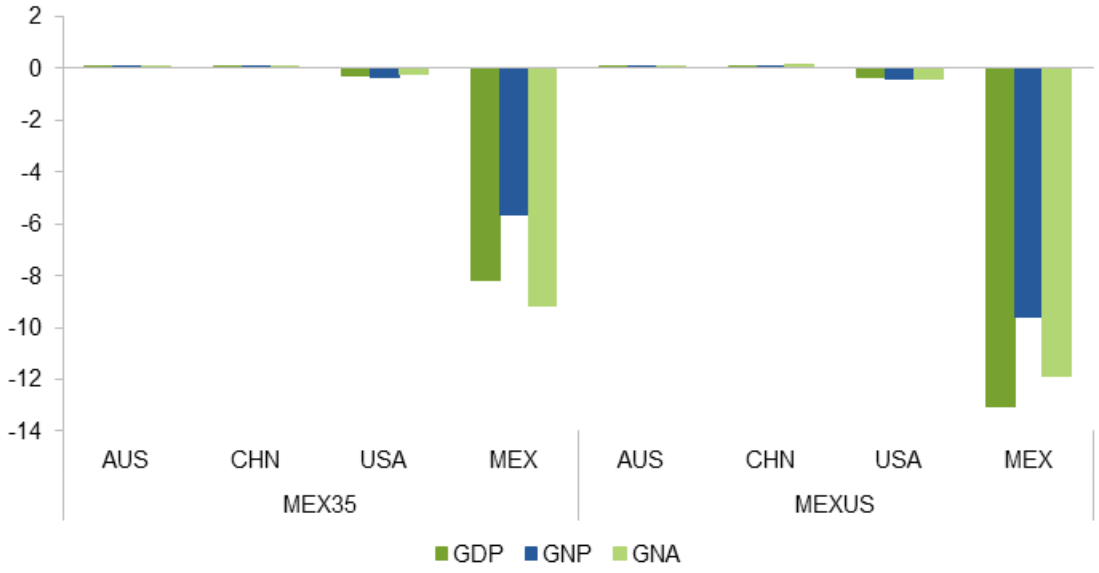


Data source: Commission estimates generated using the PC Global model.

In 2016, Mexico exported US$303b worth of goods to the United States (81 per cent of Mexican exports) while the United States exported US$231b (16 per cent of US exports) to Mexico (UN 2017).The imbalance in Mexican–US trade implies that increasing Mexican tariffs on imports from the US has a large effect on Mexico and smaller effects on the US (figure 9).

Figure 9 **Changes in real GDP, GNP and GNA — MEX35 and MEXUS**

Percentage change

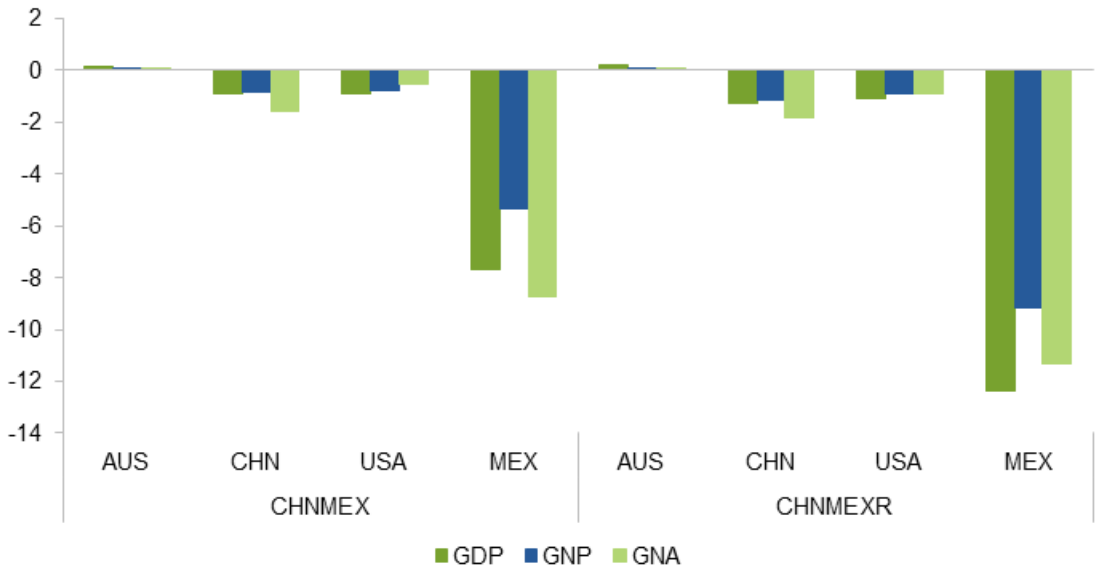


Data source: Commission estimates generated using the PC Global model.

Chinese and Mexican retaliation would cause greater harm to China and Mexico than to the United States. However, the losses to Chinese and Mexican production and income are smaller than those that would occur if either county was targeted separately and retaliated. The smaller losses occur because Mexico and China are substitutes in terms of supplying exports to the United States. In the simulations in which each is targeted separately, China and Mexico can substitute for each other. When tariffs are imposed on exports from both countries simultaneously, this substitution does not occur and US firms source imports from other countries. Figure 10 shows the additional effects of retaliation.

Figure 10 **Changes in real GDP, GNP and GNA — CHNMEX and CHNMEXR**

Percentage change



Data source: Commission estimates generated using the PC Global model.

Border adjustments

Border adjustments (BAs) are part of a destination-based cash flow tax proposed in the United States as an alternative to the current origin-based corporate income tax. In contrast to the way in which taxable income is calculated currently, BAs define the corporate income tax base to exclude revenues from exports and include imports. Chapter 3 of the research report includes a detailed discussion of the proposed policy and of the arguments about whether it is likely to be trade neutral.

In this report, border adjustments are modelled as a 20 per cent tax on the CIF value of all imports and a 20 per cent subsidy on the free on board (FOB) value of exports — other researchers have used similar proxies to model the BAs but different assumptions (box 8).[26] This simulation only models the BA part of the proposed destination-based cash flow tax system. It does not model:

- the proposed reduction in income tax rate from 35 per cent to 20 per cent nor
- the cash flow component, which would allow firms to expense capital expenditure and would not consider interest costs as a deductible expense.

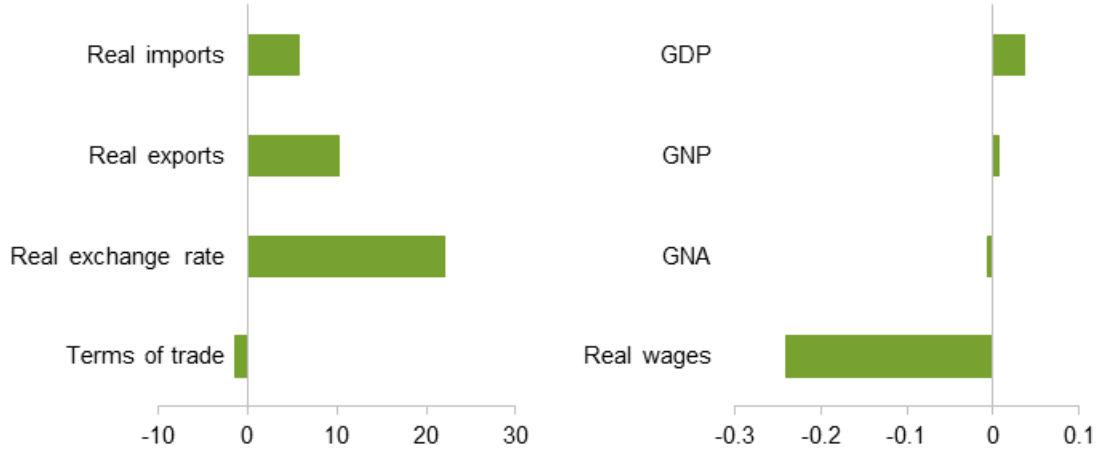
[26] Both import and export shocks exempt financial services, consistent with proposed plans to exempt financial services from border adjustments.

The BA2020 scenario shows that a border adjustment is not trade neutral. While Auerbach and Holtz-Eakin (2016) argue that equal import and export adjustments can be expected to have a compensating effect on US nominal exchange rates or on the US price level relative to that of the rest of the world (the real exchange rate), the United States' economic scale influences world prices. With a large tax on imports, US firms face higher import prices, so decrease their demand for imports, which decreases world prices accordingly. At the same time, an export subsidy makes US exports cheaper abroad, also decreasing world prices. The net effect of the two mechanisms is an approximate 3.3 per cent decline in world prices (box 9).

The reduction in world prices means that import prices for US purchasers increase by less than the 20 per cent tax on imports. Coupled with a 20 per cent subsidy on exports, this results in a net subsidy for US exporters, which stimulates US exports. There is also some increase in imports associated with increased production. The disproportionate increase in US exports appreciates the US real exchange rate beyond the 20 per cent required to achieve trade neutrality (figure 11).

Figure 11 **Changes in US trade, prices, real GDP, GNP and GNA — BA2020[a]**

Percentage change



[a] The real exchange rate is defined as the ratio of a country's prices relative to prices in the rest of the world. The terms of trade is defined as the ratio of a country's export prices to its import prices.

Data source: Commission estimates generated using the PC Global model.

The net export subsidy promotes growth in the domestic industry and US GDP. Although there is an increase in production, the global price decline has a negative impact on the US terms of trade, because the price of US exports falls more than the price of US imports. This accounts for the small decrease in real GNA as shown in the right panel of figure 11.

US prices rise relative to those of the rest of the world, which accounts for the reported rise in the real exchange rate.[27]

Partners in the North American Free Trade Agreement (the United States, Canada and Mexico) experience real gains in this simulation. Mexico increases exports to the United States, and Canada redirects existing export flows to the United States to help fuel the expansion that occurs there. At the same time, both Mexico and Canada increase imports as world prices decline. The effects are larger for Mexico than they are for Canada because of Mexico's export focus on manufactures and inputs to US production, which the United States requires to increase production (figure 12).

As the real exchange rate appreciates in the United States, it declines for the rest of the world. Many other countries incur mixed effects from the border adjustment including:

- cheaper exports from the United States taking market share from other exporters as cheaper US exports lower import costs across the world
- increased US demand for imports, related to increased US activity.

The lack of trade neutrality of the BAs raises the question: 'is there a combination of tax on imports and subsidy on exports that is trade neutral?' This is explored in box 9.

Effects on Australia

For many countries such as Australia, the net effect of these countervailing forces is only minor changes in aggregate trade, production and income. That said, there are some structural changes. Australian exports shift away from the sectors that are most affected by the net export subsidy in the United States, as US producers crowd out other producers, of vehicles or electronics for example.

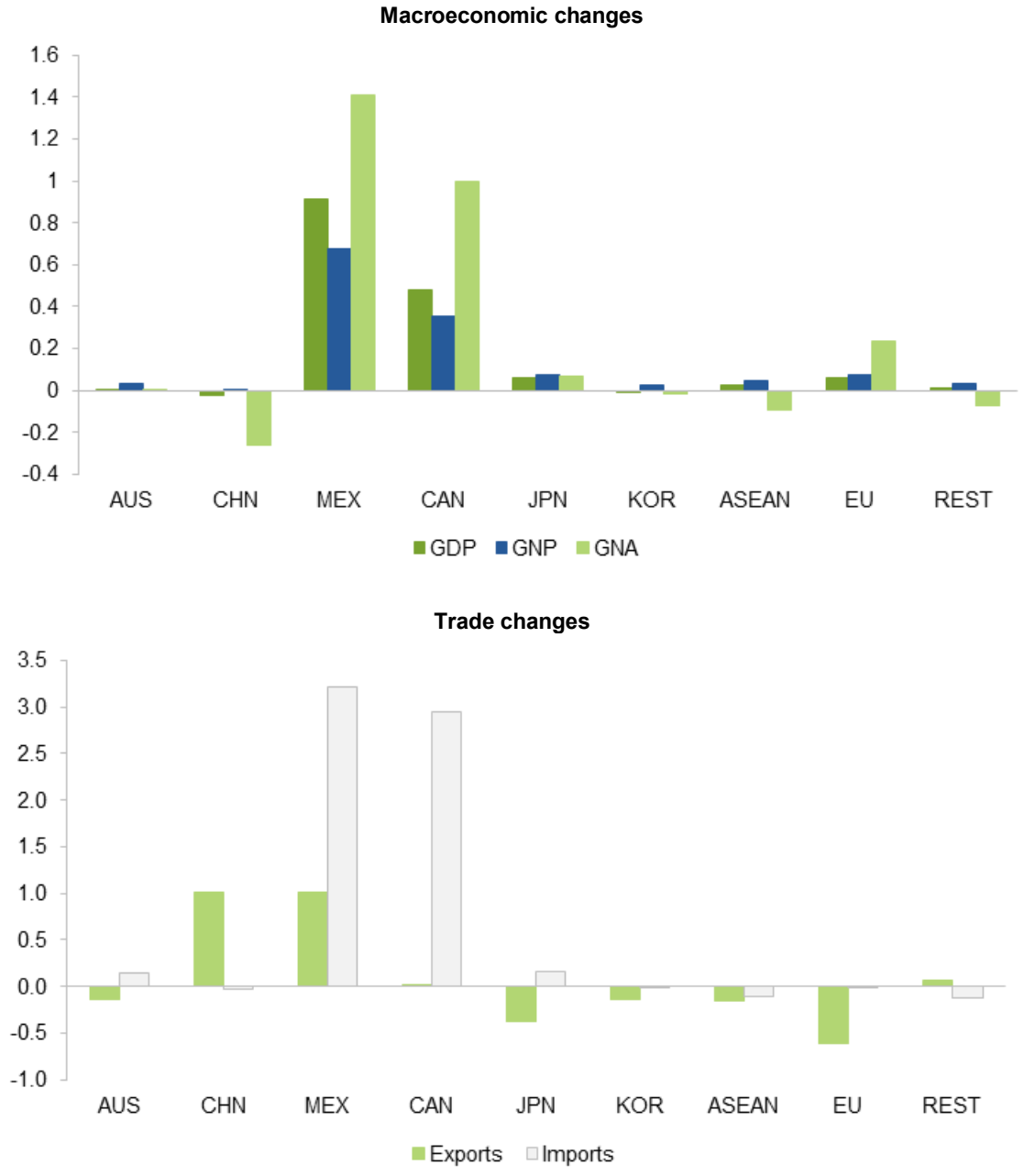
As world prices decline as a result of the US export subsidy, imports become cheaper and Australia benefits from this part of the change in its terms of trade. This contributes to an increase in Australia's real GDP and GNA.

Consistent with the proposed tax reforms, BAs are assumed not to apply to financial sectors. Therefore, the net export subsidy that reduces the export prices of other US industries does not reduce the price of US financial exports and results in a contraction of US financial services globally, leaving room for others, such as Australia, to increase their production and exports of financial services.

[27] If the 20 per cent import tax was exactly offset by the export subsidy, the US real exchange rate would rise exactly by 20 per cent. But the export subsidy more than offsets the effect of the import tax, decreasing the price of US exports (-4.9 per cent), which in turn reduces world prices (-3.7 per cent) and US import prices (-3.5 per cent) — and the US terms of trade fall (-1.4 per cent). The US real exchange rate increases (22 per cent), because of the import tax (20 per cent) and prices fall in the rest of the world (-2 per cent). US nominal wages increase (17.99 per cent) but the GDP deflator declines (-18.23 per cent) with lower returns to capital, leaving a small net decline in real wages (-0.2 per cent).

Figure 12 **Changes in real GDP, GNP, GNA and trade — BA2020**

Percentage change



Data source: Commission estimates generated using the PC Global model.

Box 8 A different way of modelling border adjustments — Ciuriak and Xiao (2017)

The BA2020 simulation models border adjustments as a tax on imports and a subsidy on exports at the proposed corporate income tax rate of 20 per cent. This combination of a tax on the value of imports and a subsidy based on the value of exports is designed to emulate the effect of the BAs relative to the effects of current deductions that are used to determine taxable corporate income.

Ciuriak and Xiao (2017) model the BAs as:

- a 20 per cent tax on imported inputs as defined by the table of inter-industry use
- a subsidy on exports calculated as 20 per cent of the share of profits attributable to exports.

This combination of shocks is significantly different from the combination used in this report. The changes in export prices are likely to be a fraction of that required for a trade neutral outcome. In addition, only applying the tax on imports to intermediates means that a significant amount of imports are excluded from the BAs. Therefore, this combination of shocks is unlikely to be trade neutral in that US exports and imports are likely to decrease and the trade deficit likely to increase in this scenario.

As observed in the BA2020 simulation and in chapter 3 of the research report, BAs are unlikely to be trade neutral. That said, the BA2016 experiment shows that adjusting the export subsidy to match changes in the CIF prices of US imports produces a trade neutral outcome (box 9).

The differences in modelling approaches produce substantial differences in results. Applying the tax on all imports and the subsidy on the full value of exports results in a net subsidy on exports as might be expected, whereas limiting the shocks to imported intermediates and export profits produces a large net tax.

The Ciuriak and Xiao method produces large distortions in US trade[a]

Changes in:	*BA2020*[b]	*Ciuriak and Xiao*[c]
Import tax rate	20% on all imports	20% on intermediates
Export subsidy rate	20% on all exports	20% on export profits
Real GDP (%)	0.04	-1.28
Exports (US$b)	81.40	-366.27
Imports (US$b)	55.59	-406.82
Balance of trade (US$b)	25.81	40.55

[a] All changes for the US. [b] Dollar values for BA2020 are in 2016 US$m. [c] The authors do not specify the reference year. Dollar values in this column are assumed to be in 2011 US$m.

Sources: Ciuriak and Xiao (2017); Productivity Commission estimates generated using the PC Global model.

Box 9 Another aspect of trade distortions created by border adjustments

As shown in the BA2020 simulation, border adjustments produce substantial trade distortions. The economic scale of the United States and the consequent effect on world prices create a net subsidy for US exports. As a result, both exports and imports increase substantially (see left panel of the figure below).

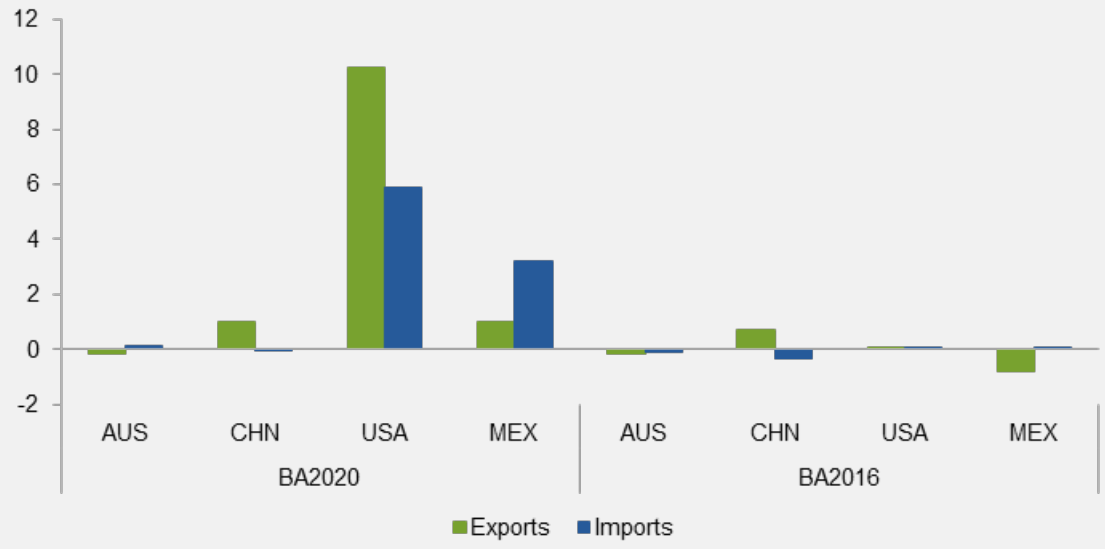
A simulation (BA2016) is used as an experiment to illustrate how the export subsidy used in the BA2020 simulation must be adjusted to compensate for the import tax.[a]

In the BA2020 simulation, the CIF prices of US imports decline by about 3.3 per cent. This means that the border adjusted (tax inclusive) price of imports under the BA is 16.7 per cent higher than it is without the BA. Domestic prices increase by the same amount. Reducing the export subsidy to 16.7 per cent eliminates the net subsidy on exports and the trade distortion that is observed in the BA2020 simulation.

