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Macroeconomic Impacts of Global Demographic Change on Australia

Weifeng Liu and Warwick McKibbin

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Abstract

The world will experience dramatic demographic change over this century. This paper examines the impacts of this global demographic change on the Australian economy at both the aggregate and sectoral levels in a global multi-region and multi-sector general equilibrium model. Using a detailed structural model, we simulate demographic shocks of six regions in the world economy as well as Australian own demographic shock to investigate their impacts on Australian macroeconomic conditions, economic structure and trade patterns. The results suggest that demographic change in different regions of the world economy will have different impacts on sectors in Australia depending on trade patterns between Australia and other regions and also between other regions. The energy, mining and durable manufacturing sectors in Australia are the most affected. Demographic change in China, Japan and Korea has significant negative impacts on Australia, but partly offsetting these shocks are positive demographic shocks from emerging Asia. The overall impact of the rest of the world on Australian GDP is quantitatively negligible, but the impacts on the real interest rate and trade balances are significant. Global demographic change increases Australian real interest rates in the next two decades on the assumption that emerging countries can access global capital markets and take advantage of their demographic dividends.

Keywords: Global demographic change, Australian economy, international trade, international capital flows, DSGE, CGE, heterogeneous agents, G-Cubed

JEL Codes: C63, C68, F32, F41, E21, J11

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1. Introduction

The issue of population ageing in Australia has been the focus of much debate and policy discussion. Yet the phenomenon of population ageing is a global issue, many countries will experience far more ageing than Australia. As argued in McKibbin (2006), the Australian experience should be analysed in a global framework since the demographic adjustment in the global economy is large. The elderly dependency ratios (the ratio of population over 65 to population over 15-64) have been increasing and are forecast to increase more rapidly in the next several decades (Figure 1a). The youth dependency ratios (the ratio of population under 15 to population over 15-64) have been decreasing and are forecast to decrease further (Figure 1b). The growth of the global working-age population (aged over 15-64) has been decreasing, but the size will continue to increase until 2050, mainly contributed by Africa and emerging Asia. Japan, Korea and Europe have been experiencing negative growth in working-age population (Figure 1c). The heterogeneity in demographic change across regions and countries will significantly change the geographic distribution of the world population. The total population in developed economies is forecast to be stable in the next several decades while developing countries are forecast to witness strong growth except for China (Figure 1d). In this global context, Australian demographic trends lie between developed and developing regions. The Australian population is still young due to its migration policy. The elderly dependency ratio is slightly above 0.2 and is forecast to increase slowly this century.

This global demographic change will likely significantly shape the world economy in many dimensions. As a small open economy, Australia will inevitably be affected by the world demographic change overlaying the domestic demographic transition. In particular, Asia is forecast to experience significant demographic change, particularly the Asian economies that are Australia's major trading partners. Australia's top three trading partners Japan, Korea and China have all been ageing and are forecast to age more rapidly in the next several decades. In contrast, Southeast Asian economies are relatively young, except Thailand and Vietnam, and South Asia is even younger.

There is a large literature examining domestic impacts of demographic change in ageing pioneer countries such as Japan and Europe, or other major economies, including the United States and China. In contrast, there is much less literature examining the international aspects of demographic change and this strand of the literature also focuses on major economies in the world (see Liu and McKibbin 2020 for a review). There are fewer studies on Australian

demographic change. The Productivity Commission (1999) provides a collection of studies on the policy implications of Australia's population ageing, where several studies focus on fiscal and macroeconomic impacts. Guest and McDonald (2001, 2002) and Guest (2006) examine the impacts of Australian population ageing on saving and consumption in a Ramsey model. Kulish et al. (2010) examine the macroeconomic effects of Australian demographic change in an overlapping-generation (OLG) model of a closed economy. Kudrna et al. (2011a, 2011b, 2015, 2019) focus on the fiscal impacts of Australian demographic change and pension reforms in a small open economy OLG model. The Productivity Commission (2013) and Australian Government (2015) estimate the fiscal impacts of demographic change, but these studies are not based on macroeconomic models and thus do not take account of behavioural responses to population ageing. Neither studies examine the impacts of Australian demographic change on Australia's economic structure and bilateral trade, nor studies examine the impacts of global demographic change on Australia. Tyers and Shi (2007) use a multi-country-multi-sector dynamic GTAP model with Australia as one of the countries to examine the impacts of global demographic change, but they focus on the impacts on major economies rather than Australia. Both domestic and global demographic changes are likely to have important impacts on Australian macroeconomic conditions, economic structures and trade patterns because of Australia's high trade dependence and integration into the world capital markets.