The experiment demonstrates that in addition to the other arguments brought to bear on the trade neutrality of border adjustments (see chapter 3 in the research report), the border adjustments create changes in world prices that result in a net subsidy for exports.

Changes in trade flows — BA2020 and BA2016

Percentage change



Data source: Commission estimates generated using the PC Global model.

[a] This simulation is not a representation of a border adjustment, which implies that imports and exports attract the same rates of tax and subsidy relative to the current treatment. The experiment uses the instruments from the BA2020 simulation to find the circumstances that are required for trade neutrality.

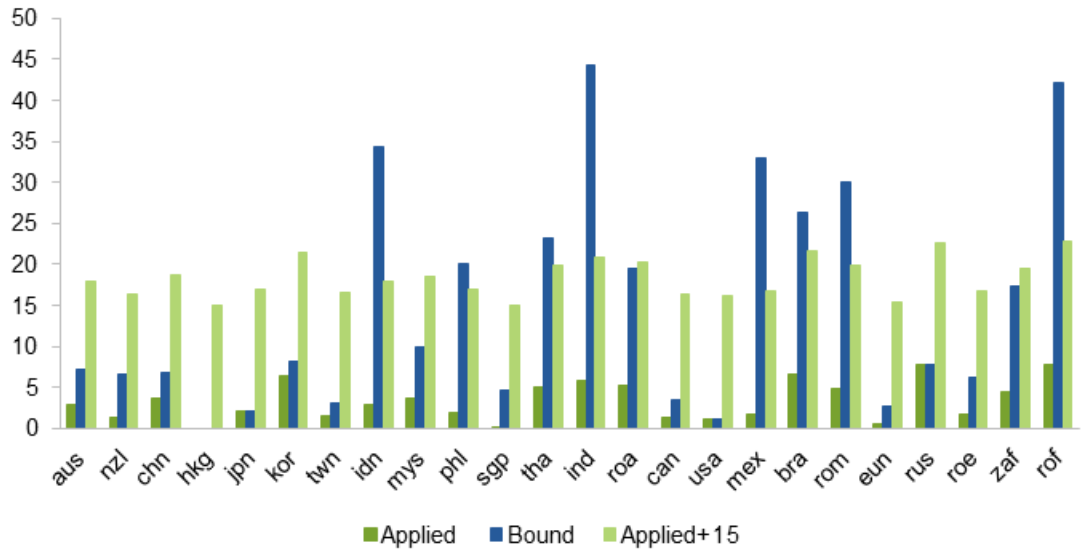
Global tariff increase

This simulation is designed to illustrate the effects of a global contagion scenario (simulation G1). In many developed economies, applied tariffs are close to their bound rates (figure 13).[28] Since increasing tariffs to bound rates produces small tariff increases in some cases, the simulation was developed as a 15 percentage point increase in applied tariffs across the board. This results in uneven tariff *levels* across countries, which plays a large part in explaining allocation results.

The generalised increase in tariffs results in a large decrease in global trade (22 per cent) and the consequent declines in allocative efficiency add up to a 2.9 per cent decrease in global GDP. The global demand for capital falls, and assuming an adjustment in target rates of return of about 5 per cent, the equilibrium global capital stock declines about 5 per cent. These results are consistent with other modelling of global contagion scenarios (box 10).

Figure 13 **Average applied and bound tariffs[a,b,c]**

Per cent



[a] aus — Australia; nzl — New Zealand; chn — China; hkg — Hong Kong; jpn — Japan; twn — Taiwan; idn — Indonesia; mys — Malaysia; phl — Philippines; sgp — Singapore; tha — Thailand; ind — India; roa — rest of Asia; can — Canada; usa — USA; mex — Mexico; bra — Brazil; rom — rest of Americas; eun — European Union nations; rus — Russia; roe — rest of Europe; zaf — South Africa; rof — rest of Africa. [b] Trade weighted. [c] Averages obscure zero and very low tariffs. Tariffs on a significant share of Mexico's trade are well above the averages reported here, due to its membership of the North American Free Trade Agreement.

Data sources: GTAP database (Aguiar, Narayanan and McDougall 2016), Comtrade (UN 2017), TAO database (WTO 2017).

28 Bound rates are rates that governments have agreed not to exceed in the context of WTO agreements.

Box 10 Other modelling of global contagion

McKibbin and Stoekel (2009) and Dixon (2017) report results for global contagion scenarios. Although there are many differences between the models and assumptions used, the main results from those studies are consistent with those found in this report: a global rise in protectionism results in large declines in global trade, output and incomes.

Dixon (2017, p. 8) models the largest shocks and obtains the largest results, reporting that if 'this was to occur, the volume of world trade would fall by more than one third, and there would be large declines in GDP in all regions akin to a major recession'.

McKibbin and Stoekel (2009) model smaller tariff increases than in this report. They report decreases in global trade in the order of 17 per cent, but larger GDP declines, which are due to the endogenous capital accumulation mechanisms that are included in the model used.

By comparison, simulation G1 produces a 22 per cent decrease in global trade and nearly 3 per cent decline in global GDP and income.

The main characteristics of the different simulations and selected results are compared to the extent possible with simulation G1 in the table below.

Changes in real GDP

Global contagion, percentage change

	Simulation	*US*	*China*	*Australia*
Dixon (2017)[a]	US and China increase tariffs to 45 % rest of the world increase to 20%	-3.0	-7.0	-4.0
McKibbin and Stoekel (2009)	Global increase by 10 ppts	-1.3	-4.3	-1.4
PC Global	Global increase by 15 ppts	-0.6	-2.5	-1.1

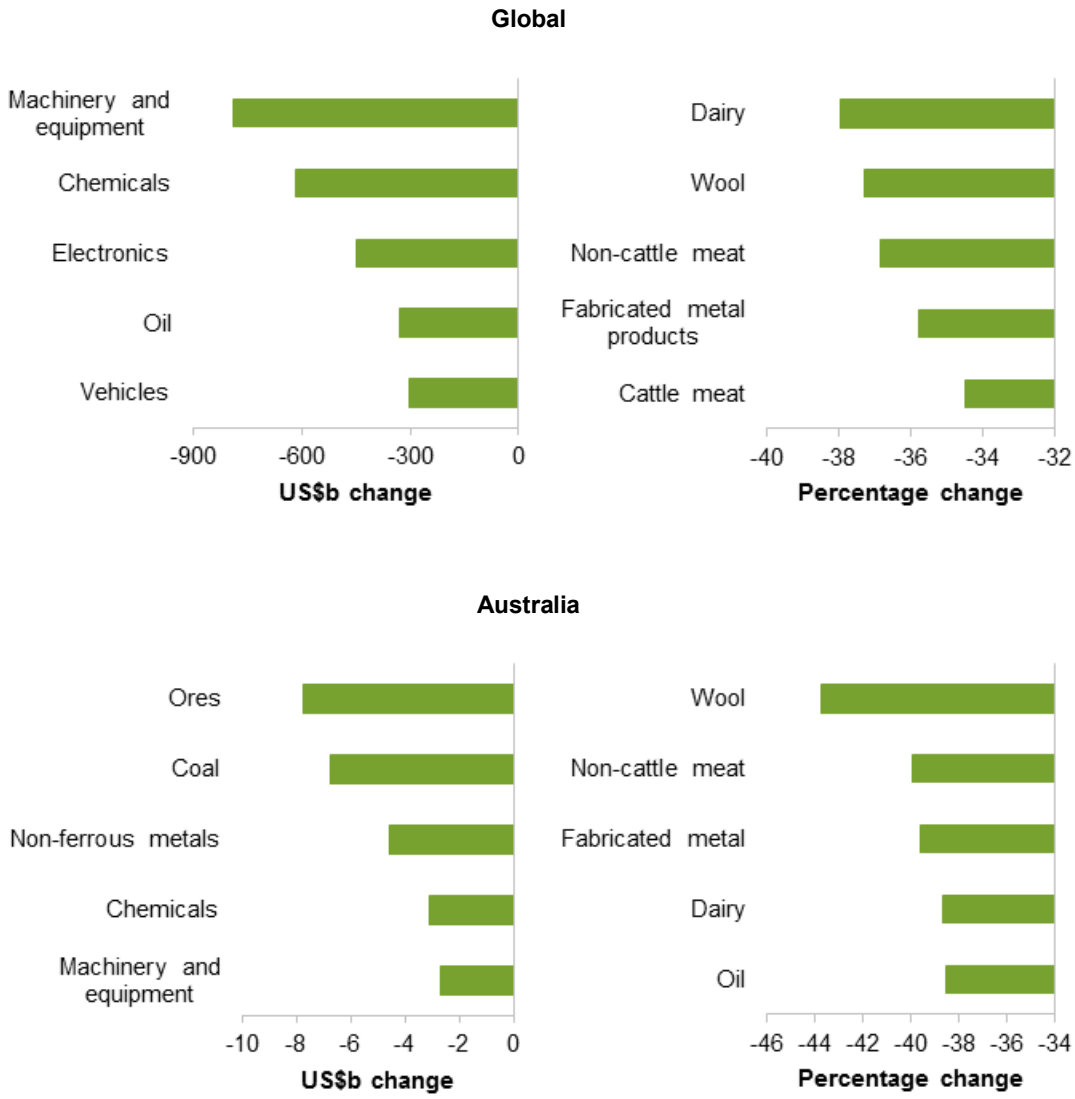
[a] Results estimated from figure 8 in Dixon (2017).

Sources: McKibbin and Stoekel (2009), Dixon (2017) and Commission estimates generated using the PC Global model.

The decrease in global trade varies across sectors depending on sectoral demands and elasticities. While dairy, meat and wool experience the greatest relative declines (global exports decline up to 39 per cent), manufactured goods lead global losses in absolute terms (figure 14).

Figure 14 **Largest changes in exports — simulation G1**

2016 US$ billion and percentage change, by sector



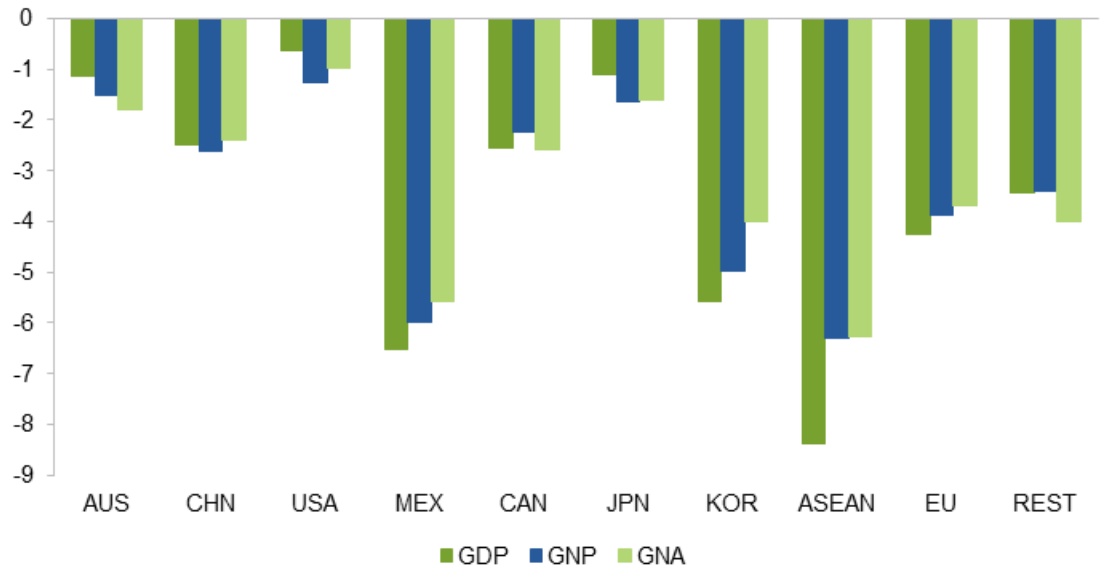
Data source: Commission estimates generated using the PC Global model.

Increasing tariffs globally results in a large misallocation of resources across all economies, and therefore large efficiency losses from this misallocation toward import-competing industries. Since the efficiency losses are a quadratic function of the level of the tariffs, countries with the highest tariffs experience the largest losses (figure 15). For example:

- efficiency losses in the Association of South East Asian Nations and Korea are larger because initial tariffs are relatively high in these countries
- conversely, efficiency losses for Australia, the United States and Japan are relatively small because the initial tariffs are relatively small in these countries.

This translates into declines in economic activity across the world (figure 15). The declines are smaller in low tariff economies as is the case for Australia. These relatively small decreases in GDP mean that although the global capital stock has declined, capital is reallocated toward Australia and away from economies with larger tariffs. The decline in Australian real GNP is smaller because Australian investors own less capital abroad and foreign investors own more capital in Australia — as a result, Australia receives less returns from the capital it owns abroad and pays more returns to foreigners who own capital in Australia.

Figure 15 **Changes in real GDP, GNP, GNA — simulation G1**
Percentage change



Data source: Commission estimates generated using the PC Global model.

One way in which the effects of tariff increases can be presented is in terms of a 'multiplier' that links decreases in output or income to increases in tariff revenues. This is illustrated for effects on output in box 11.

Distributional impacts in Australia

The distributional impacts on household income of a global increase in protection are complex and depend to a large extent on the original composition of households' incomes, which are sourced from labour, capital and government benefits; the composition of households' consumption; and the modelled effects on income sources and the cost of the consumption bundles.

Box 11 The GDP costs of increasing tariffs

The OECD (2010) presents the GDP costs of a tariff in terms of a 'multiplier' expressed as:

$$\frac{\Delta GDP}{\Delta Tariff\ revenue}$$

In the context of a global contagion scenario, the OECD (2010, p7) reported that: 'simulations suggest a USD 1 increase in tariff revenues results in […] a USD 0.73 drop in world income'. The change in tariff revenues is mainly determined by the change in the tariff rate, whereas the GDP costs reflects the global misallocation of resources toward import-competing industries. These losses occur at the global level and at the individual economy level.

In PC Global, the tariff increase has negative effects on each economy's GDP in terms of:

- costs due to a misallocation of resources
- costs due to the loss of capital to other economies due to a reduction in returns to capital in the economy imposing the tariff.

In simulation G1, a US$1 increase in tariff revenues decreases real global GDP by US$1.18. The larger impact is attributable to a larger assumed increase in protection in terms of rate and regional coverage in simulation G1 than are assumed in OECD (2010). There are also differences in closure; the authors of OECD (2010) assume that:

- capital used in each region is fixed, which reduces effects on GDP relative to simulation G1
- wages in each region are fixed, which reduces employment and increases effects on GDP.

The multiplier is smaller for economies with relatively low initial tariffs, such as Australia and the United States, and higher for economies with relatively high initial tariffs, such as Mexico.

Changes in tariff revenues and in real GDP

Simulation G1, US$ 2016 billion

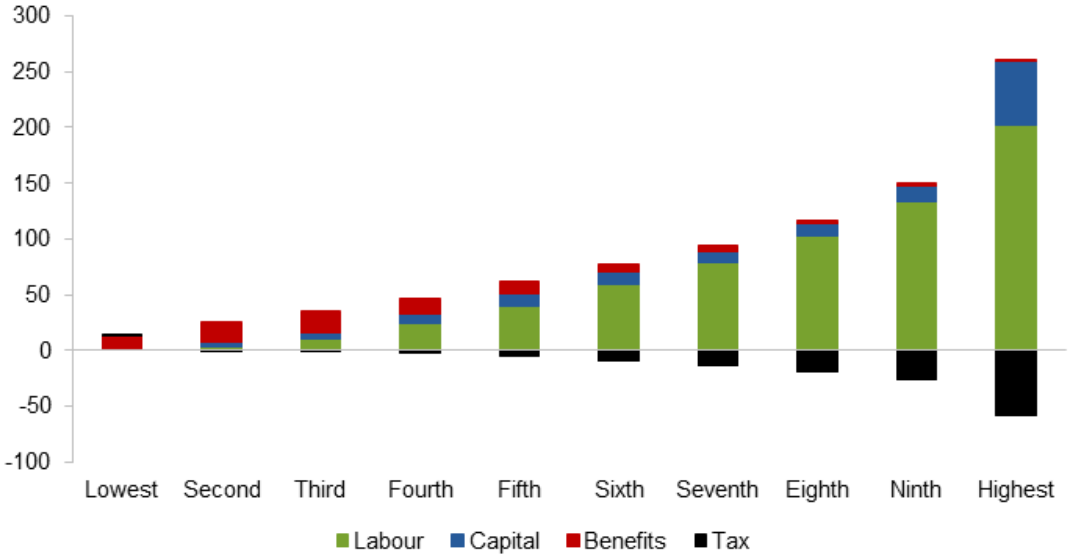
	Revenues	*GDP*	*Multiplier*
Australia	24 452	-15 711	-0.64
USA	246 329	-96 631	-0.39
Mexico	32 770	-75 531	-2.31
World	1 737 328	-2 043 133	-1.18

Source: Commission estimates generated using the PC Global model.

Source: OECD (2010).

The *Household Expenditure Survey and Survey of Income and Housing* (ABS 2012) reports relatively small contributions of income from capital across deciles and relatively large contributions from wages (figure 16). For this reason, changes in wages are likely to make a relatively large contribution to changes in incomes across the distribution.

Figure 16 **Sources of income by decile, per household — Australia[a]**
A$'000



[a] Based on population weighted data from 2011.

Data source: *Household Expenditure Survey and Survey of Income and Housing* (ABS 2012).

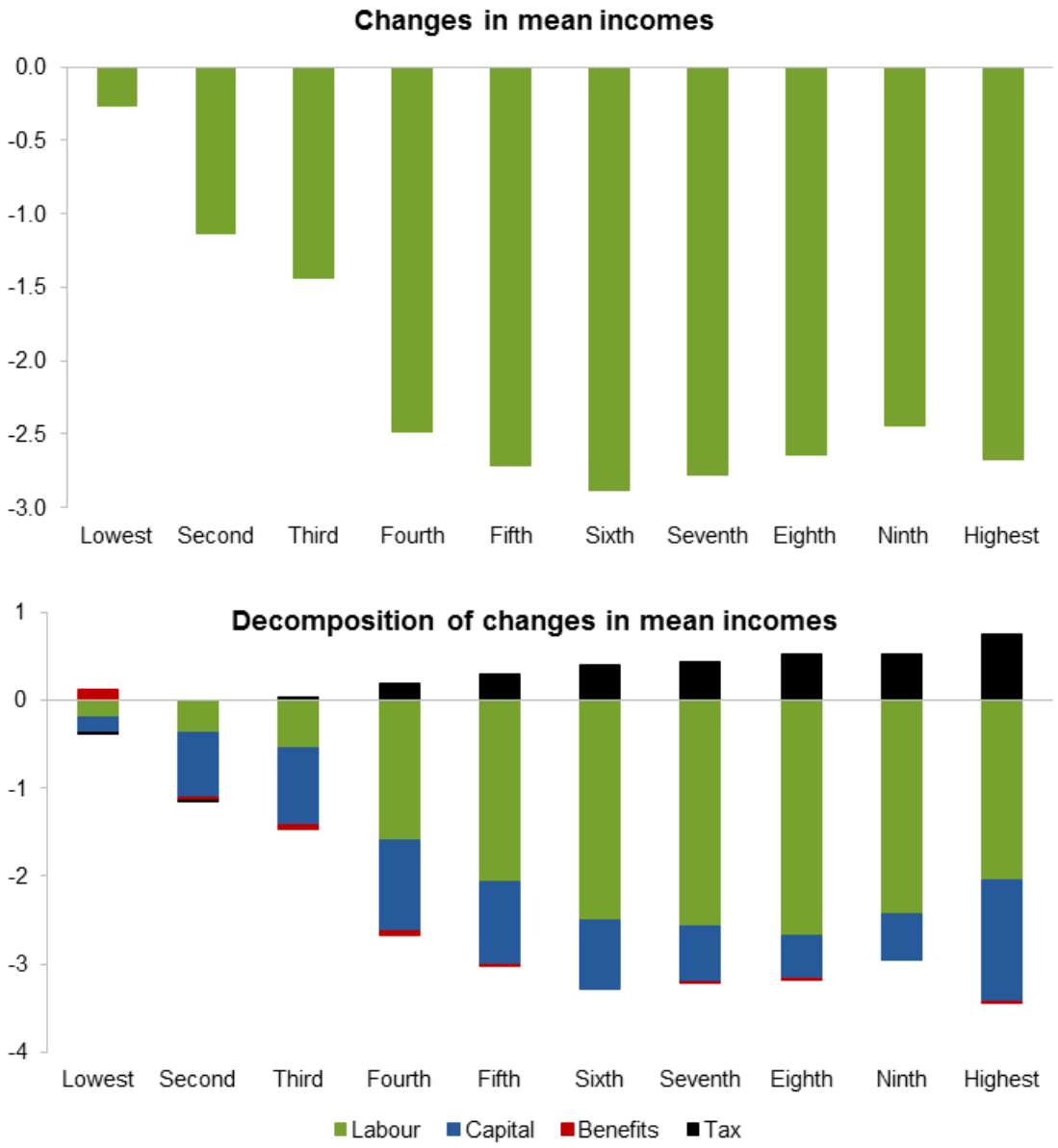
As tariffs increase, Australian households experience substantial price increases for imported products, as well as for domestic products that rely on imported inputs and products that compete with imports. Increased prices decrease the purchasing power of households' wage and capital incomes and of benefits.[29] For households that rely on benefits that are indexed to the consumer price index (CPI) for a substantial part of their incomes, the potential decrease in purchasing power due to increased tariffs is compensated by the indexation of these benefits to the CPI. To the extent that the composition of their consumption differs from the basket of goods used to calculate the CPI, these households could experience greater or smaller changes in real incomes than others. In particular, households that consume mainly goods that do not fit in the categories directly affected by tariffs are likely to maintain or increase their purchasing power.

Real incomes decline for all deciles as a result of increases in consumer prices and declines in wages and income from capital (figure 17).[30,31] The declines are relatively small at lower incomes and range between 2 and 3 per cent from the fourth decile upward.

[29] Some benefits are indexed to wages (average weekly ordinary time earnings), others to the consumer price index. This is modelled by indexing the relevant benefits to changes in wages or to the consumer price index.

[30] Real incomes decline for each decile as a group. Similarly, real income declines for the average member of the group.

Figure 17 **Changes in real incomes by decile — Australia[a]**
Percentage change



[a] Changes in incomes and in income components are deflated by household-specific price indexes.

Data source: Commission estimates generated using the PC Global and PC National models.

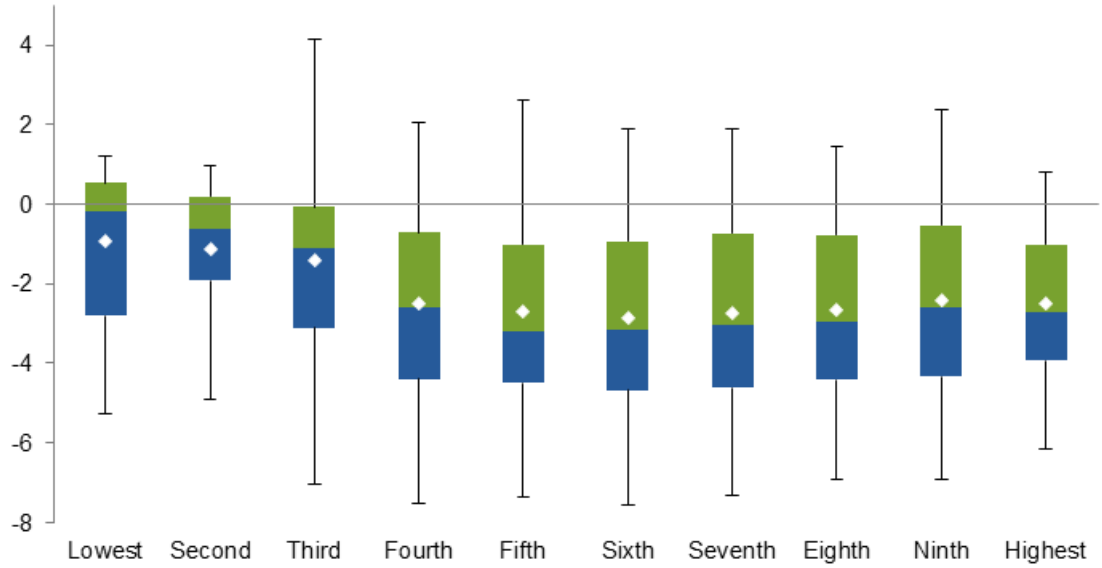
31 Income from capital declines for two reasons: a decline in returns to capital (the rental price of capital) and a decline in capital holdings. See the discussion on model closures above.

Given the importance of labour income, it is the main contributor to these declines in average incomes (figure 17, bottom panel).[32]

Households with real income gains

Although incomes in each decile decline on average, there is a distribution of outcomes within each decile (figure 18).

Figure 18 **Variation in changes in real incomes within deciles[a,b]**
Percentage change



a For each decile, the diamond represents the average change in income. The end of the bottom whisker reports the income change for households at the bottom 5th percentile of the distribution of income changes; the top of the upper whisker reports changes for the 95th percentile of the distribution. The bottom of the blue box represents changes for households at the 25th percentile of the distribution of income changes, the top of the blue box reports changes for the median household (50th percentile) and the top of the green box reports the change in income households at the 75th percentile of the distribution. **b** Average changes in income within a decile is different from the change in mean income reported in other figures. The former are weighted using population weights, while the latter use income weights.

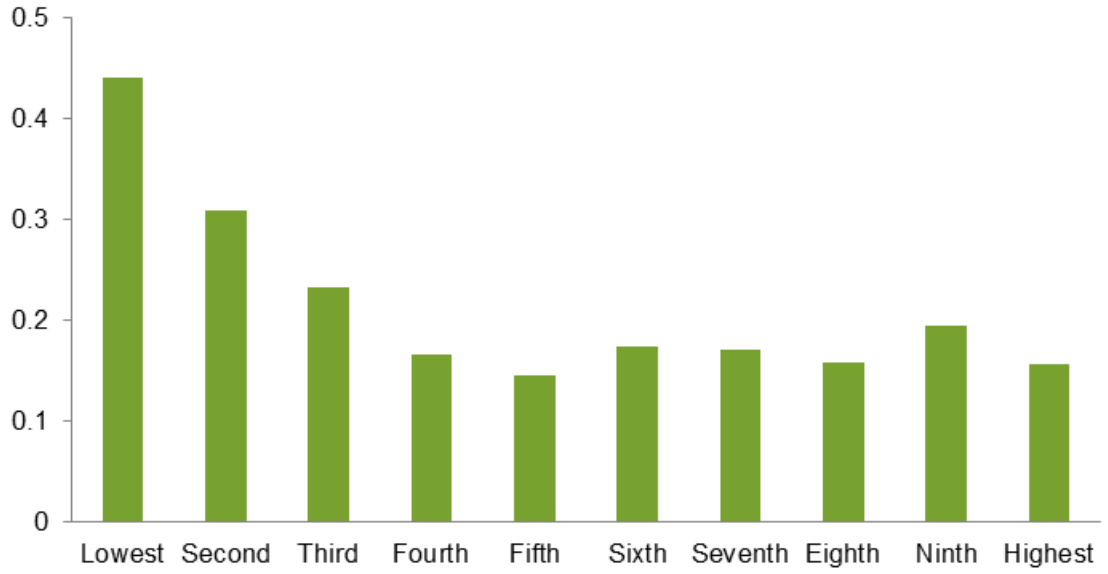
Data source: Commission estimates generated using the PC Global and PC National models.

Some households (about 21 per cent) experience an increase in real income. They are relatively concentrated at the lower end of the income distribution and account for about 44

[32] The *Survey of Income and Housing* provides information on the amount of income tax paid. This information is used to calculate the average rate of income tax, which is used to calculate the changes in income tax reported. As average incomes fall, so do the amounts of income tax owed.

per cent of households in the lowest decile, about 30 per cent in the second decile, and between 15 and 25 per cent in the other deciles (figure 19).

Figure 19 **Share of households with increased real income, by decile**



Data source: Commission estimates generated using the PC Global and PC National models.

In the first (lowest) decile, households rely mostly on income from benefits (figure 20) and spend a large part of their incomes on domestically produced goods and services that do not face strong competition from imports (for example, food and housing services). The prices of these domestic goods decrease relative to those of goods that are more affected by the price of imports. Households that rely on benefits that are indexed to the CPI and on goods whose prices decline more than the CPI see their purchasing power increase.

In other deciles, similar mechanisms are at work. The main characteristics of the households whose real incomes increase are that:

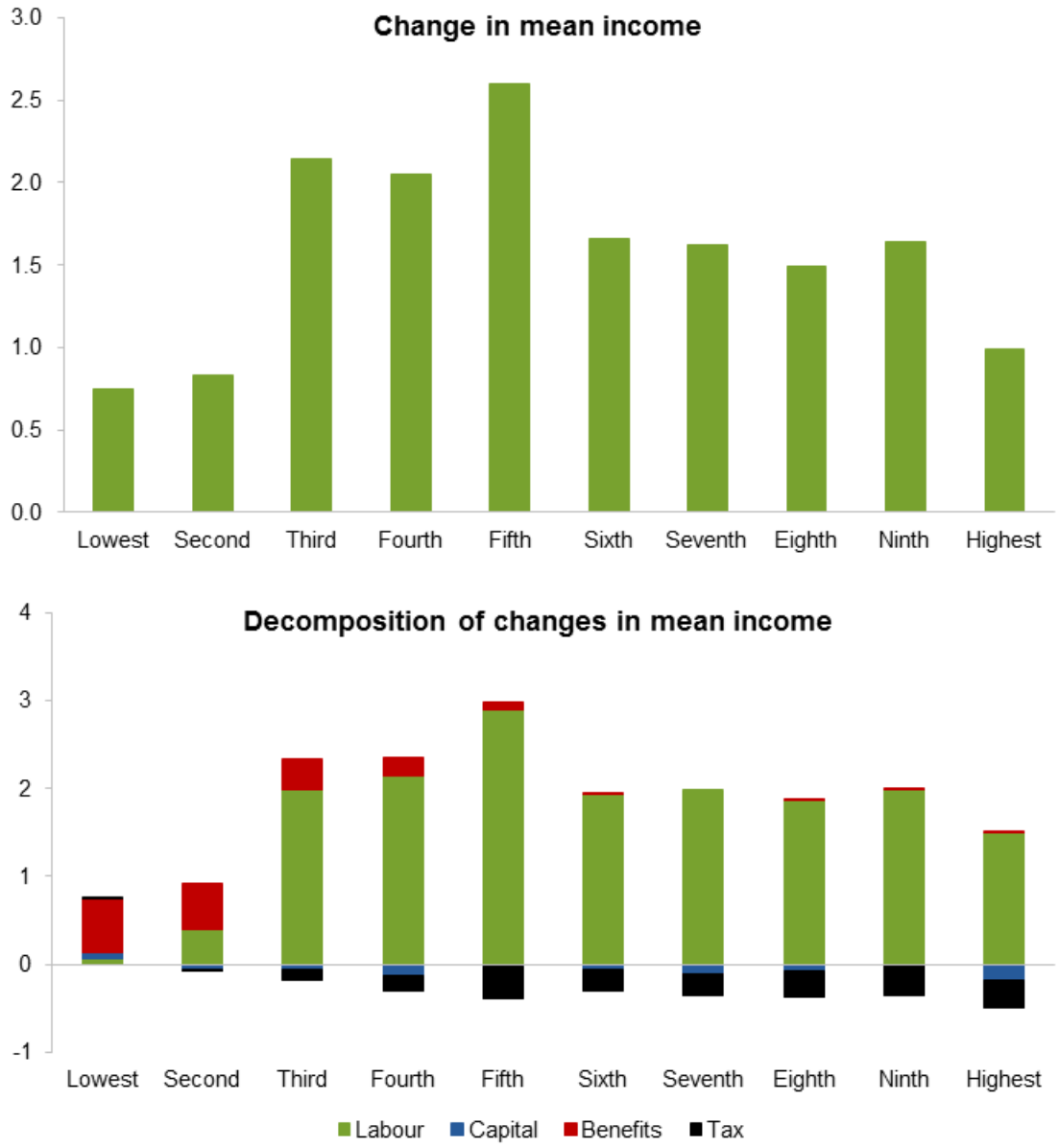
- they do not rely on capital income for a large proportion of their incomes
- benefits account for some proportion of their incomes
- the costs of their consumption bundles fall relative to the costs of the consumption bundles of other households.
- some members of the household are employed as community services workers (for example, in the health, education and government sectors) and to a lesser extent as professionals, who benefit from an increase in their wages as demand for these occupations increases, relative to the demand for other workers. This occurs because

the demand for services increases as their relative prices decline, and these services make a relatively intensive use of these occupations.[33]

[33] PC National recognises eight types of labour. The supply of each type is assumed to be fixed. Within each economy, wages for each type adjust as the relative demands for each type adjusts to the imposed shocks. Adding a labour supply module would mitigate such changes as increased demand in one type of labour would lead some workers to switch from their current occupation to the one in higher demand, thus increasing the supply of that occupation (and decreasing its wage) and decreasing the supply of others (and increasing those wages). Such a labour supply module was not developed for the purpose of this project for two reasons. First, it would add complexity to both the PC Global and the PC National models. Second, the distributional module means that an algorithm would have to be developed to determine which observations switch occupations, which again would add complexity.

Figure 20 **Changes in real income by decile for households with increased real incomes**

Percentage change



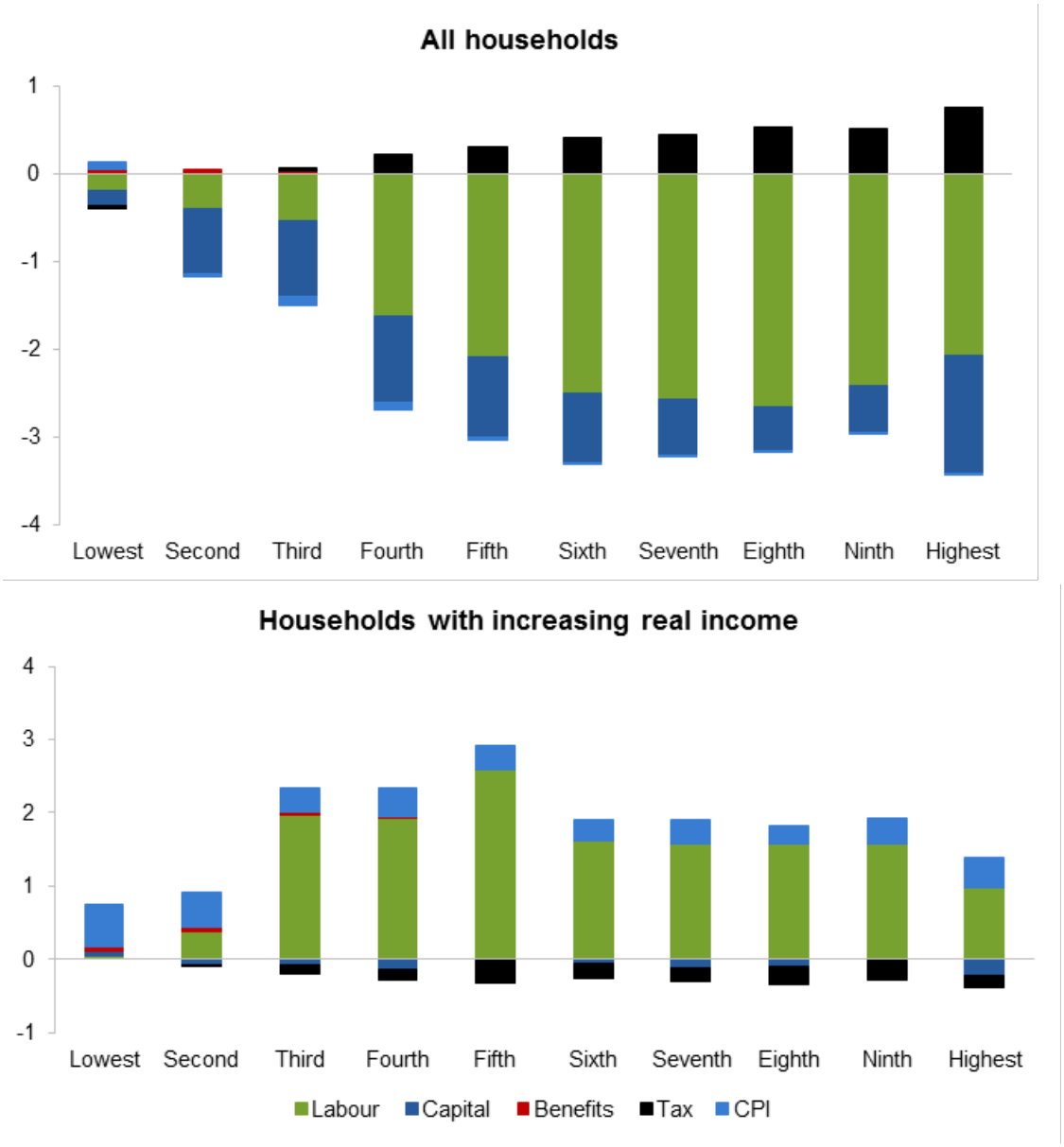
Data source: Commission estimates generated using the PC Global and PC National models.

Role of consumption bundles and prices

The effects of the composition of consumption bundles is illustrated in figure 21. This composition and how the cost of each item changes contributes to the change in real incomes as follows. Tariff increases do not apply to services, so their prices decline

relative to those of goods that are subject to tariffs. So do food prices, because they are largely produced locally and many do not compete with imports.

Figure 21 **Decomposition of changes in mean income[a,b]**



[a] Average effects for each decile. [b] CPI: household-specific consumer price index. A decline in the household-specific price index makes a positive contribution to real income.

Data source: Commission estimates generated using the PC National model.

In the top panel, the effects on all households of the household-specific price indexes (labelled CPI) are negative (except in the first decile), and small relative to other effects. As mentioned above, declines in returns to capital and in nominal wages contribute most of the declines in incomes in each decile.

The positive impact of household-specific price indexes appears in the lower panel, in the effects for households whose real incomes increase. The improvement in real income comes through the lower cost of certain bundles. In all deciles, there are households for whom the cost of consumption declines.

The effect of the household-specific price index is especially prevalent in the two lower deciles, and is due to these households spending a majority of their incomes on goods and services whose prices decline (in particular, food and housing services) relative to those of, mainly manufactured, goods.[34] To a lesser extent, the household price index effect occurs across the deciles for the average households who experience gains in real income.

As observed above: households that benefit from increases in incomes also benefit from:

- increased labour income because they are mainly employed as community services workers, whose wages increase relative to others'
- experience only small losses in terms of capital income because capital accounts for a small proportion of their incomes as described in the *Survey of Income and Housing*.

Geographical distribution

The analysis does not show significant differences across states and territories and across capital cities and regional areas (box 12). It is worth noting that more disaggregation might identify more diversity across regions, with some experiencing more or less change in real income than can be reported here. That said, greater regional disaggregation quickly reduces the reliability of results for small regions, given the relatively small number of observations available from the survey.

Possible responses to global contagion

Chapter 5 of the research report develops a range of scenarios to gauge possible policy responses to a global tariff increase. The scenarios range from Australia:

- unilaterally holding protection at current levels (simulation G2)
- co-operating with a group of countries to maintain protection at current levels (simulation G3)
- joining with that group in reducing NTBs on goods and BTS (simulation G4)
- joining with that group in reducing NTBs on goods and BTS and in eliminating all tariffs on a MFN basis (simulation G5).