This paper investigates the potential impacts of domestic and global demographic change in the next several decades on Australia's macroeconomic conditions, economic structure, trade patterns, and external balances. The paper draws on the global model developed by Liu and McKibbin (2020) who examine the macroeconomic impacts of global demographic change on major economies including the US, Japan, Europe, China, emerging Asia and Africa. This paper focuses on the impacts of global demographic change on Australia, not only on the macroeconomic variables but also on sector adjustments and bilateral trade. We decompose the global shock into seven regional shocks and investigate the impacts of each regional shock on Australia.

The remainder of this paper is structured as follows. Section 2 provides a brief overview of the Australian economy focusing on its economic structure, trade patterns and external balances. Section 3 introduces the model and the approach of incorporating life cycle features. Section 4 presents the baseline scenario without demographic change around the world. Section 5 presents the results of various demographic shocks. Section 6 concludes.

2. A Brief Overview of the Australian Economy

Australia is a small open economy, with its population accounting for 0.3% of the global population and its GDP 1.5% of global GDP in 2015. Table 1 presents the structure of the Australian economy based on the 2014 Australian input-output table sourced from GTAP 10 database (Aguiar et al. 2019). We aggregate the data in this table to be consistent with the level of aggregation in the model used for this study. Column 1 lists six sectors: energy, mining, agriculture, durable Manufacturing, non-durable manufacturing and services, represented by numbers 1-6 respectively in the table. Column 2 is the share of gross output by sector. Australia's services output overwhelmingly dominates other sectors, with a share of 68.9%. Manufacturing output accounts for 15.8%, and primary sector output (energy, mining and agriculture) accounts for 15.3%. Columns 3-7 present the shares of different uses of gross output by sector. For example, in the energy sector, 59.5% of gross output is used for intermediate input into other sectors, and 15.3% is consumed by households. 41.7% of energy output is exported while 16.9% is imported. The agriculture and durable manufacturing sectors have similar export shares of their gross outputs, with 31.0% and 27.2% respectively. The mining sector has a high export share of 64.2%, which is one of the most notable features of the Australian economy. On the other hand, manufacturing sectors import significantly, with an import share of 73.2% and 30.2% for durable and non-durable manufacturing sectors respectively. Australia also imports a moderate share of its energy use (16.9%) and a small share of its agricultural products (6.0%).

Table 1 Australian Input-Output Table (2014)

1	2	3	4	5	6	7
Sector	Gross Output Share (%)	Output Use Share (%)				
		Intermediate Use	Consumption	Investment	Export	Import
Energy	7.6	59.9	15.3	0.0	41.7	16.9
Mining	4.9	34.3	0.0	2.2	64.2	0.6
Agriculture	2.8	63.5	9.5	2.1	31.0	6.0
Durable Manufacturing	7.4	70.8	26.2	49.0	27.2	73.2
Non-Durable Manufacturing	8.4	60.9	52.2	1.8	15.3	30.2
Services	68.9	42.1	53.6	4.4	2.9	3.0

Australia has close trading relationships with many countries in the world, particularly with Asian economies. Exports from Australia account for 1.5% of global exports in 2015, which is a ranking of 20th in the world. In 2015, Australian exports expressed as a per cent of GDP were 17% and imports were 18.4%. Table 2 presents the share of trade value between Australia and each country or region in Australia's total trade value in 2015. This set of countries and regions are consistent with the country profile in the model used in this paper except that South Asia and Southeast Asia are further disaggregated in the model. We present the trade data in 2015 because it is the base year in our model. Asia is Australia's most important trading partner, accounts for more than 60% of trade with Australia. China, Japan and Korea are the three largest trading partners in Asia, and South Asia and Southeast Asia combined contribute 20.5% of trade with Australia.

Table 2 Australia's Trade Shares (2015)

Regions	Region Codes	Trade Shares (%)
China	CHI	23.9
Western Europe	EUW	15.9
Japan	JPN	11.0
United States	USA	10.6
South Asia	SOA	10.8
Southeast Asia	SEA	9.6
Korea	KOR	5.9
Canada and New Zealand	OEC	4.6
Middle East and North Africa	MEN	2.8
Eastern Europe and Central Asia	ROW	1.9
Latin America	LAM	1.7
Sub-Sahara Africa	AFR	1.3

Source: The United Nations Comtrade Database and Authors' Calculations.