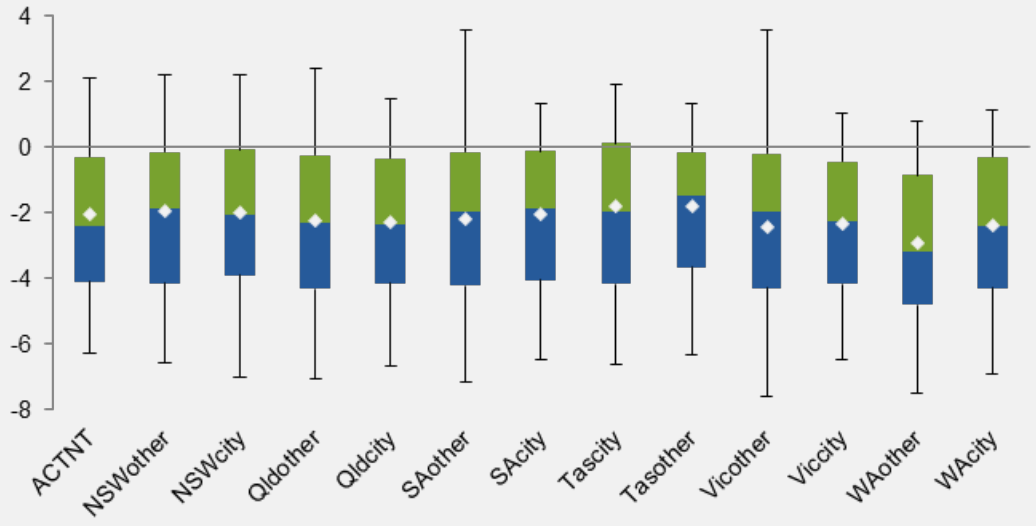
[34] The household price index effect is larger than the effect of benefit indexation. The latter is shown as the small increase in benefits labelled as 'Benefit' in figure 21.

Box 12 Spatial effects

The Commission added a spatial dimension to the analysis by adding a geographical indicator to the standard *Survey of Income and Housing*. For each state, the indicator identifies whether a household resides in the capital city or outside — the ACT and the Northern Territory are aggregated separately. Similar to figure 18, the box plot below shows a wide variation in changes in household incomes across states, capital cities and regional areas.

Variation in changes in real incomes by region[a,b]

Percentage change



[a] For each region, the diamond represents the average change in income. The end of the bottom whisker reports the income change for households at the bottom 5th percentile of the distribution of income changes; the top of the upper whisker reports changes for the 95th percentile of the distribution. The bottom of the blue box represents changes for households at the 25th percentile of the distribution of income changes, the top of the blue box reports changes for the median household (50th percentile) and the top of the green box reports the change in income households at the 75th percentile of the distribution. [b] 'city' identifies capital city; 'other' identifies outside capital city; the ACT and the Northern Territory are aggregated.

Data source: Commission estimates generated using the PC National model.

Following the discussion in chapter 5 of the research report, the simulations use the Regional Comprehensive Economic Partnership (RCEP) group to illustrate the effects of cooperative liberalisation.

Consistent across all simulations in this section are the benefits to Australia of liberalisation — when tariffs increase globally, Australia adopting a more liberal stance mitigates the negative effects of global protection, and these benefits are larger when Australia acts as part of a larger group.

Figure 22 shows the macroeconomic outcomes for Australia across each of the policy responses, along with the base global contagion simulation, labelled G1. Whereas

indicators of Australian economic activity, income and purchasing power decline in the global contagion scenario, these negative effects are mitigated and progressively improved as the scope for liberalisation increases, both in terms of sectoral and regional coverage.

Figure 22 **Changes in real GDP, GNP and GNA, Australia — global contagion and liberalisation simulations[a]**

Percentage change

[a] G1 — all countries increase tariffs by 15 percentage points; G2 — all countries excluding Australia increase tariffs; G3 — all countries excluding RCEP members increase tariffs; G4 — all countries increase tariffs except for RCEP members who holds tariffs steady and remove some non-tariff barriers as well as some barriers to services; G5 — all countries increase tariffs except for RCEP members who abolish all tariffs on a MFN basis and reduce some non-tariff barriers and barriers to services in a non-discriminatory way.

Data source: Commission estimates generated using the PC Global model.

Australia holds tariffs constant

Simulation G2 models a global contagion scenario where Australia holds tariffs at current rates. This decreases the price of imports to Australian users relative to those paid by users in the rest of the world. When Australia does not increase tariffs, it does not experience the allocative inefficiencies that the rest of the world experiences. This does not mean that there are no structural changes, as Australian producers and exporters adjust to the higher tariffs, but these adjustments do not incur the deadweight losses that are associated with Australia increasing its own tariffs.

As the tariff-inclusive cost of traded goods increases around the world, global demand for exports falls and their world prices decline. This benefits Australia in the form of lower import costs — Australia's import prices decline 0.9 per cent.

However, as world prices decline, the prices received for Australian exports also fall, about 5.5 per cent. This contributes to maintaining the volume of Australian exports relatively unchanged, but results in a decline in the terms of trade (figure 23).

Since it does not suffer the efficiency losses incurred in other economies, Australia becomes a more attractive destination for foreign capital. This contributes to a net increase in real GDP of 0.4 per cent (figure 24). Real GNP declines as a result of the increase in returns to capital that are due to foreign capital owners. The terms of trade loss is responsible for the decrease in real GNA. That said, in both cases, these losses are smaller relative to the losses experienced under simulation G1 (figure 24), consistent with Australia benefitting from not increasing its own tariffs. In addition, the increase in Australian capital stock increases labour productivity, and real wages (figure 24).

Figure 23 **Effects on Australian capital stock, trade flows and prices — simulation G2[a,b]**

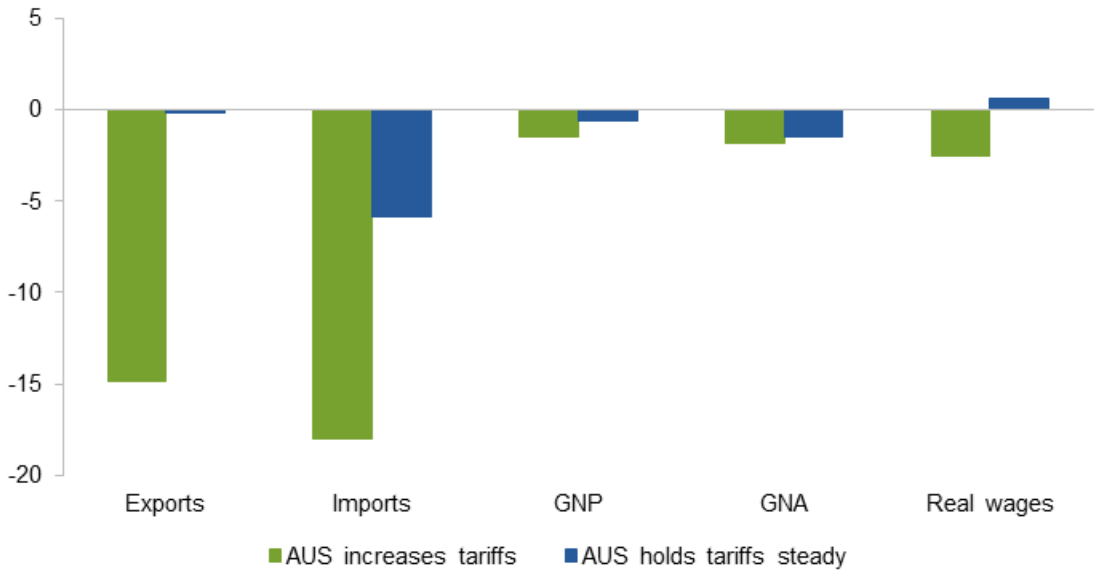
Percentage changes

[a] Imports and exports are expressed as real changes, that is, the quantity changes. [b] Negative outflow of domestic capital represents a repatriation of Australian owned capital from abroad.

Data source: Commission estimates generated using the PC Global model.

Figure 24 **Trade and income benefits from not increasing tariffs — simulations G1 and G2[a]**

Percentage change



[a] G1: AUS increases tariffs; G2: AUS holds tariffs steady.

Data source: Commission estimates generated using the PC Global model.

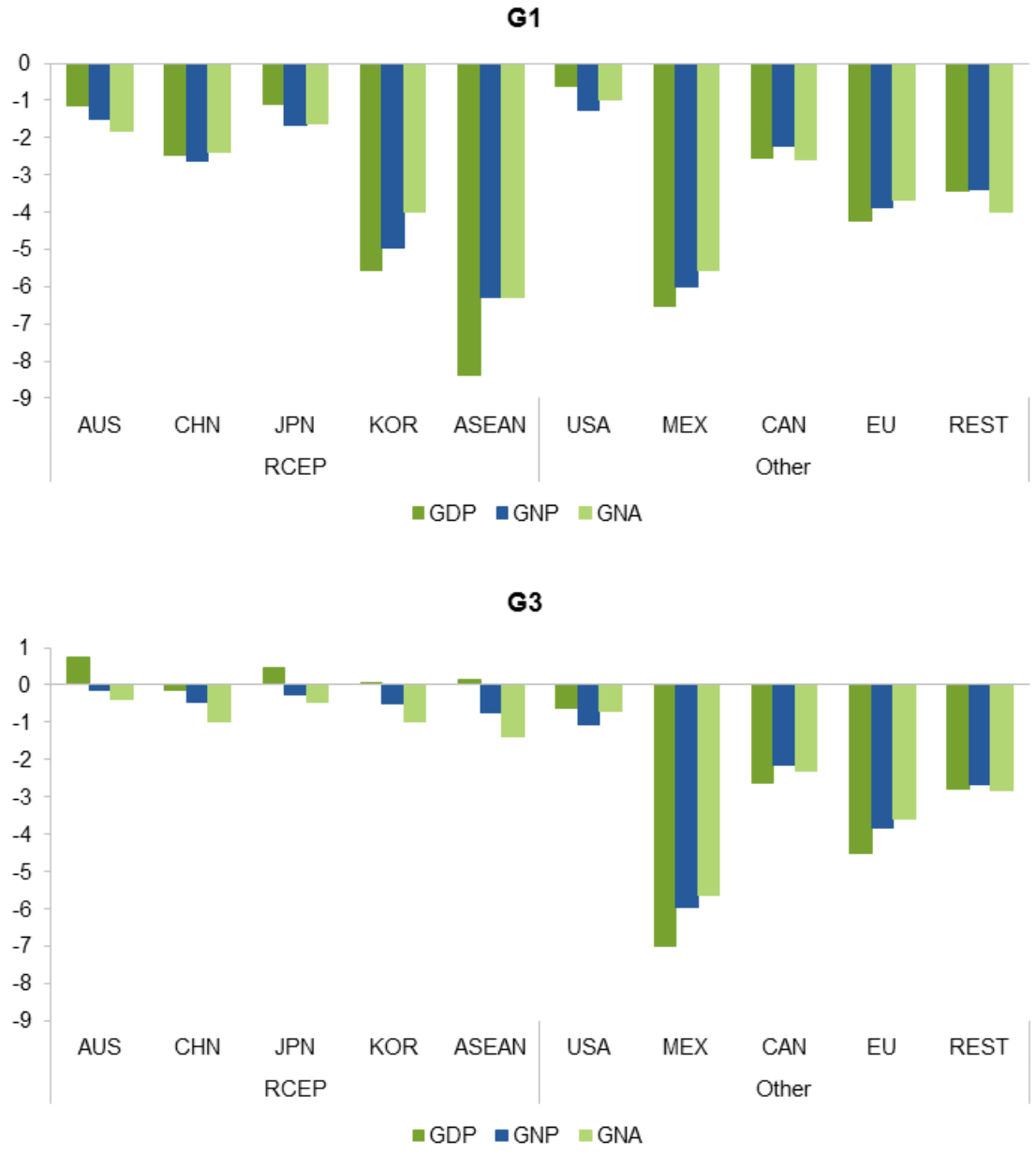
Coordinated responses

Under simulation G3, the RCEP group of economies is assumed not to increase tariffs. In this simulation, RCEP economies experience relatively small losses and some gains relative to countries that increase tariffs (figure 25). As shown in figure 23, there are greater benefits for Australia when it acts with a large group of other economies. These benefits originate from the:

- importance of RCEP economies in the global economy — RCEP economies represent about 30 per cent of world GDP
- reduced impacts on these economies' incomes
- relative importance of RCEP economies as trading partners for Australia
- improved market access for Australian exports, relative to previous simulations.

The effects of RCEP members not increasing tariffs show both improvements in outcomes for Australia and for the broader group of RCEP economies.

Figure 25 **Changes in real GDP, GNP and GNA — simulations G1 and G3**
Percentage change



Data source: Commission estimates generated using the PC Global model.

Removing non-tariff barriers and barriers to trade in services

In simulation G4, RCEP members are assumed to hold tariffs constant and reduce the effects of NTBs and BTS. Reducing NTBs and BTS reduces the cost of imports relative to that of domestic production. Benefits accrue in the form of lower costs of imports and of domestically produced goods and services as local producers adjust to meet the lower costs of competing imports.

The assumed impacts of NTBs and BTS on prices vary across goods and services and across the different economies (figure 26); some are large despite the assumptions made in reducing the original estimates. In terms of goods, the assumed price effects are highest for liquefied natural gas and for beef, indicating that the estimation processes described above identified significant effects of regulations on these goods. High estimates are concentrated in Malaysia and the Philippines, and to a lesser extent in Australia and Indonesia. These economies are likely to benefit most from reducing NTBs as they are modelled.

BTS estimates tend to be large and, as might be expected, are concentrated in financial services and in government services. There is no clear concentration of estimates across the RCEP economies. As a result of this, and because financial and government services represent similar shares of the RCEP economies, no member of RCEP is likely to benefit more than the other members from reducing BTS as they are modelled.

That said, there are substantial gains in terms of real GDP, GNP and GNA from decreasing NTBs and BTS. In the case of Australia, the negative effects of the global contagion scenario are fully compensated (figure 27).

Decreasing NTBs and BTS significantly improves outcomes for RCEP members relative to the outcomes for countries that increase tariffs.

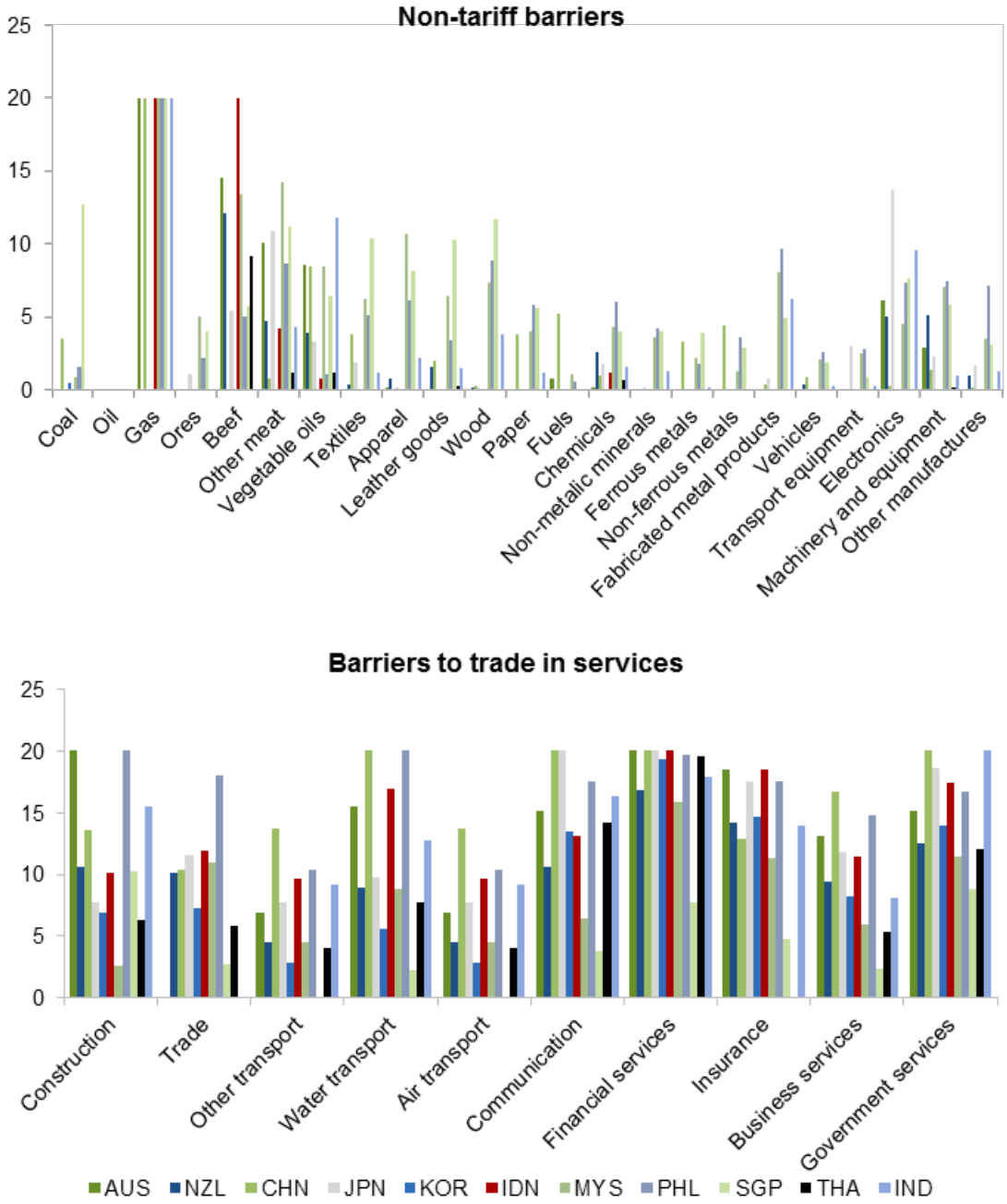
The economies with the largest modelled NTBs and BTS see the largest effects. In particular, the ASEAN economies identified above experience the largest gains relative to scenario G1.

Reducing non-tariff barriers and barriers to trade in services and abolishing tariffs

Simulation G5 models a reduction in RCEP members' NTBs and BTS (as in simulation G4) and removes all tariffs in RCEP countries on a MFN basis.

Figure 26 **Non-tariff barriers and barriers to trade in services implemented[a,b]**

Per cent

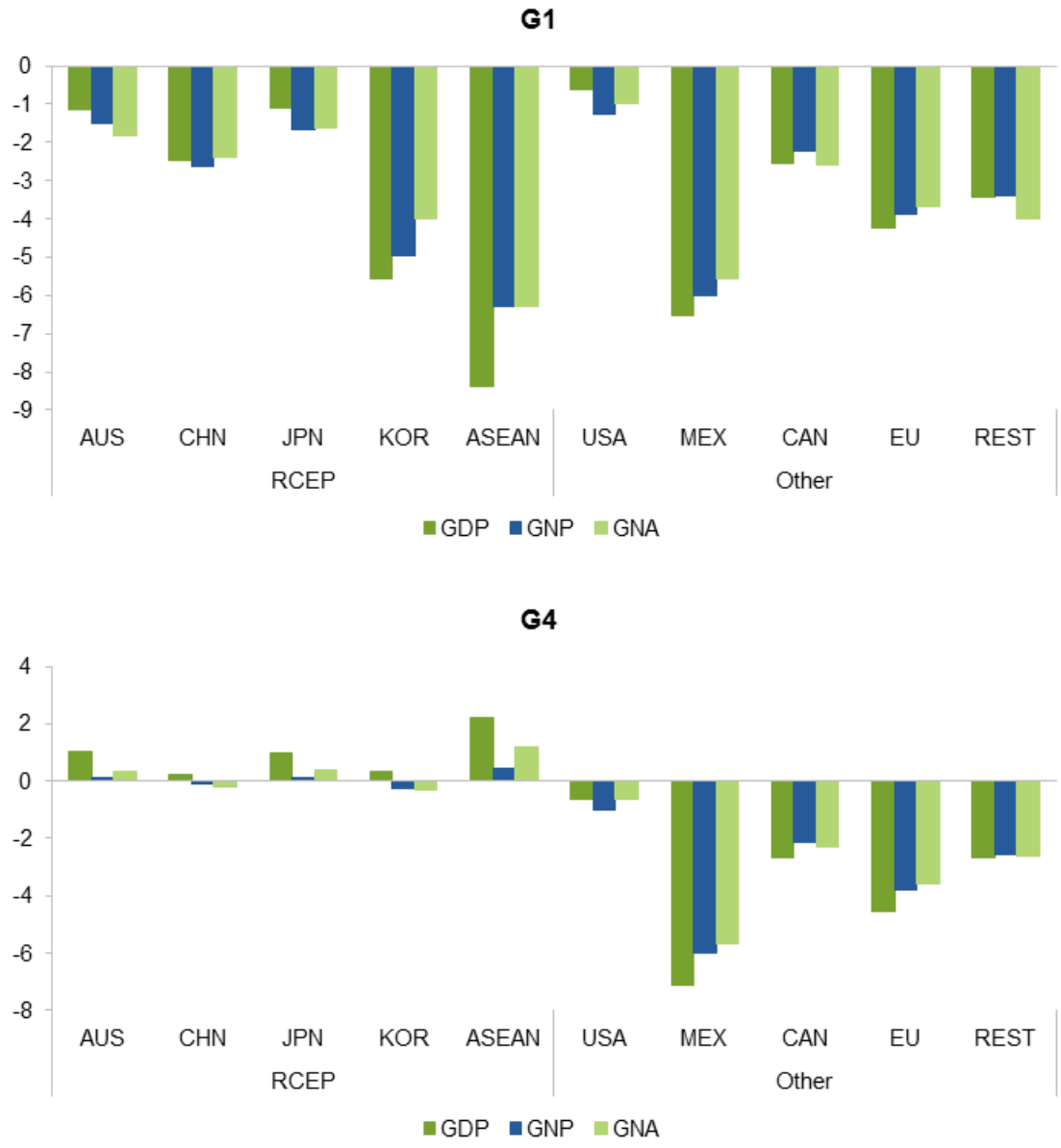


a Estimates assumed to increases the cost of imports. See text for basis of estimates. **b** AUS – Australia; NZL – New Zealand; CHN – China; JPN – Japan; KOR – Korea; IDN – Indonesia; MYS – Malaysia; PHL – Philippines; SGP – Singapore; THA – Thailand; IND - India.