Table 3 contains Australia's trade structure by sector. Column 2 is the share of Australian exports in total world exports by sector. For example, Australian mining exports account for 23.9% of total world mining exports. Column 3 is the share of each sector exports in total Australian exports. Exports are relatively equal across the energy, mining, durable manufacturing, and services sectors which account for about 20% each. Non-durable manufacturing is 12% and agriculture is 8%. Imports are concentrated in manufacturing goods (durable and non-durable) with a share of 70%, followed by services with 17.5%, energy with 9.3%. Agriculture and mining imports are very small. Column 4 shows the three largest

destination of Australian exports by sector. Column 5 shows the share of exports to each export partner in Australia's total exports by sector. Columns 6-9 read similarly but for imports. Columns 4 and 8 show Australia's major trading partners by sector. Most country codes are presented in Table 2 except two additional codes: OAS represents South Asia excluding India, and INO represents Indonesia.

Table 3 Australia's Major Trading Partners By Sector (2015)

1	2	3	4	5	6	7	8	9
Sectors	World Export Share (%)	Sector Export Share (%)	Export Partners	Partner Export Share (%)	World Import Share (%)	Sector Import Share (%)	Import Partners	Partner Import Share (%)
Energy	3.9	20.2	JPN	50.2	1.9	9.3	OAS	19.4
			CHI	13.0			KOR	19.2
			KOR	10.4			JPN	10.7
Mining	23.9	21.7	CHI	72.9	0.4	0.4	LAM	50.9
			JPN	12.4			USA	12.4
			KOR	8.6			OEC	12.1
Agriculture	3.1	8.2	CHI	32.6	1.2	2.9	CHI	40.7
			INO	9.3			OEC	10.6
			MEN	8.6			EUW	10.4
Durable Manufacturing	0.7	17.9	CHI	27.1	2.0	46.8	CHI	22.0
			USA	10.9			EUW	20.0
			OAS	10.7			USA	14.8
Non-Durable Manufacturing	0.9	12.0	USA	18.1	1.8	23.1	EUW	26.5
			CHI	12.3			CHI	26.2
			OEC	11.6			USA	11.4
Services	1.7	20.0	EUW	26.3	1.6	17.5	EUW	33.2
			USA	16.9			USA	18.4
			OAS	11.1			OAS	12.0

Source: The United Nations Comtrade Database and Authors' Calculations.

In terms of external balances, Australia has run current account deficits for most of its history, with an average of -4.2% of GDP over 1990-2018 (Figure 2). These current account deficits reflect a large number of investment opportunities in Australia relative to the level of national savings.

3. The Hybrid DSGE/CGE Global Model

For this paper, we use a global intertemporal general equilibrium model with heterogeneous agents developed in Liu and McKibbin (2020). This model is a hybrid of dynamic stochastic general equilibrium (DSGE) models and computable general equilibrium (CGE) models. We follow the approach in the G-Cubed model (McKibbin and Wilcoxen 1999, 2013) and make

two contributions to the further development of the G-Cubed model. We model a different set of countries to the original G-Cubed model and incorporate demographic characteristics into the model.

(a) The G-Cubed Model

This model used in this paper divides the world economy into eighteen countries and regions (hereafter regions) with six sectors in each region. Table 3 presents all sectors in the model. The model is based on the input-output tables in the GTAP database (Aguiar et al. 2016) and therefore differentiates sectors of production. Each sector in each country has different capital-labour ratios.

Table 3 Model Sectors

Sector Numbers	Sectors
1	Energy
2	Mining
3	Agriculture
4	Durable Manufacturing
5	Non-Durable Manufacturing
6	Services

Table 4 presents all regions in the model. We aggregate all countries into eighteen regions with a detailed disaggregation of Asia. The aggregation of regions is detailed in Appendix A.

Table 4 Model Regions

Region Codes	Regions
USA	United States
JPN	Japan
EUW	Western Europe
AUS	Australia
KOR	Korea
OEC	Rest of Advanced Economies (Canada and New Zealand)
CHI	China
IND	India
INO	Indonesia
PHL	Philippines
VNM	Vietnam
THA	Thailand
MYS	Malaysia
OAS	Other Asia (mainly South Asia excluding India)

LAM	Latin America
AFR	Sub-Sahara Africa
MEN	Middle East and North Africa
ROW	Rest of World (mainly Eastern Europe and Central Asia)

The approach to developing a G-Cubed model is outlined in McKibbin and Wilcoxen (1998, 2013). Several key features of the standard G-Cubed model are worth highlighting here.

First, the model completely accounts for stocks and flows of physical and financial assets. For example, budget deficits accumulate into government debt, and current account deficits accumulate into foreign debt. The model imposes an intertemporal budget constraint on all households, firms, government, and countries. Thus, a long-run stock equilibrium obtains through the adjustment of asset prices, such as the interest rate for government fiscal positions or real exchange rates for the balance of payments. However, the adjustment towards the long-run equilibrium of each economy can be slow, occurring over much of a century.