Data sources: Commission estimates based on Kee et al. (2009); Fontagné, Mitaritonna and Signoret (2016).

Figure 27 **Changes in real GDP, GNP and GNA — simulations G1 and G4**

Percentage change



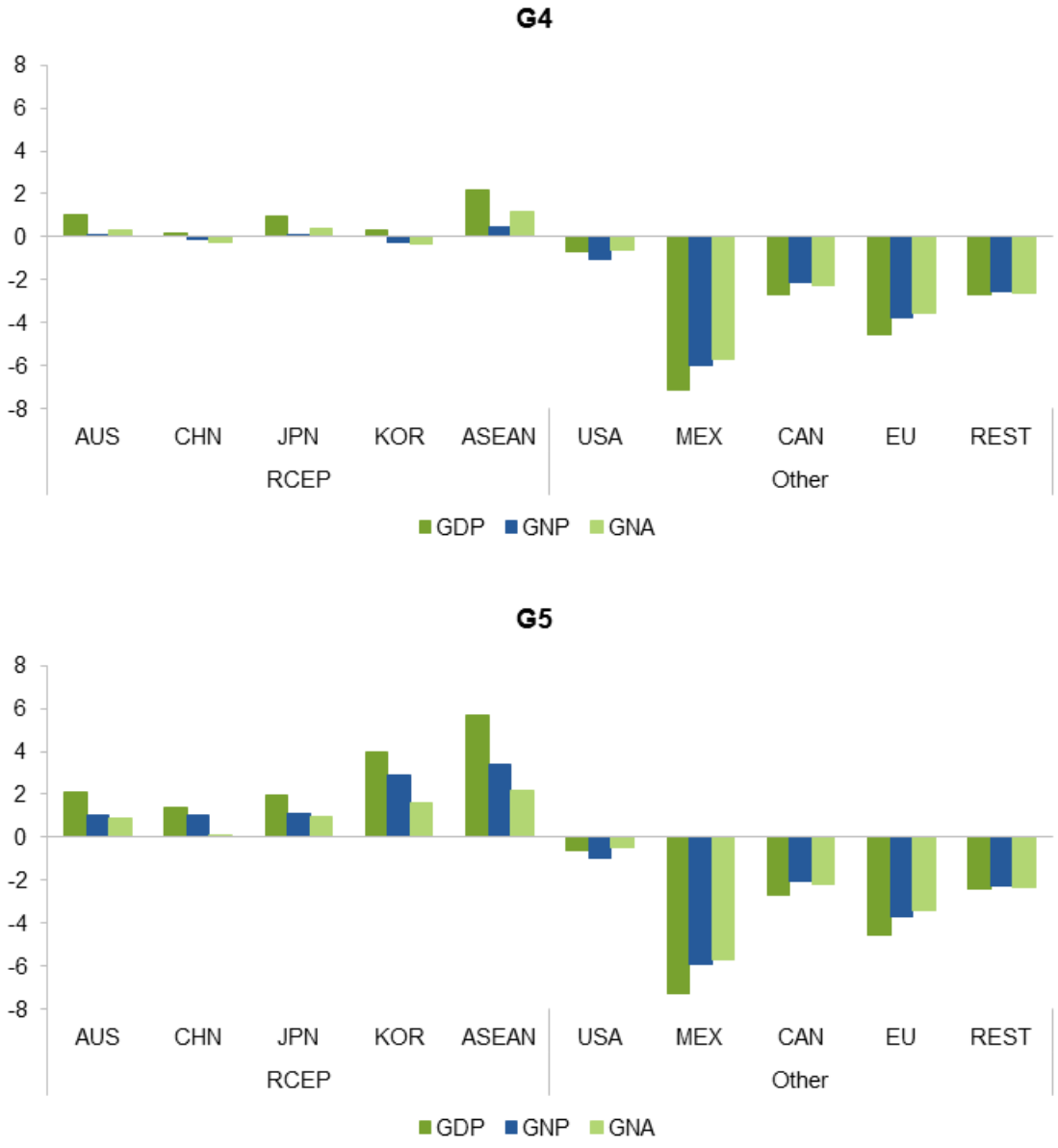
Data source: Commission estimates generated using the PC Global model.

Results in this simulation reinforce the benefits of liberalisation relative to those obtained in simulation G4. The RCEP economies with relatively large tariffs are Korea and some members of ASEAN. These are the economies that gain most from reducing their own tariffs and benefit from an improved allocation of resources, which in turn contributes to increasing their real GDP (figure 28). The efficiency gains attract foreign capital to these economies, the other contributor to increased real GDP. This gives rise to payments to foreign capital

owners, which means that real GNP increases less than real GDP. The smaller increase in real GNA associated with tariff reductions is a result of a decline in the terms of trade, a cost worth bearing given the significant improvement that liberalisation delivers.

Figure 28 **Changes in real GDP, GNP and GNA — simulations G4 and G5**

Percentage change



Data source: Commission estimates generated using the PC Global model.

Appendix 1: Industries and regions

Table A.1 **Industries in the PC Global 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 A.2 **Regions in the PC Global 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 2: PC Global – model and database

This appendix outlines the PC Global database structure and 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 PC Global 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)

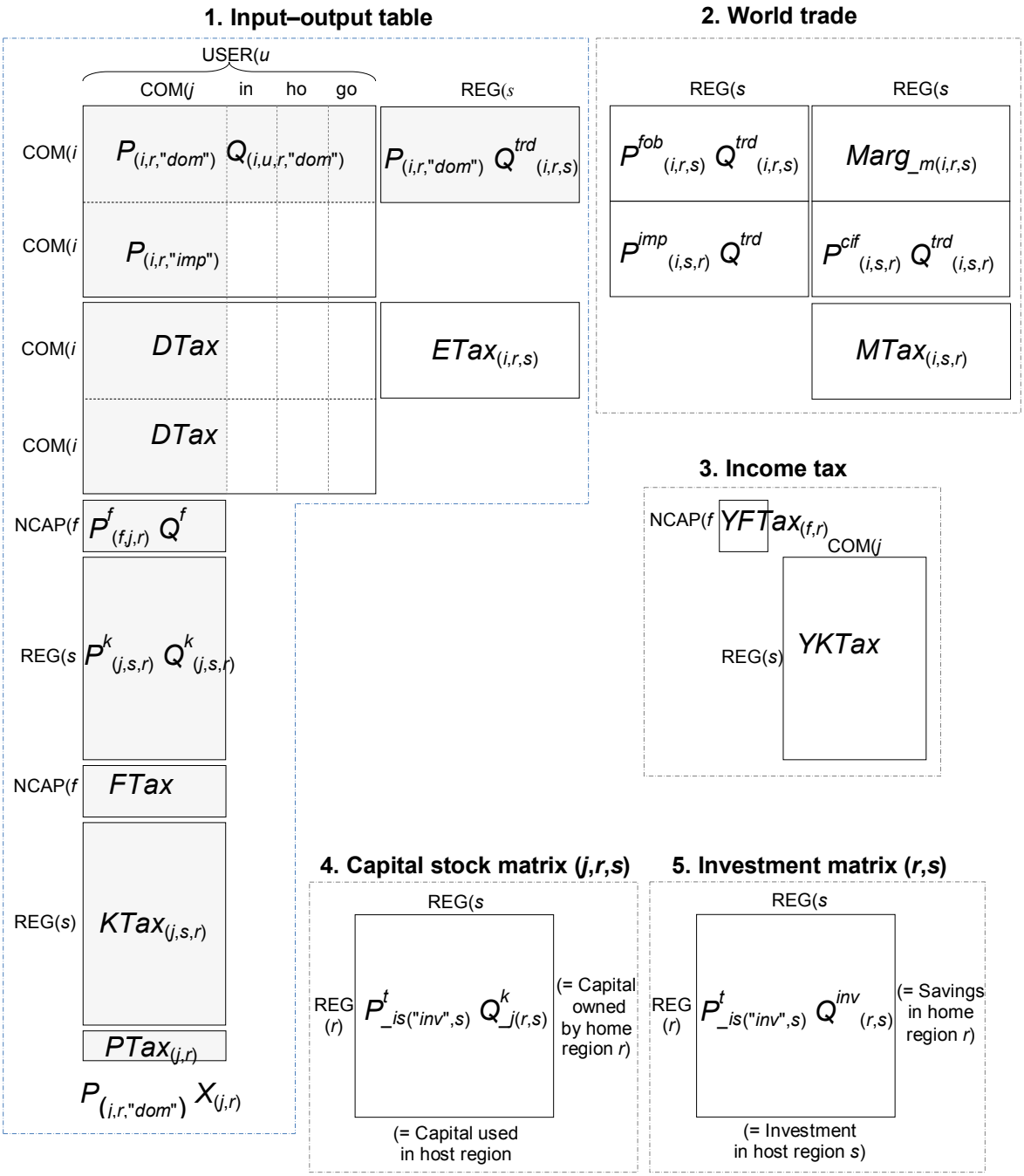
Database

The basic structure of the database for a representative region *r* is illustrated in figure A.1. The database consists of five components: a national input-output table; bilateral trade matrixes; 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 9 database. The bilateral capital stock and investment matrixes are compiled with additional data from various sources.[35]

35 The additional data used include Balance of Payments Statistics 2011; GDyn database (Ianchovichina and Walmsley 2012) and Lakatos and Walmsley and Chappuis (2011).

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



Each component of the database consists of a number of matrices or vectors. The elements in these matrices and vectors are values, expressed in US dollars, representing economic activities. These values are linked to the relevant variables in the core model. The values

are the product of a price variable and a quantity variable, each of which is defined separately in the 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 ($P_{(i,r,"dom")}Q^{trd}_{(i,r,s)}$)
- 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 ($P^k_{(s,r)}Q^k_{(j,s,r)}$)
- 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 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 free-on-board (FOB) values of exports ($P^{fob}_{(i,r,s)}\ Q^{trd}_{(i,r,s)}$), which is equal to the domestic basic value of exports ($P_{(i,r,"dom")}\ Q^{trd}_{(i,r,s)}$) plus export taxes (ETax). The FOB export matrix plus the export margin matrix ($Marg\_m(i,r,s)$) gives the cost, insurance and freight (CIF) import matrix ($P^{cif}_{(i,r,s)}\ Q^{trd}_{(i,r,s)}$). The CIF import matrix plus the import tariff matrix (MTax) gives the domestic basic value import matrix ($P^{imp}_{(i,r,s)}\ Q^{trd}_{(i,r,s)}$), 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 have a region dimension (the destination region), whereas the latter includes industry, source and destination

dimensions. This industry dimension is required when modelling barriers to foreign investment at the industry level. The implied tax rates are those of the destination or using region.

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 A.1 that firms in an industry of each region can source capital from their own regions *and* from any other 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. It also means that the effects of changes in the trading environment on the allocation of capital can be analysed.

Part 4 of figure A.1 shows the capital stock matrix in the 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 its single vector expression in the standard GTAP database to a two-dimensional matrix. Its structure, as shown in Part 5 of figure A.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. 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 1–9)

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 s for import i from region r

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

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

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

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

$$P^{cif}_{(i,r,s)} = P^{fob}_{(i,r,s)} + \frac{1}{Q^{trd}_{(i,r,s)}} \sum_m Q^{mrg}_{(m,i,r,s)}\, P^{mrg}_{(m)} \qquad (i\in\text{COM};\ r,s\in\text{REG})$$

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

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

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

(5) Regional user demands for composite import i

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

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

$$Q_{(i,u,r,s)} = CES\,(P^t_{(i,u,r,s)},\ P^t_{\_s(i,u,r)},\ Q_{\_s(i,u,r)})$$

($i \in$ 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,

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

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

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

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

$$Q_{\_s(i,u,r)} = \begin{cases} Leontief\,(X_{(u,r)}) & (i,\ u \in \text{COM};\ r \in \text{REG}) \\ CDE\,(V_{(u,r)},\ P^t_{\_s(i_1,u,r)},\ \ldots,\ P^t_{\_s(i_n,u,r)})^{36} & (i \in \text{COM};\ u=hou;\ r \in \text{REG}) \\ f\,(V_{(u,r)},\ P^t_{\_s(i,u,r)}) & (i \in \text{COM};\ u=gov;\ r \in \text{REG}) \\ Leontief\,(V_{(u,r)} / P^t_{\_is(u,r)}) & (i \in \text{COM};\ u=inv;\ r \in \text{REG}) \end{cases}$$

(9) Purchasers' price index for composite goods for user u in region r

$$P^t_{\_is(u,r)} = \sum_i \frac{Q_{\_s(i,j,r)}}{Q_{\_is(u,r)}} P^t_{\_s(i,u,r)} \qquad (u \in \text{USER};\ r \in \text{REG})$$

where $Q_{\_is(u,r)}$ is the total demand of user u for composite goods,

$$Q_{\_is(u,r)} = \sum_i Q_{\_s(i,u,r)} \qquad (u \in \text{USR};\ r \in \text{REG})$$

Industrial demands for factors (equations 10–17)

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 capital demands from all regions. This is specified in a second tier CES demand function for capital (equation 14).

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).

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

(10) Output of industry j in region r

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

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

$$Q^{mexp}_{(m,r)} = CES\,(P_{(m,r,"dom")},\ P^{mrg}_{(m)},\ Q^{mrg}_{\_irs(m)}) \qquad (m \in \text{MCOM};\ r \in \text{REG})$$

where $P^{mrg}_{(m)}$ is a CES price index for composite margin good m,

$$P^{mrg}_{(m)} = CES\,(P_{(m,r_1,"dom")},\ \ldots,\ P_{(m,r_n,"dom")}) \qquad (m \in \text{MCOM})$$

and $Q^{mrg}_{\_irs(m)}$ is the world demand for composite margin good m, a global sum of demands of trade in non-margin good i for composite margin good m, defined as a Leontief function,

$$Q^{mrg}_{(m,i,r,s)} = Leontief\,(Q^{trd}_{(i,r,s)}) \qquad (m \in \text{MCOM};\ i \in \text{COM};\ r,s \in \text{REG})$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$P^{f}_{(j,"cap",s)} = \frac{1}{\sum_r X^{k}_{(r,s)}} \sum_r X^{k}_{(r,s)}\ P^{k}_{(r,s)} \qquad (s \in \text{REG})$$

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

$$P_{(j,r,"dom")} = \left(\frac{Q\_is(j,r)}{X_{(j,r)}} P^{t}\_is(j,r) + \frac{Q^{f}\_f(j,r)}{X_{(j,r)}} P^{tf}\_f(j,r) \right) (1 + tp_{(j,r)}) \quad (j \in \text{COM}; r \in \text{REG})$$

where $tp_{(j,r)}$ is the rate of a production tax and $P^{t}\_is(j,r)$ is the purchaser price index for user j,

$$P^{t}\_is(j,r) = \frac{1}{Q\_is(j,r)} \sum_{i} Q\_s(i,u,r) P^{t}\_s(i,j,r) \qquad (j \in \text{USR}; r \in \text{REG})$$

Regional supplies of factors (equations 18–24)

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 fixed by industry. Labour is assumed to be mobile across industries but not between regions (equation 19) so that industrial wage rates will be equalised in equilibrium (equation 20).

In a comparative static context, it is assumed that the capital stock, owned by a region, can be reallocated in other regions to maximise the rate of return for its owners (equation 21). In equilibrium, the rates of return to a home region's capital stock will be equalised across all host regions (equation 23).

(18) Supply of land in industry j of region r

$$X^{land}_{(j,r)} = Q^{f}_{("land",j,r)}$$

(19) Supply of labour in region r (MEC for regional labour)

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

(20) The basic prices of labour equalisation

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

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

(21) Supply of capital by home region r to host region s (MEC for regional capital)

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

(22) Rate of return to capital

$$R_{(r,s)} = \frac{P^{kt}_{(r,s)}}{P^{t}\_is("inv",s)} \qquad (r,s \in \text{REG})$$

(23) Global allocation rule for regional capital stocks

$$R_{(r,s)} = R\_{s(r)} \qquad (r,s \in \text{REG})$$

where $R\_{js(r)}$ is the equilibrium rate of return to capital owned by home region r.

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

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

where $t^{kt}_{(s)}$ is the rate of tax on capital.

Final users' expenditure (equations 25–36)

There are three final users in the model: household, government and investor. Their expenditures are shown in equation 25. 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 34). These bilateral investment flows must be constrained by regional investment (equation 32). This requires the host region's net foreign investment inflow to adjust independently.

(25) 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).

(26) Total saving in region r

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

(27) Post-income tax price for factor f in region s

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

where $t^{ft}_{(f,s)}$ is the rate of an income tax on non-capital factor services.

(28) Household disposable income

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

(29) Government income from tax revenue

$$Ygov_{(r)} = (Total\ Tax\ Revenue) \qquad (r \in \text{REG})$$

(30) Capital stock at the end of period

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

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

(31) Real investment from region *r* to region *s*

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

(32) Market equilibrium condition (MEC) for savings in region *r*

$$V^{sav}_{(r)} = \sum_{s} V^{inv}_{(r,s)} \qquad (r \in \text{REG})$$

(33) Expected rates of return equalisation

$$R^{e}_{(r,s)} = R_{(r,s)} \left(\frac{X^{ke}_{(r,s)}}{X^{k}_{(r,s)}} \right)^{-\gamma_{(r)}} \qquad (r,s \in \text{REG})$$

where $\gamma_{(r)}$ is a parameter that controls the sensitivity of capital growth to change in the expected rate of return.

(34) Global allocation rule for regional savings

$$R^{e}_{(r,s)} = R^{e}_{\_s(r)} \qquad (r,s \in \text{REG})$$

where $R^{e}_{\_s(r)}$ is the general equilibrium rate of return for region r.

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

$$Q_{\_is("inv",r)} = \sum_{s} Q^{inv}_{(s,r)} \qquad (r \in \text{REG})$$

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

(36) Supply of capital from region *r*

$$X^{k}_{\_s(r)} = \sum_{s} X^{k}_{(r,s)} \qquad (r \in \text{REG})$$

There are 36 equations in the core system. All of them are used to define uniquely an endogenous variable, except eight equations. In these equations, five of them are market equilibrium conditions: equations 18, 19, and 21 for land, labour and capital, and equations 32 and 35 for savings and investment, respectively. The remaining three are global allocation rules for regional capital stocks and savings: equations 23 and 34, and the supplies of regional capital stocks, equation 36.

In this system, all variables for tax rates, saving rates and depreciation rates are set as exogenous. All variables for factor endowments, $X^{land}_{(j,r)}$, $X^{lab}_{(r)}$ and $X^{k}_{\_s(r)}$, are also set as exogenous. Among 36 endogenous variables, 28 are uniquely defined by one equation. The

other eight endogenous variables are not defined by any equation (they appear only on the right hand side of equations in the system). They include factor prices and the rate of return to capital in the owner regions ($Pf_{("land",j,r)}$, $W_{(r)}$, $Pk_{(r,s)}$ and $R\_s_{(r)}$); and the world expected rate of return to investment, inter-regional investment and capital stocks, and regional net foreign investment inflows ($R^{e}\_s_{(r)}$, $Vinv_{(r,s)}$, $Xk_{(r,s)}$ and $VNFI_{(r)}$). Each of these undefined variables corresponds to one of the eight equations for market equilibrium conditions or global allocation rules. These undefined variables can be seen as general equilibrium variables: each of them needs to be independently adjusted to clear a corresponding market or to satisfy a global allocation rule, specified above.