Second, agents in G-Cubed must use money issued by central banks for all transactions. Thus, central banks in the model set short term nominal interest rates to target macroeconomic outcomes (such as inflation, unemployment, exchange rates, etc.) based on Henderson-McKibbin-Taylor monetary rules. These rules approximate actual monetary regimes in each country or region in the model. These monetary rules tie down the long-run inflation rates in each country as well as allowing short term adjustment of policy to smooth fluctuations in the real economy.

Third, nominal wages are sticky and adjust over time based on country-specific labour contracting assumptions. Firms hire labour in each sector up to the points that the marginal product of labour equals the real wage defined in terms of the output price level of that sector. Any excess labour enters the unemployed pool of workers. Unemployment or the presence of excess demand for labour causes the nominal wage to adjust to clear the labour market in the long run. In the short-run unemployment can arise due to structural supply shocks or changes in aggregate demand in the economy.

Fourth, rigidities prevent the economy from moving quickly from one equilibrium to another. These rigidities include nominal stickiness caused by wage rigidities, a lack of complete foresight in the formation of expectations, cost of adjustment in investment by firms with physical capital being sector-specific in the short run, monetary and fiscal authorities following particular monetary and fiscal rules. Short term adjustment to economic shocks can be very

different from the long-run equilibrium outcomes. The focus on short-run rigidities is important for assessing the impact over the initial decades of demographic change.

Fifth, the model incorporates heterogeneous households and firms. Firms are modelled separately within each sector. There is a mixture of two types of consumers and two types of firms within each sector, within each country. One group bases their decisions on forward-looking expectations and the other group follows simpler rules of thumb which are optimal in the long run, but not necessarily in the short run.

(b) Adding Demographics

We introduce demographics into our model following the approach of Blanchard (1985). The approach assumes all households, regardless of their ages, are faced with a constant probability of death p. When households make decisions on their lifetime consumption profile, they consider the uncertainty of their life spans and thus discount their planned future consumption by the probability of death. Households are assumed to insure against the risk of death in a competitive insurance market such that they receive a rate p of their wealth each period if they survive but leave all wealth to the insurance company if they die. This arrangement changes households' budget constraint by adding a rate p to the return from their holdings of financial wealth.

In addition to the probability of death, we further introduce age-dependent productivity for households based on their age-earnings profile following the approach of Faruqee (2002). The approach assumes that household age-earnings profile follows a certain function generating a hump-shaped profile, and we then truncate the productivity profile at age 65, assuming households retire at age 65 (Figure 3). Due to lack of age-earnings data, we assume the same age-earning profile for all countries in this paper. Future work will focus on extending this to actual data for all countries.

Using the United National population projections, we calculate the change in effective labour supply over time as follows: (1) Borrow individual age-earnings profile parameters for Japan and apply the set of parameter values to all regions in the model; (2) Aggregate individual productivity over all cohorts based on the United Nations population projections (referred to as total effective labor supply); (3) Produce sector-wise labor-augmenting technological progress (referred to as sectoral productivity) over time based on a catchup model, as illustrated in Section 4; (4) Combine total effective labor supply with sectoral productivity.

4. Baseline Scenario

There can be many different demographic change scenarios depending on assumptions about future growth and demographic change. As in Liu and McKibbin (2020), we start by choosing a scenario (the baseline scenario) against which we can compare the alternatives. We choose a simple and intuitive baseline by assuming that population sizes and structures do not change from 2015 onwards.

We first solve the model from 2016 to 2100 with 2015 as the base year. The key inputs into the baseline are the initial dynamics from 2015 to 2016 and subsequent projections from 2016 onwards for sectoral productivity (or technological) growth rates by sector and by country. The sectoral productivity projections follow the approach of Barro (1991, 2015). Over long periods, Barro estimates that the average catchup rate of individual countries to the worldwide productivity frontier is 2% per year. We use the Groningen Growth and Development database (2018) to estimate the initial productivity level in each sector of each region in the model, and then take the ratio of the initial productivity relative to the equivalent sector in the United States, which we assume is the frontier. Given this initial gap in sectoral productivity, we use the Barro catchup model to generate long-term projections of the productivity growth rate of each sector within each country. Where we expect that regions will catch up more quickly to the frontier due to economic reforms (e.g., China) or more slowly to the frontier due to institutional rigidities (e.g., Russia), we vary the catchup rate over time. The calibration of the catchup rate attempts to replicate recent growth experiences of each country and region in the model. The sectoral productivity growth is the exogenous drivers of sector growth for each country. The growth in the capital stock in each sector of each region is determined endogenously within the model.