Undefined variables and corresponding equations

$Pf_{("land",j,r)}$	Equation 18 ($Xland_{(j,r)}$)
$W_{(r)}$	Equation 19 ($Xlab_{(r)}$)
$Pk_{(r,s)}$	Equation 21 ($Xk_{(r,s)}$)
$Xk_{(r,s)}$	Equation 23 ($R_{(r,s)}$)
$R^{e}\_s_{(r)}$	Equation 32 ($Vsav_{(r)}$)
$Vinv_{(r,s)}$	Equation 34 ($Re_{(r,s)}$)
$VNFI_{(r)}$	Equation 35 ($Q\_is_{("inv",r)}$)
$R\_s_{(r)}$	Equation 36 ($\dot{X}^{k}\_s_{(r)}$)

As a result, the numbers of endogenous variables and equations are equal. This setting can be used as a basic closure for model simulations.

According to Walras' Law, not all prices can be determined in a CGE model. If an endogenous price variable is chosen as the numeraire (the price relative to which changes in all other prices are measured), the corresponding equation can be removed—which maintains the equality between the number of endogenous variables and the number of equations. Alternatively, a global price index can be introduced with a new equation—and this price index can be used as the numeraire. As is the case in GTAP, the numeraire in PC Global is the price index of global investment, which is set to be exogenous.

An important feature of the basic closure is that capital stocks owned by each region can be reallocated across regions so that changes in rates of return are equalised (closure 2). This basic closure can be modified to meet the specific requirements of a particular application. For example, the supplies of regional capital can be set as endogenous by swapping with the corresponding rates of return, which are then exogenous (closure 3).

Appendix 3: Detailed results

US 45% tariff on Chinese imports

Global changes (% change)

GDP	-0.11
Exports	-0.43
Capital stock	-0.02
Rate of return	-0.04

Key indicators (% change)

	AUS	*CHN*	*JPN*	*KOR*	*CAN*	*USA*	*MEX*	*EU*	*ASEAN*	*REST*
Real GDP	0.05	-0.94	0.08	0.26	0.19	-0.62	1.72	0.09	0.43	0.14
Real GNP	0.02	-0.83	0.03	0.17	0.08	-0.45	1.15	0.05	0.26	0.10
Real GDA adjusted	0.04	-1.60	0.08	0.31	0.19	-0.34	1.70	0.10	0.45	0.17
Primary output	-0.08	0.24	0.02	-0.02	-0.25	-0.39	-0.95	0.04	-0.13	0.00
Manufacturing output	0.01	-0.45	0.13	0.11	0.98	0.26	2.00	0.00	0.94	0.15
Service output	0.05	-0.87	0.07	0.21	-0.03	-0.29	1.60	0.09	0.37	0.14
Exports	0.32	-3.71	1.02	0.73	1.21	-5.52	3.27	0.23	1.35	0.49
Imports	0.33	-7.49	0.96	0.85	1.47	-2.70	4.64	0.24	1.63	0.70
Domestic demand	0.00	-0.29	0.03	0.03	0.07	0.23	1.25	0.02	0.35	0.05
Rate of return	-0.02	-0.81	0.01	0.11	-0.03	-0.05	0.42	0.01	0.20	0.08
Real wages	0.05	-0.87	0.08	0.21	0.32	-0.70	1.54	0.07	0.46	0.16
Foreign capital inflows	0.14	-3.35	0.34	0.93	0.53	-1.00	3.91	0.33	1.30	0.24
Domestic capital outflow	-0.23	2.30	-0.44	-1.65	-0.57	0.92	-2.51	-0.28	-0.41	0.10
Terms of trade	0.21	-3.02	0.38	0.31	0.49	0.95	1.62	0.12	0.40	0.26
Real exchange rate	-0.04	-4.35	0.07	0.29	1.35	1.11	2.89	0.16	0.52	0.34

Bilateral trade flows (% change)

rows = exporter; columns = importer

	AUS	*CHN*	*JPN*	*KOR*	*CAN*	*USA*	*MEX*	*EU*	*ASEAN*	*REST*
AUS	-	-2.15	0.28	0.09	3.32	9.78	4.63	0.53	1.09	0.24
CHN	16.50	-	16.09	17.58	25.74	-82.46	33.58	20.21	19.63	18.46
JPN	-0.50	-8.59	-	-1.89	5.26	18.99	6.68	-0.38	-0.24	-0.91
KOR	-1.26	-8.36	-2.14	-	4.63	26.42	7.65	-0.61	0.17	-1.31
CAN	-7.05	-10.38	-4.66	-4.59	-	5.01	-0.08	-5.05	-4.37	-4.87
USA	-7.82	-13.50	-6.52	-7.40	-2.01	-	-0.50	-5.60	-7.43	-5.84
MEX	-12.04	-13.63	-14.18	-10.13	-7.97	8.65	-	-11.25	-10.97	-10.85
EU	-1.42	-8.46	-1.88	-1.62	3.40	13.02	6.04	-0.50	0.09	-0.93
ASEAN	-2.10	-8.88	-3.12	-2.24	2.05	33.57	6.48	-2.11	-0.85	-1.78
REST	-1.57	-5.56	-1.05	-1.05	1.86	11.78	5.12	-0.49	-0.20	-0.74

US 45% tariff on Chinese imports with half Armington elasticities

Global changes (% change)

GDP	-0.10
Exports	-0.30
Capital stock	-0.05
Rate of return	-0.07

Key indicators (% change)

	AUS	*CHN*	*JPN*	*KOR*	*CAN*	*USA*	*MEX*	*EU*	*ASEAN*	*REST*
Real GDP	0.06	-1.11	0.12	0.30	0.22	-0.60	2.00	0.11	0.47	0.17
Real GNP	0.01	-0.94	0.05	0.18	0.08	-0.40	1.27	0.06	0.27	0.12
Real GDA adjusted	0.03	-2.17	0.10	0.35	0.21	-0.16	1.99	0.13	0.51	0.21
Primary output	0.07	0.25	0.07	0.02	-0.33	-0.57	-0.95	0.08	-0.08	0.03
Manufacturing output	0.00	-0.45	0.14	0.13	0.79	-0.41	2.22	0.01	0.79	0.12
Service output	0.04	-1.39	0.10	0.28	0.07	-0.22	2.06	0.11	0.50	0.19
Exports	0.25	-1.20	0.73	0.48	0.74	-4.99	2.49	0.16	0.98	0.26
Imports	0.21	-6.41	0.75	0.65	1.05	-1.67	4.12	0.22	1.35	0.58
Domestic demand	0.01	-0.74	0.08	0.14	0.17	0.05	1.84	0.07	0.46	0.12
Rate of return	-0.03	-1.25	0.01	0.11	-0.05	-0.06	0.51	0.02	0.26	0.13
Real wages	0.05	-1.19	0.11	0.26	0.36	-0.98	1.88	0.10	0.50	0.20
Foreign capital inflows	0.16	-5.11	0.47	1.11	0.59	-1.24	4.86	0.44	1.54	0.32
Domestic capital outflow	-0.33	3.60	-0.62	-2.33	-0.77	1.12	-3.03	-0.36	-0.52	0.11
Terms of trade	0.22	-4.58	0.50	0.40	0.50	1.91	1.93	0.17	0.50	0.36
Real exchange rate	-0.21	-6.79	-0.05	0.22	1.80	2.22	3.85	0.14	0.55	0.43

Bilateral trade flows (% change)

rows = exporter; columns = importer

	AUS	*CHN*	*JPN*	*KOR*	*CAN*	*USA*	*MEX*	*EU*	*ASEAN*	*REST*
AUS	-	-2.18	0.46	0.27	2.93	7.14	4.86	0.65	1.16	0.42
CHN	12.84	-	12.60	13.61	20.06	-56.54	26.47	15.64	15.11	14.33
JPN	-0.25	-7.08	-	-1.21	4.66	13.73	6.63	0.01	0.12	-0.45
KOR	-0.79	-6.80	-1.44	-	4.20	18.59	7.39	-0.06	0.33	-0.67
CAN	-5.12	-8.42	-3.43	-3.38	-	3.43	1.22	-3.61	-3.08	-3.50
USA	-6.99	-11.90	-5.85	-6.57	-2.05	-	-0.22	-5.15	-6.66	-5.29
MEX	-8.54	-10.91	-10.23	-7.14	-4.87	6.37	-	-8.20	-7.56	-7.52
EU	-1.07	-7.25	-1.39	-1.17	2.93	9.03	5.76	-0.30	0.18	-0.62
ASEAN	-1.35	-7.07	-2.11	-1.45	2.28	22.96	6.46	-1.14	-0.26	-1.00
REST	-1.10	-4.92	-0.71	-0.73	1.88	8.02	5.19	-0.27	0.02	-0.45

US 35% tariff on Mexican imports

Global changes (% change)

GDP	-0.12
Exports	-0.35
Capital stock	-0.22
Rate of return	-0.17

Key indicators (% change)

	AUS	*CHN*	*JPN*	*KOR*	*CAN*	*USA*	*MEX*	*EU*	*ASEAN*	*REST*
Real GDP	0.06	0.08	0.07	0.12	0.32	-0.30	-8.15	0.08	0.11	0.07
Real GNP	0.01	0.05	0.02	0.06	0.10	-0.32	-5.64	0.01	0.04	0.02
Real GDA adjusted	0.02	0.11	0.05	0.12	0.29	-0.24	-9.15	0.03	0.07	0.05
Primary output	-0.01	-0.08	-0.20	-0.02	-0.18	-0.04	-0.84	-0.08	-0.03	0.01
Manufacturing output	0.10	0.10	0.16	0.21	1.08	-0.02	-9.15	0.21	0.33	0.15
Service output	0.07	0.09	0.06	0.05	0.24	-0.17	-7.74	0.05	0.05	0.07
Exports	0.02	0.21	0.20	0.24	1.64	-2.95	-16.70	0.21	0.36	0.18
Imports	0.18	0.52	0.39	0.24	2.19	-1.73	-24.73	0.19	0.37	0.26
Domestic demand	0.08	0.07	0.09	0.13	0.24	0.07	-5.97	0.09	0.12	0.07
Rate of return	-0.17	0.02	-0.10	-0.03	-0.22	-0.33	-2.69	-0.11	-0.05	-0.05
Real wages	0.08	0.10	0.09	0.10	0.33	-0.44	-7.01	0.09	0.11	0.09
Foreign capital inflows	0.32	0.61	0.51	0.80	1.17	-0.89	-17.56	0.55	0.58	0.20
Domestic capital outflow	-0.18	-0.76	-0.49	-0.48	-0.99	-1.07	8.99	-0.58	-0.16	0.01
Terms of trade	0.03	0.22	0.22	0.11	0.70	0.80	-11.46	0.04	0.05	0.06
Real exchange rate	0.26	0.50	0.49	0.41	0.85	0.08	-15.26	0.30	0.34	0.27

Bilateral trade flows (% change)

rows = exporter; columns = importer

	AUS	*CHN*	*JPN*	*KOR*	*CAN*	*USA*	*MEX*	*EU*	*ASEAN*	*REST*
AUS	-	-0.11	-0.16	-0.11	0.57	2.84	-23.99	-0.11	0.16	-0.08
CHN	-0.94	-	-0.45	-0.38	-3.35	6.06	-26.94	-1.03	-0.08	-1.27
JPN	-0.93	-0.53	-	-0.62	-2.21	7.44	-26.03	-1.20	-0.32	-1.05
KOR	-0.37	0.19	0.03	-	-1.99	7.24	-26.10	-0.57	0.38	-0.61
CAN	-2.05	-1.45	-2.03	-1.80	-	4.23	-23.89	-1.75	-1.52	-2.39
USA	-0.55	-0.12	-0.04	-0.08	-1.16	-	-24.30	-0.48	0.02	-1.24
MEX	95.39	105.43	124.75	84.77	107.76	-66.50	-	139.17	106.45	106.81
EU	0.10	0.56	0.42	0.46	0.17	4.09	-24.49	0.02	0.60	-0.11
ASEAN	-0.23	0.17	-0.26	0.03	-1.64	5.71	-25.59	-0.48	0.36	-0.39
REST	0.06	-0.16	0.10	0.08	-0.27	4.35	-24.52	-0.48	0.26	-0.41

US 45% tariff on Chinese imports and 35% on Mexican imports

Global changes (% change)

GDP	-0.25
Exports	-0.84
Capital stock	-0.28

Key indicators (% change)

	AUS	*CHN*	*JPN*	*KOR*	*CAN*	*USA*	*MEX*	*EU*	*ASEAN*	*REST*
Real GDP	0.12	-0.91	0.17	0.45	0.53	-0.91	-7.67	0.19	0.63	0.23
Real GNP	0.03	-0.82	0.06	0.28	0.18	-0.79	-5.34	0.07	0.35	0.13
Real GDA adjusted	0.06	-1.59	0.15	0.53	0.50	-0.57	-8.71	0.14	0.62	0.23
Primary output	-0.11	0.23	-0.20	-0.05	-0.47	-0.51	-1.15	-0.06	-0.21	-0.01
Manufacturing output	0.13	-0.41	0.30	0.38	2.10	0.27	-8.50	0.23	1.55	0.33
Service output	0.12	-0.84	0.14	0.31	0.22	-0.46	-7.35	0.15	0.49	0.22
Exports	0.34	-3.84	1.30	1.11	2.93	-8.81	-15.90	0.48	2.07	0.73
Imports	0.54	-7.56	1.51	1.31	3.81	-4.59	-23.76	0.47	2.44	1.02
Domestic demand	0.08	-0.24	0.12	0.20	0.32	0.33	-5.60	0.12	0.56	0.14
Rate of return	-0.21	-0.85	-0.09	0.11	-0.29	-0.42	-2.60	-0.11	0.17	0.03
Real wages	0.14	-0.84	0.19	0.37	0.70	-1.18	-6.57	0.18	0.67	0.27
Foreign capital inflows	0.49	-2.96	0.95	2.03	1.79	-1.95	-16.46	0.96	2.21	0.48
Domestic capital outflow	-0.41	1.66	-0.99	-2.36	-1.64	-0.36	7.48	-0.93	-0.66	0.11
Terms of trade	0.24	-3.00	0.68	0.51	1.24	1.98	-11.10	0.17	0.52	0.33
Real exchange rate	0.25	-4.12	0.68	0.88	2.33	1.29	-14.41	0.52	1.01	0.66

Bilateral trade flows (% change)

rows = exporter; columns = importer

	AUS	*CHN*	*JPN*	*KOR*	*CAN*	*USA*	*MEX*	*EU*	*ASEAN*	*REST*
AUS	-	-2.43	0.13	-0.03	3.91	13.29	-22.19	0.46	1.41	0.17
CHN	16.64	-	16.94	18.81	23.06	-81.44	-6.13	20.50	21.64	18.29
JPN	-1.65	-9.87	-	-2.66	2.52	28.78	-23.56	-1.85	-0.39	-2.18
KOR	-1.95	-9.02	-2.38	-	2.11	38.80	-24.12	-1.56	0.75	-2.28
CAN	-9.26	-12.17	-6.73	-6.40	-	9.48	-25.96	-6.89	-5.73	-7.36
USA	-8.60	-14.20	-6.70	-7.57	-3.35	-	-26.83	-6.23	-7.32	-7.19
MEX	82.72	85.72	108.88	75.46	107.02	-62.00	-	128.61	99.83	98.88
EU	-1.39	-8.46	-1.48	-1.08	3.59	18.37	-22.26	-0.51	1.04	-1.12
ASEAN	-2.69	-9.63	-3.77	-2.43	0.00	45.67	-25.20	-3.06	-0.40	-2.53
REST	-1.61	-6.16	-0.99	-1.00	1.46	17.22	-23.20	-0.98	0.20	-1.20

Reciprocal US and China tariffs

Global changes (% change)

GDP	-0.15
Exports	-0.66
Capital stock	-0.05
Rate of return	-0.08

Key indicators (% change)

	AUS	*CHN*	*JPN*	*KOR*	*CAN*	*USA*	*MEX*	*EU*	*ASEAN*	*REST*
Real GDP	0.08	-1.32	0.11	0.36	0.23	-0.69	1.77	0.10	0.48	0.16
Real GNP	0.03	-1.19	0.04	0.24	0.08	-0.49	1.15	0.05	0.28	0.11
Real GDA adjusted	0.07	-1.88	0.11	0.44	0.23	-0.46	1.74	0.10	0.51	0.20
Primary output	0.10	0.31	-0.08	0.00	-0.19	-1.08	-1.04	0.08	-0.14	0.10
Manufacturing output	0.10	-0.53	0.21	0.35	1.00	0.06	2.12	0.10	1.11	0.18
Service output	0.07	-1.11	0.07	0.26	0.01	-0.31	1.67	0.06	0.38	0.14
Exports	0.45	-5.36	1.22	1.04	1.38	-7.10	3.43	0.30	1.51	0.56
Imports	0.55	-9.00	1.19	1.23	1.71	-4.24	4.85	0.30	1.82	0.83
Domestic demand	0.03	-0.26	0.04	0.14	0.08	0.25	1.31	0.03	0.40	0.07
Rate of return	-0.04	-1.02	-0.01	0.14	-0.07	-0.10	0.41	-0.01	0.20	0.08
Real wages	0.07	-1.35	0.11	0.31	0.36	-0.75	1.59	0.08	0.50	0.16
Foreign capital inflows	0.26	-4.18	0.45	1.33	0.66	-1.31	4.14	0.40	1.53	0.28
Domestic capital outflow	-0.34	2.79	-0.60	-2.17	-0.78	1.09	-2.79	-0.38	-0.53	0.08
Terms of trade	0.30	-2.72	0.50	0.43	0.62	0.23	1.71	0.13	0.44	0.31
Real exchange rate	0.22	-4.19	0.38	0.67	1.36	0.25	2.81	0.35	0.78	0.66

Bilateral trade flows (% change)

rows = exporter; columns = importer

	AUS	*CHN*	*JPN*	*KOR*	*CAN*	*USA*	*MEX*	*EU*	*ASEAN*	*REST*
AUS	-	0.10	-0.18	-0.19	1.72	7.40	2.90	0.01	0.27	-0.16
CHN	14.73	-	14.61	16.12	21.72	-83.03	29.28	18.04	17.95	16.57
JPN	-0.99	-3.80	-	-1.98	2.57	15.89	4.26	-1.08	-0.49	-1.24
KOR	-1.72	-3.80	-2.29	-	2.09	23.16	5.27	-1.52	-0.10	-1.80
CAN	-6.07	-1.73	-4.59	-3.98	-	4.34	-1.59	-4.23	-3.58	-4.17
USA	-4.00	-78.36	-2.79	-3.31	-0.02	-	1.70	-2.22	-3.07	-2.08
MEX	-10.78	-9.89	-12.44	-8.91	-8.23	8.37	-	-9.98	-9.60	-9.57
EU	-1.37	-2.63	-1.66	-1.24	2.00	11.17	4.40	-0.49	0.30	-0.83
ASEAN	-2.18	-4.74	-3.17	-2.12	0.51	30.78	4.93	-2.39	-0.71	-1.84
REST	-1.66	-1.74	-1.02	-0.79	0.42	9.89	2.74	-0.67	-0.22	-0.90

Reciprocal US and Mexico tariffs

Global changes (% change)

GDP	-0.18
Exports	-0.61
Capital stock	-0.33
Rate of return	-0.27

Key indicators (% change)

	AUS	*CHN*	*JPN*	*KOR*	*CAN*	*USA*	*MEX*	*EU*	*ASEAN*	*REST*
Real GDP	0.09	0.10	0.11	0.22	0.40	-0.37	-13.07	0.13	0.18	0.10
Real GNP	0.01	0.07	0.02	0.12	0.10	-0.41	-9.57	0.02	0.06	0.03
Real GDA adjusted	0.04	0.15	0.08	0.25	0.33	-0.44	-11.91	0.05	0.12	0.06
Primary output	-0.08	-0.11	-0.22	-0.02	0.12	-0.15	-0.71	-0.07	-0.05	-0.01
Manufacturing output	0.24	0.14	0.30	0.39	1.34	-0.25	-14.09	0.37	0.50	0.29
Service output	0.10	0.12	0.08	0.10	0.27	-0.22	-11.56	0.05	0.09	0.08
Exports	0.11	0.30	0.40	0.46	2.03	-4.56	-30.27	0.38	0.56	0.27
Imports	0.32	0.74	0.64	0.50	2.62	-3.55	-34.56	0.33	0.57	0.34
Domestic demand	0.12	0.10	0.14	0.24	0.31	0.08	-7.89	0.13	0.19	0.12
Rate of return	-0.26	0.02	-0.15	-0.03	-0.37	-0.50	-4.19	-0.17	-0.08	-0.08
Real wages	0.11	0.13	0.13	0.20	0.42	-0.48	-13.08	0.14	0.17	0.13
Foreign capital inflows	0.52	0.89	0.79	1.38	1.48	-1.33	-25.98	0.84	0.93	0.28
Domestic capital outflow	-0.28	-1.12	-0.74	-0.83	-1.41	-1.62	14.37	-0.88	-0.26	0.00
Terms of trade	0.06	0.29	0.36	0.23	0.81	-0.03	-8.26	0.07	0.07	0.05
Real exchange rate	0.39	0.74	0.74	0.72	1.05	-0.74	-14.91	0.51	0.49	0.48

Bilateral trade flows (% change)

rows = exporter; columns = importer

	AUS	*CHN*	*JPN*	*KOR*	*CAN*	*USA*	*MEX*	*EU*	*ASEAN*	*REST*
AUS	-	0.07	-0.22	-0.03	0.29	1.79	9.37	-0.13	0.13	-0.08
CHN	-1.35	-	-0.61	-0.57	-3.46	4.59	11.18	-1.27	-0.37	-1.44
JPN	-1.27	-0.73	-	-0.87	-2.41	6.17	20.09	-1.50	-0.61	-1.32
KOR	-0.75	-0.04	-0.20	-	-2.12	5.89	14.13	-1.10	0.04	-0.93
CAN	-2.34	-1.55	-2.63	-2.10	-	3.41	36.79	-1.74	-1.87	-2.64
USA	3.03	3.77	3.28	3.53	1.92	-	-74.37	2.94	3.80	2.36
MEX	62.54	77.35	83.04	58.30	70.16	-71.88	-	101.69	73.52	72.10
EU	-0.19	0.68	0.35	0.50	-0.37	2.93	21.55	0.04	0.46	-0.13
ASEAN	-0.26	0.41	-0.18	0.09	-1.65	4.73	8.54	-0.38	0.51	-0.30
REST	-0.06	-0.07	0.15	0.14	-0.68	2.73	20.30	-0.39	0.26	-0.34

Reciprocal US and China and US and Mexico tariffs

Global changes (% change)

GDP	-0.36
Exports	-1.01
Capital stock	-0.54
Rate of return	-0.37

Key indicators (% change)

	AUS	*CHN*	*JPN*	*KOR*	*CAN*	*USA*	*MEX*	*EU*	*ASEAN*	*REST*
Real GDP	0.18	-1.26	0.23	0.65	0.65	-1.07	-12.39	0.24	0.75	0.28
Real GNP	0.04	-1.16	0.07	0.40	0.18	-0.93	-9.17	0.07	0.40	0.15
Real GDA adjusted	0.11	-1.80	0.20	0.78	0.58	-0.90	-11.32	0.16	0.72	0.27
Primary output	0.00	0.26	-0.33	-0.03	-0.11	-1.33	-1.04	-0.02	-0.24	0.07
Manufacturing output	0.35	-0.44	0.51	0.80	2.36	-0.16	-13.15	0.49	1.89	0.50
Service output	0.18	-1.04	0.17	0.40	0.30	-0.52	-10.94	0.13	0.54	0.23
Exports	0.56	-5.40	1.68	1.65	3.48	-12.08	-29.03	0.71	2.43	0.88
Imports	0.89	-8.81	1.96	1.93	4.48	-8.01	-33.13	0.66	2.80	1.22
Domestic demand	0.16	-0.17	0.19	0.42	0.39	0.37	-7.34	0.17	0.69	0.20
Rate of return	-0.32	-1.05	-0.16	0.14	-0.48	-0.64	-4.04	-0.19	0.15	0.00
Real wages	0.20	-1.28	0.26	0.56	0.82	-1.26	-12.45	0.24	0.77	0.31
Foreign capital inflows	0.81	-3.49	1.34	3.00	2.23	-2.71	-24.38	1.33	2.79	0.59
Domestic capital outflow	-0.62	1.73	-1.39	-3.22	-2.27	-0.72	12.14	-1.32	-0.87	0.09
Terms of trade	0.35	-2.58	0.92	0.74	1.49	0.36	-8.15	0.21	0.58	0.37
Real exchange rate	0.65	-3.65	1.24	1.57	2.52	-0.45	-14.05	0.93	1.43	1.20

Bilateral trade flows (% change)

rows = exporter; columns = importer

	AUS	*CHN*	*JPN*	*KOR*	*CAN*	*USA*	*MEX*	*EU*	*ASEAN*	*REST*
AUS	-	-0.69	0.07	0.20	2.08	6.30	1.20	0.13	0.91	0.14
CHN	10.74	-	11.48	12.60	15.40	-56.55	19.74	13.21	14.23	12.07
JPN	-1.47	-4.01	-	-1.76	1.32	15.56	7.26	-1.69	-0.22	-1.52
KOR	-1.63	-3.39	-1.59	-	1.29	21.42	4.18	-1.61	0.45	-1.68
CAN	-5.31	-2.90	-4.13	-3.45	-	4.97	12.02	-3.63	-2.87	-4.00
USA	-1.69	-58.48	-0.51	-0.67	1.44	-	-53.57	-0.32	-0.31	-0.52
MEX	20.47	28.03	28.62	21.39	28.61	-43.58	-	41.07	28.25	27.84
EU	-0.89	-2.16	-0.65	-0.13	1.99	9.67	8.20	-0.12	1.18	-0.45
ASEAN	-1.54	-3.71	-2.18	-1.17	0.41	26.26	0.92	-1.65	0.61	-1.21
REST	-1.05	-2.23	-0.36	-0.25	0.62	7.87	7.93	-0.49	0.47	-0.61

US border adjustment

Global changes (% change)

GDP	0.05
Exports	0.87
Capital stock	0.17
Rate of return	0.16

Key indicators (% change)

	AUS	*CHN*	*JPN*	*KOR*	*CAN*	*USA*	*MEX*	*EU*	*ASEAN*	*REST*
Real GDP	0.00	-0.02	0.06	0.00	0.48	0.04	0.91	0.06	0.03	0.01
Real GNP	0.03	0.00	0.07	0.03	0.36	0.01	0.67	0.08	0.05	0.03
Real GDA adjusted	0.00	-0.26	0.06	-0.02	1.00	-0.01	1.41	0.23	-0.09	-0.08
Primary output	-0.02	0.10	0.02	-0.02	-0.50	0.53	-0.08	-0.07	0.02	0.06
Manufacturing output	-0.46	0.00	-0.50	-0.42	-1.28	2.44	0.14	-0.84	-0.30	-0.38
Service output	0.02	-0.16	0.12	0.17	0.84	-0.32	1.29	0.34	0.19	0.03
Exports	-0.14	1.01	-0.38	-0.14	0.00	10.26	1.01	-0.61	-0.15	0.06
Imports	0.14	-0.03	0.16	-0.01	2.95	5.86	3.21	-0.01	-0.11	-0.12
Domestic demand	-0.07	-0.16	-0.07	-0.19	0.21	-0.23	0.73	0.02	-0.03	-0.14
Rate of return	0.20	0.04	0.19	0.11	0.37	0.26	0.42	0.17	0.11	0.10
Real wages	0.01	-0.06	-0.03	0.00	0.51	-0.24	0.85	0.04	0.04	-0.02
Foreign capital inflows	-0.06	-0.53	0.06	-0.32	1.27	0.66	1.88	0.09	0.04	0.00
Domestic capital outflow	0.26	0.90	0.27	0.40	0.19	0.18	-0.25	0.34	0.29	0.10
Terms of trade	0.19	-0.03	0.11	0.03	1.57	-1.46	1.55	0.12	0.08	0.15
Real exchange rate	-4.98	-5.57	-5.31	-5.08	-3.67	22.04	-4.12	-6.03	-5.03	-6.33

Bilateral trade flows (% change)

rows = exporter; columns = importer

	AUS	*CHN*	*JPN*	*KOR*	*CAN*	*USA*	*MEX*	*EU*	*ASEAN*	*REST*
AUS	-	-0.37	-0.37	-0.81	-2.33	6.52	-3.88	-0.21	-0.91	-0.75
CHN	-1.38	-	-1.15	-1.46	-3.68	7.17	-5.16	0.17	-1.13	-0.72
JPN	-1.91	-1.61	-	-2.20	-5.97	6.68	-5.69	-0.49	-1.76	-2.01
KOR	-1.31	-0.93	-1.21	-	-4.81	7.14	-5.07	-0.35	-1.39	-1.22
CAN	-6.00	-4.21	-4.83	-4.60	-	2.58	-7.89	-3.91	-4.56	-4.58
USA	12.14	13.35	8.51	11.11	8.38	-	9.87	9.51	12.57	10.98
MEX	-3.39	-2.38	-4.00	-2.53	-7.42	2.72	-	-1.95	-2.65	-3.33
EU	-2.87	-2.51	-1.78	-2.40	-2.23	7.72	-5.31	-0.94	-2.04	-1.76
ASEAN	-1.24	-0.90	-1.29	-1.07	-2.95	6.21	-4.71	0.08	-1.48	-0.92
REST	-1.32	-0.83	-0.59	-0.73	-2.88	5.89	-6.04	-0.44	-0.79	-1.09

US trade-neutral border adjustment experiment

Global changes (% change)

GDP	0.00
Exports	-0.11
Capital stock	0
Rate of return	-0.01

Key indicators (% change)

	AUS	*CHN*	*JPN*	*KOR*	*CAN*	*USA*	*MEX*	*EU*	*ASEAN*	*REST*
Real GDP	0.01	-0.02	0.05	-0.02	0.09	-0.03	0.01	0.04	-0.03	-0.01
Real GNP	0.00	-0.01	0.01	-0.01	0.06	-0.01	0.00	0.02	0.00	0.00
Real GDA adjusted	-0.07	-0.28	-0.01	-0.09	0.30	0.16	0.24	0.14	-0.20	-0.18
Primary output	0.00	0.07	0.13	0.03	-0.27	-0.01	-0.14	0.02	-0.01	0.04
Manufacturing output	-0.09	0.10	-0.23	-0.05	-0.93	0.03	-0.31	-0.21	-0.09	0.01
Service output	-0.01	-0.16	0.06	0.00	0.27	-0.04	0.15	0.08	-0.01	-0.07
Exports	-0.14	0.72	-0.35	-0.07	-1.48	0.10	-0.80	-0.39	-0.16	0.08
Imports	-0.13	-0.33	-0.07	-0.10	0.18	0.09	0.01	0.02	-0.23	-0.33
Domestic demand	-0.01	-0.07	-0.01	-0.04	0.15	-0.01	0.13	0.05	-0.02	-0.05
Rate of return	0.02	-0.06	0.08	-0.03	0.03	0.00	0.00	0.02	-0.04	-0.06
Real wages	0.01	-0.03	-0.01	-0.03	0.13	-0.87	0.04	0.03	-0.01	-0.02
Foreign capital inflows	0.02	-0.24	0.33	-0.18	0.17	-0.14	0.05	0.12	-0.19	-0.03
Domestic capital outflow	-0.06	0.17	-0.31	0.05	-0.19	0.10	-0.07	-0.14	0.03	0.01
Terms of trade	-0.05	-0.13	0.04	-0.05	0.18	0.31	-0.01	0.04	-0.05	-0.11
Real exchange rate	-4.41	-4.94	-4.66	-4.48	-4.07	19.87	-4.34	-5.45	-4.50	-5.75

Bilateral trade flows (% change)

rows = exporter; columns = importer

	AUS	*CHN*	*JPN*	*KOR*	*CAN*	*USA*	*MEX*	*EU*	*ASEAN*	*REST*
AUS	-	-0.13	-0.19	-0.12	-0.06	-0.05	-0.20	0.18	-0.14	-0.27
CHN	0.32	-	0.19	0.27	0.60	1.93	0.27	0.73	0.21	0.21
JPN	-0.26	-0.67	-	-0.44	-0.20	0.60	-0.24	-0.03	-0.54	-0.77
KOR	0.00	-0.24	-0.25	-	0.12	0.68	0.09	0.34	-0.22	-0.32
CAN	-1.74	-1.47	-1.11	-1.12	-	-1.54	-1.63	-1.20	-1.52	-1.56
USA	-0.08	-0.28	-0.04	-0.12	0.36	-	0.23	0.44	-0.37	-0.15
MEX	-0.55	-0.61	-0.68	-0.54	-0.62	-0.96	-	-0.01	-0.54	-0.39
EU	-0.62	-1.04	-0.62	-0.64	-0.25	-0.23	-0.64	-0.20	-0.70	-0.78
ASEAN	-0.16	-0.32	-0.35	-0.27	0.25	0.31	-0.18	0.23	-0.33	-0.32
REST	0.16	0.00	0.16	0.13	-0.02	0.07	-0.18	0.24	0.09	-0.07

Global 15% tariff increase

Global changes (% change)

GDP	-2.88
Exports	-21.96
Capital stock	-5.02
Rate of return	-4.82

Key indicators (% change)

	AUS	*CHN*	*JPN*	*KOR*	*CAN*	*USA*	*MEX*	*EU*	*ASEAN*	*REST*
Real GDP	-1.14	-2.48	-1.11	-5.56	-2.54	-0.62	-6.53	-4.25	-8.38	-3.43
Real GNP	-1.52	-2.62	-1.66	-4.97	-2.24	-1.26	-6.00	-3.86	-6.30	-3.41
Real GDA adjusted	-1.81	-2.40	-1.61	-3.99	-2.57	-0.97	-5.56	-3.69	-6.28	-3.99
Primary output	-5.41	0.15	3.31	1.40	-3.40	-1.19	-2.77	-0.77	-0.82	-2.79
Manufacturing output	2.78	-1.20	-1.37	-8.75	-3.55	0.72	-7.56	-6.32	-14.83	-1.03
Service output	-1.13	-1.89	-0.87	-3.90	-1.66	-0.54	-5.63	-3.19	-6.76	-3.30
Exports	-14.85	-22.88	-18.69	-24.52	-21.82	-28.05	-25.09	-22.64	-27.80	-18.09
Imports	-17.99	-26.03	-19.71	-23.14	-22.64	-20.37	-24.85	-21.70	-27.84	-20.98
Domestic demand	1.17	0.87	0.59	-1.59	1.24	1.77	-2.06	0.42	-3.91	0.70
Rate of return	-4.78	-4.06	-4.25	-6.05	-4.74	-4.75	-5.04	-5.41	-6.77	-4.50
Real wages	-2.50	-4.62	-2.93	-9.84	-4.64	-2.31	-8.30	-7.89	-11.50	-5.11
Foreign capital inflows	-0.78	0.55	0.14	-12.59	-5.22	-0.17	-8.49	-8.90	-20.83	-5.52
Domestic capital outflow	-5.26	-7.34	-7.59	0.90	-2.52	-7.44	-0.85	-2.08	-0.30	-5.63
Terms of trade	-1.60	0.90	0.90	2.04	-1.69	2.79	-1.27	0.69	0.39	-2.16
Real exchange rate	1.89	-0.30	-0.48	-4.95	-1.29	4.66	-1.13	-2.42	-3.44	-0.70

Bilateral trade flows (% change)

rows = exporter; columns = importer

	AUS	*CHN*	*JPN*	*KOR*	*CAN*	*USA*	*MEX*	*EU*	*ASEAN*	*REST*
AUS	-	-11.90	-11.65	-14.66	-18.93	-17.95	-20.95	-15.86	-22.59	-16.33
CHN	-18.07	-	-28.48	-29.70	-18.97	-22.54	-17.76	-22.49	-28.15	-20.36
JPN	-6.04	-27.80	-	-25.60	-6.39	-15.02	-10.77	-13.51	-22.00	-14.62
KOR	-11.36	-35.56	-28.77	-	-12.07	-18.67	-16.44	-19.62	-31.37	-19.03
CAN	-16.26	-22.08	-8.69	-13.85	-	-24.50	-22.76	-16.44	-20.14	-16.94
USA	-23.34	-35.60	-26.32	-30.73	-27.31	-	-29.72	-26.28	-34.07	-26.88
MEX	-17.15	-20.79	-25.78	-20.21	-23.19	-26.39	-	-20.93	-23.12	-21.60
EU	-15.61	-31.44	-22.21	-25.04	-14.03	-19.03	-21.94	-23.88	-22.18	-20.04
ASEAN	-27.93	-36.02	-26.99	-29.08	-17.47	-29.05	-28.50	-18.79	-36.45	-22.58
REST	-15.20	-19.25	-9.22	-16.39	-20.38	-16.06	-14.54	-16.26	-24.69	-21.30

Global 15% tariff increase without Australia

Global changes (% change)

GDP	-2.85
Exports	-21.75
Capital stock	-4.96
Rate of return	-4.76

Key indicators (% change)

	AUS	*CHN*	*JPN*	*KOR*	*CAN*	*USA*	*MEX*	*EU*	*ASEAN*	*REST*
Real GDP	0.40	-2.44	-1.09	-5.48	-2.56	-0.63	-6.57	-4.26	-8.30	-3.44
Real GNP	-0.60	-2.58	-1.63	-4.89	-2.24	-1.25	-6.00	-3.86	-6.23	-3.40
Real GDA adjusted	-1.51	-2.31	-1.55	-3.84	-2.58	-0.97	-5.58	-3.68	-6.14	-3.98
Primary output	-3.10	0.12	3.21	1.36	-3.46	-1.25	-2.77	-0.80	-0.80	-2.78
Manufacturing output	4.78	-1.16	-1.36	-8.65	-3.56	0.74	-7.61	-6.31	-14.64	-1.05
Service output	0.29	-1.84	-0.85	-3.82	-1.68	-0.55	-5.68	-3.21	-6.72	-3.31
Exports	-0.20	-22.84	-18.70	-24.48	-21.85	-27.99	-25.11	-22.66	-27.59	-18.11
Imports	-5.88	-25.78	-19.55	-22.96	-22.67	-20.33	-24.88	-21.68	-27.54	-20.97
Domestic demand	1.20	0.91	0.61	-1.50	1.22	1.76	-2.11	0.41	-3.84	0.69
Rate of return	-4.30	-3.98	-4.18	-5.94	-4.69	-4.68	-5.00	-5.36	-6.67	-4.47
Real wages	0.58	-4.56	-2.90	-9.75	-4.65	-2.31	-8.33	-7.89	-11.45	-5.12
Foreign capital inflows	3.51	0.60	0.12	-12.40	-5.30	-0.21	-8.66	-9.00	-20.69	-5.55
Domestic capital outflow	-7.11	-7.32	-7.47	0.88	-2.42	-7.29	-0.75	-1.93	-0.20	-5.61
Terms of trade	-5.24	1.14	1.09	2.20	-1.70	2.81	-1.26	0.71	0.53	-2.12
Real exchange rate	-1.39	-0.12	-0.31	-4.73	-1.28	4.72	-1.10	-2.35	-3.30	-0.69

Bilateral trade flows (% change)

rows = exporter; columns = importer

	AUS	*CHN*	*JPN*	*KOR*	*CAN*	*USA*	*MEX*	*EU*	*ASEAN*	*REST*
AUS	-	-3.28	-0.41	-4.22	0.05	3.84	0.18	3.30	-1.94	3.17
CHN	-3.60	-	-28.66	-29.91	-19.25	-22.78	-18.00	-22.72	-28.35	-20.73
JPN	3.84	-27.88	-	-25.78	-6.68	-15.30	-11.01	-13.70	-22.23	-14.99
KOR	-2.12	-35.51	-28.85	-	-12.22	-18.82	-16.49	-19.74	-31.42	-19.23
CAN	-5.47	-22.33	-9.82	-15.06	-	-24.47	-22.75	-16.51	-20.69	-17.24
USA	-13.43	-35.71	-26.48	-30.96	-27.42	-	-29.80	-26.33	-34.36	-27.09
MEX	-4.03	-21.24	-26.47	-21.20	-23.24	-26.42	-	-20.93	-23.63	-21.79
EU	-6.82	-31.50	-22.26	-25.11	-14.16	-19.15	-22.03	-23.92	-22.22	-20.23
ASEAN	-12.97	-36.21	-28.10	-29.71	-17.66	-29.11	-28.52	-18.93	-36.64	-22.96
REST	-0.53	-19.51	-9.77	-16.67	-20.52	-16.13	-14.55	-16.27	-24.89	-21.52

Global 15% tariff increase without RCEP

Global changes (% change)

GDP	-2.07
Exports	-16.20
Capital stock	-3.60
Rate of return	-3.40

Key indicators (% change)

	AUS	*CHN*	*JPN*	*KOR*	*CAN*	*USA*	*MEX*	*EU*	*ASEAN*	*REST*
Real GDP	0.72	-0.13	0.46	0.04	-2.64	-0.64	-7.02	-4.50	0.14	-2.77
Real GNP	-0.13	-0.45	-0.25	-0.49	-2.13	-1.08	-5.96	-3.81	-0.73	-2.67
Real GDA adjusted	-0.36	-0.99	-0.46	-1.00	-2.32	-0.69	-5.65	-3.60	-1.37	-2.84
Primary output	-2.09	-0.29	0.43	0.13	-2.19	-0.30	-1.31	-0.04	-0.29	-1.82
Manufacturing output	3.34	0.63	1.58	1.43	-5.15	-0.34	-8.95	-7.43	0.74	-1.87
Service output	0.67	-0.14	0.33	-0.39	-1.60	-0.49	-6.13	-3.21	0.18	-2.58
Exports	1.40	-2.54	1.11	0.79	-22.39	-26.96	-25.89	-23.17	0.46	-16.19
Imports	-1.01	-5.36	-2.35	-1.84	-22.42	-18.62	-25.76	-21.61	-1.50	-17.45
Domestic demand	1.05	0.59	0.77	0.81	0.92	1.43	-2.77	-0.03	0.55	0.61
Rate of return	-2.97	-1.33	-2.14	-1.65	-3.87	-3.68	-4.55	-4.66	-1.93	-3.57
Real wages	0.70	-0.09	0.46	-0.04	-4.93	-2.45	-8.91	-8.24	0.17	-4.41
Foreign capital inflows	4.24	6.80	5.31	6.18	-5.98	-0.81	-11.05	-10.70	4.51	-4.98
Domestic capital outflow	-4.67	-9.93	-6.92	-6.18	-1.37	-5.71	1.12	0.73	-4.62	-4.79
Terms of trade	-1.74	-2.20	-1.30	-1.18	-0.87	3.72	-1.07	0.86	-1.37	-0.46
Real exchange rate	0.33	-1.24	-0.56	-0.92	-1.35	4.28	-1.96	-2.91	-0.86	0.16

Bilateral trade flows (% change)

rows = exporter; columns = importer

	AUS	*CHN*	*JPN*	*KOR*	*CAN*	*USA*	*MEX*	*EU*	*ASEAN*	*REST*
AUS	-	3.07	2.53	5.03	-7.15	-4.95	-10.41	-3.70	8.59	-1.14
CHN	13.42	-	8.97	10.05	-3.41	-10.13	-3.77	-7.00	9.35	-2.75
JPN	13.42	9.16	-	9.51	3.00	-7.76	-4.50	-2.83	8.61	-4.87
KOR	11.92	8.14	7.06	-	0.92	-7.49	-3.47	-5.85	7.97	-2.58
CAN	-9.02	-8.53	-2.76	-4.59	-	-26.66	-27.30	-18.83	-6.83	-17.88
USA	-18.07	-21.65	-17.92	-20.13	-29.24	-	-33.46	-27.79	-22.32	-28.53
MEX	-7.07	-7.83	-9.81	-5.71	-24.10	-28.48	-	-20.22	-9.44	-21.55
EU	-10.95	-16.32	-11.68	-12.93	-15.50	-21.86	-26.26	-25.59	-11.20	-21.46
ASEAN	8.97	6.37	6.15	5.45	0.00	-10.11	-5.32	-3.61	7.03	-4.11
REST	-3.26	-8.28	-3.84	-3.76	-23.25	-19.29	-19.76	-18.06	-7.27	-21.35

Global 15% tariff increase without RCEP and RCEP reduces NTBs and BTS

Global changes (% change)

GDP	-1.92
Exports	-15.30
Capital stock	-3.29
Rate of return	-3.10

Key indicators (% change)

	AUS	*CHN*	*JPN*	*KOR*	*CAN*	*USA*	*MEX*	*EU*	*ASEAN*	*REST*
Real GDP	1.48	0.70	1.52	0.80	-2.66	-0.65	-7.14	-4.53	3.65	-2.61
Real GNP	0.58	0.38	0.67	0.26	-2.11	-1.03	-5.97	-3.79	1.91	-2.48
Real GDA adjusted	0.34	-0.23	0.38	-0.32	-2.28	-0.62	-5.70	-3.56	1.19	-2.61
Primary output	-1.77	-0.23	-0.16	0.29	-2.15	-0.25	-1.19	0.03	-0.15	-1.77
Manufacturing output	3.57	0.90	2.22	2.13	-5.48	-0.65	-9.23	-7.74	4.27	-2.05
Service output	0.97	0.05	0.74	-0.22	-1.57	-0.45	-6.24	-3.16	2.28	-2.44
Exports	3.75	-0.06	6.28	2.16	-22.48	-26.82	-26.05	-23.29	6.58	-15.95
Imports	1.45	-2.73	1.93	-0.52	-22.38	-18.21	-25.97	-21.60	3.81	-17.06
Domestic demand	1.09	0.59	0.85	1.00	0.85	1.36	-2.93	-0.11	2.01	0.59
Rate of return	-2.57	-0.85	-1.53	-1.26	-3.66	-3.42	-4.43	-4.47	-1.00	-3.39
Real wages	1.45	0.71	1.42	0.64	-4.95	-2.46	-9.02	-8.27	3.42	-4.22
Foreign capital inflows	4.95	7.30	7.33	6.75	-6.19	-0.96	-11.65	-11.05	12.29	-4.96
Domestic capital outflow	-4.43	-10.04	-7.20	-5.90	-1.13	-5.28	1.60	1.33	-5.87	-4.66
Terms of trade	-1.82	-2.42	-2.01	-1.30	-0.76	3.95	-1.05	0.91	-1.57	-0.31
Real exchange rate	0.25	-1.23	-0.96	-0.88	-1.35	4.27	-2.13	-2.95	0.22	0.23

Bilateral trade flows (% change)

rows = exporter; columns = importer

	AUS	*CHN*	*JPN*	*KOR*	*CAN*	*USA*	*MEX*	*EU*	*ASEAN*	*REST*
AUS	-	5.16	6.22	7.12	-5.85	-3.52	-9.35	-2.18	13.23	0.45
CHN	16.04	-	17.50	11.20	-1.55	-8.94	-2.77	-5.29	14.26	-0.77
JPN	16.99	16.94	-	13.52	7.60	-3.90	-0.40	1.64	16.28	-1.31
KOR	12.85	10.03	12.95	-	1.79	-7.24	-3.85	-5.14	11.51	-2.38
CAN	-4.67	-5.51	-1.67	-4.17	-	-27.11	-28.12	-19.29	-2.63	-18.08
USA	-17.38	-20.57	-14.32	-20.00	-29.63	-	-34.15	-28.12	-19.78	-28.90
MEX	-6.37	-5.92	-6.48	-5.32	-24.21	-28.85	-	-20.20	-6.23	-21.52
EU	-10.45	-14.33	-8.85	-12.77	-15.72	-22.32	-27.00	-25.92	-7.76	-21.77
ASEAN	16.16	15.15	13.97	9.46	3.14	-5.31	0.57	-0.50	18.47	-1.02
REST	-1.04	-7.58	-2.18	-3.10	-23.47	-19.46	-20.26	-18.22	-4.67	-21.41

Global 15% tariff increase without RCEP and RCEP eliminates tariffs and reduces NTBs and BTS

Global changes (% change)

GDP	-1.64
Exports	-13.17
Capital stock	-2.88
Rate of return	-2.73

Key indicators (% change)

	AUS	*CHN*	*JPN*	*KOR*	*CAN*	*USA*	*MEX*	*EU*	*ASEAN*	*REST*
Real GDP	2.11	1.40	1.97	3.99	-2.66	-0.63	-7.23	-4.52	5.69	-2.39
Real GNP	1.00	1.04	1.12	2.87	-2.06	-0.97	-5.93	-3.72	3.37	-2.22
Real GDA adjusted	0.92	0.06	0.95	1.63	-2.15	-0.50	-5.68	-3.42	2.21	-2.31
Primary output	2.95	-0.43	-11.94	-1.21	-1.20	0.26	-0.63	0.34	0.13	-1.59
Manufacturing output	3.36	1.27	2.89	7.51	-5.81	-0.93	-9.54	-7.86	7.63	-2.34
Service output	1.59	0.53	1.02	1.63	-1.56	-0.42	-6.33	-3.12	3.84	-2.18
Exports	7.80	8.69	11.39	13.33	-22.52	-26.35	-26.22	-23.26	13.76	-14.98
Imports	6.18	5.81	7.62	8.49	-22.08	-17.43	-26.13	-21.27	9.84	-15.74
Domestic demand	1.35	0.10	0.70	2.80	0.82	1.29	-3.06	-0.16	2.68	0.46
Rate of return	-2.07	-0.14	-1.08	0.33	-3.41	-3.14	-4.28	-4.25	0.00	-3.13
Real wages	2.52	2.10	2.27	7.27	-4.99	-2.49	-9.15	-8.30	6.32	-3.82
Foreign capital inflows	6.88	9.14	8.08	16.49	-6.35	-1.05	-12.26	-11.30	17.81	-4.85
Domestic capital outflow	-4.48	-10.65	-6.64	-9.13	-0.84	-4.81	2.11	1.99	-6.12	-4.44
Terms of trade	-1.32	-3.68	-1.27	-2.39	-0.37	4.39	-0.95	1.11	-2.28	-0.02
Real exchange rate	0.09	-2.12	-0.39	1.03	-1.11	4.35	-2.22	-2.77	0.05	0.02

Bilateral trade flows (% change)

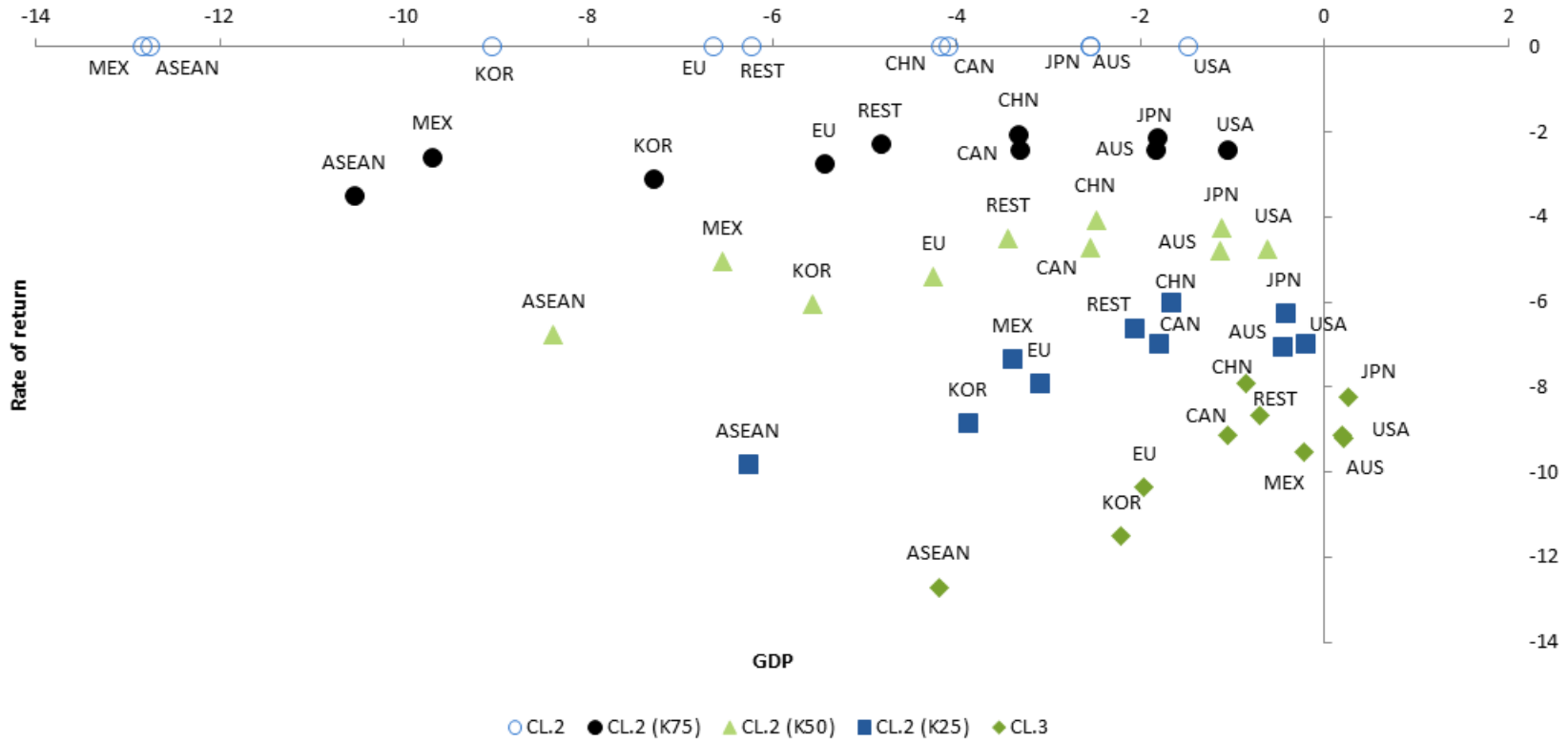
rows = exporter; columns = importer

	AUS	*CHN*	*JPN*	*KOR*	*CAN*	*USA*	*MEX*	*EU*	*ASEAN*	*REST*
AUS	0	11.77	10.82	19.18	-4.50	-2.40	-8.93	-1.08	15.46	0.91
CHN	34.47	0	30.17	28.99	6.03	-2.90	4.02	2.67	24.58	7.14
JPN	33.64	39.16	0	24.28	4.79	-7.23	-4.68	-0.72	24.49	-4.28
KOR	48.72	34.44	38.35	0	5.93	-4.84	-3.04	-2.59	25.33	1.28
CAN	-6.84	-4.41	18.37	2.67	0	-28.12	-30.15	-20.09	0.12	-18.08
USA	-26.24	-13.72	-10.18	-12.54	-30.14	0	-35.17	-28.37	-18.13	-29.65
MEX	-6.61	1.85	9.06	0.75	-24.49	-29.53	0	-19.82	-2.81	-22.52
EU	-6.53	-0.12	-4.83	-3.43	-16.49	-23.59	-28.57	-26.55	-5.40	-22.71
ASEAN	15.06	18.02	20.84	14.89	9.70	0.36	10.41	6.08	26.90	10.17
REST	-0.89	-6.06	-2.53	2.42	-23.06	-19.08	-20.19	-17.69	-0.70	-20.69

Appendix 4: Effects of closure on changes in real GDP

Figure A.2 **Effect of closures, all countries — simulation G1**

Percentage change



[a] This figure shows all results that correspond to those shown in figure 1 in the closure choice section of the Technical report.

Data source: Commission estimates generated using the PC Global model.

References

ABS (Australian Bureau of Statistics) 2012, *Household Expenditure Survey and Survey of Income and Housing*, Cat. no. 6503.0, ABS, Canberra.

Aguiar, A., Narayanan, B. and McDougall, R. 2016, 'An overview of the GTAP 9 data base', *Journal of Global Economic Analysis*, vol. 1, no. 1, pp. 181–208.

Auerbach, A. and Holtz-Eakin, D. 2016, *The Role of Border Adjustments in International Taxation*, American Action Forum, Washington.

Ciuriak, D. and Xiao, J. 2017, *Aftershocks: Quantifying the Economic Impacts of a US Border Adjustment Tax*, Working Paper, C.D. Howe Institute, Toronto.

Dixon, J. 2017, 'The impact on Australia of Trump's 45 per cent tariff on Chinese imports', *Economic Papers*, vol. Online Early View.

Fontagné, L., Mitaritonna, C. and Signoret, J. 2016, *Estimated Tariff Equivalents of Services NTMs*, Working Paper, CEPII, Paris.

Francois, J., McDonald, B. and Nordstrom, N. 1996, *Liberalization and Capital Accumulation in the GTAP Model*, GTAP Technical Paper No. 7, Centre for Global Trade Analysis, Purdue University, Indiana.

Gouel, C., Guimbard, H. and Laborde, D. 2012, *A Foreign Direct Investment Database for Global CGE Models*, Working Paper No. 2012-08, CEPII, Paris.

Ianchovichina, E. and Walmsley, T. 2012, *Dynamic Modeling and Applications for Global Economic Analysis*, Cambridge University Press, New York.

Iapadre, P. and Pace, G. 2016, 'Trade intermediaries and the tariff pass-through', *Journal of Industry, Competition and Trade*, vol. 16, no. 4, pp. 441–54.

IMF (International Monetary Fund) 2015, *Balance of Payments and International Investment Position Statistics*, http://www.imf.org/external/np/sta/bop/bop.htm (accessed 6 June 2017).

Kawasaki, K. 2014, *The Relative Significance of EPAs in Asia-Pacific*, Discussion Paper Series 14-E-009, Research Institute of Economy, Trade and Industry, Tokyo.

—— 2017, *Emergent Uncertainty in Regional Integration — Economic Impacts of Alternative RTA Scenarios*, GRIPS Discussion Paper 16-28, National Graduate Institute for Policy Studies, Tokyo.

Kee, H.L., Nicita, A. and Olarreaga, M. 2009, 'Estimating trade restrictiveness indices', *The Economic Journal*, vol. 119, no. 534, pp. 172–99.

Mankiw, N.G. 2008, *Principles of Microeconomics*, Cengage Learning, Stamford, CT.

McDougall, R. 2003, *A New Regional Household Demand System for GTAP*, GTAP Technical Paper No. 20, Centre for Global Trade Analysis, Purdue University, Indiana.

McKibbin, W. and Stoekel, A. 2009, *The Potential Impact of the Global Financial Crisis on World Trade*, Policy Research Working Paper No. 5134, The World Bank, Washington.

Murray, T. and Salerian, J. 2016, 'Unifying partial and general equilibrium modelling for applied policy analysis', Mimeo, submitted for publication.

OECD (Organisation for Economic Co-operation and Development) 2010, *Trade and Economic Effects of Responses to the Economic Crisis*, OECD Publishing, Paris.

PC and NZPC (Australian Productivity Commission and New Zealand Productivity Commission) 2012, *Strengthening trans-Tasman Economic Relations*, Joint Study, Final Report, November.

Petri, P. and Plummer, M. 2016, *The Economic Effects of the Trans-Pacific Partnership: New Estimates*, Working Paper 16-2, Peterson Institute for International Economics, Washington.

The Economist 2015, 'Capital flight from China', *The Economist*, 17 September, https://www.economist.com/news/finance-and-economics/21665042-lots-money-escaping-chinas-porous-capital-controls-flow-dynamics (accessed 5 July 2017).

UN (United Nations) 2017, *UN Comtrade Database*, http://comtrade.un.org/ (accessed 4 July 2017).

WTO (World Trade Organization) 2017, *World Trade Organization Tariff Analysis Online Facility*, https://tao.wto.org/ (accessed 5 July 2017).

Zhang, X. 2013, *A Simple Structure for CGE Models*, Paper presented at the 16th Annual Conference on Global Economic Analysis, Shanghai, China, https://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=4157 (accessed 5 July 2017).

—— 2015, *Incorporating Household Survey Data into a CGE Model*, Conference Paper, Productivity Commission, Canberra, http://www.pc.gov.au/research/supporting/household-data-cge-model (accessed 5 July 2017).