Based on these assumptions, we produce a baseline for all economies. Figure 4 presents GDP in 2015 and 2050 for all economies in the baseline. There are significant changes from 2015 to 2050 in both absolute and relative terms. These changes in the baseline are independent of demographic change as we freeze demographics from 2015 onwards. The changes are driven by sectoral productivity growth over time and endogenous capital accumulation. As the technology frontier of the world, the US productivity is assumed to grow at a constant rate into the future, and other economies close their gaps at the sector level with the United States based on the catchup model. As emerging economies have low initial technology levels relative to the United States, they enjoy fast technological progress and hence fast economic growth. This

productivity catchup alone will significantly change the landscape of the world economy this century. This baseline scenario is identical to the baseline scenario in Liu and McKibbin (2020).

Australian GDP grows steadily at an average rate of 1.3% over 2015-2050. As Australia's initial labour productivity is higher than the US in energy, mining, agriculture and services sectors, Australian GDP growth rates are lower than the US economic growth at an average rate of 1.4% over 2015-2050.

As the initial labour productivity differs across sectors in all regions except the US, the growth rate is also different across sectors in all economies including Australia, leading to economic structural change. In addition, the structural change can also be driven by different external demand by sector because of the structural change in foreign economies. In Australia, the initial labour productivity is high (relative to the United States) in energy and services sectors, followed by agriculture and mining. It is relatively low in the manufacturing sectors. Given this initial productivity relative to the United States, energy and services sectors tend to have low growth rates while manufacturing sectors tend to have high growth rates as they catch up to the US sectors. On the external side, China's continuing strong demand for mining products further pushes Australia's mining growth.

5. Demographic Impacts

This section first introduces the demographic shocks and presents the impacts of these shocks on Australian output and bilateral trade at the sectoral level. We then presents the results of demographic shocks at the macroeconomic level.

5.1 Demographic Shocks

In the alternative demographic scenarios, we use the United Nations population projections to calculate the change in effective labour supply in the future relative to 2015 based on the Blanchard-Faruqee approach outlined above. We then simulate this change in the effective labour supply as a global demographic shock. Figure 5 presents the total effective labour supply for all regions from 2015 to 2050, where productivity in 2015 is normalized to one. In order to simplify the presentation in Figure 5, we organize the regions into five groups: (1) Ageing developed economies (ADE): JPN, EUW, KOR; (2) Growing developed economies: USA, AUS, OEC; (3) Emerging Asian economies (EAE) (Southeast and South Asia): VNM, OAS, PHL, MYS, IND, INO, THA; (4) Growing Africa and the Middle East: AFR, MEN; (5) Other regions: CHI, LAM, ROW. For simulations, we focus on six regional shocks: ADE, EAE, USA, CHI, LAM, AFR and MEN combined, and run each shock separately to examine how the

demographic change in each region affects the Australian economy. We then combine all regional shocks (the non-Australian shock) to obtain the impact of demographic change in all countries except Australia on the Australian economy. Finally, we examine the impacts of Australia's demographic change on the Australian economy. When all shocks are combined, we have the impacts of global demographic change. Much of the focus is on the demographic shocks in China, ageing developed economies, and emerging Asia economies because China, Japan, Korea, and Europe are Australia's most important trading partners.

5.2 Impacts on Sectoral Output and Bilateral Trade

This section presents the impacts of external demographic shocks on Australia's sector output and bilateral trade with its major trading partners (the three largest export and import partners for each sector, respectively). Given Australia's trade patterns, we will discuss the impacts on exports in all sectors, but only focus on the impacts on imports in energy, manufacturing and services sectors. It is important to stress that in presenting the results in the following discussion, the variables are calculated as percentage change relative to what they would have been in a particular year along the baseline. The results are not calculated as relative to the base year but relative to a path that is changing over time. It is possible, for example, for a variable to decline relative to baseline in 2030 but still be higher than the value in 2016.

(1) Regional Demographic Change

(a) Chinese Demographic Change

As Australia's most important trading partner, China's demographic shock has strong impacts on the Australian economy. As China is ageing, Chinese investment and economic growth fall over time, which brings down China's demand for Australian products in all sectors in both the short and long run. As Chinese investment declines, capital flows out of China, and hence the Chinese Yuan depreciates against all other currencies including the Australian dollar, which further reduces China's imports from Australia. The contraction of China's external demand reduces Australian investment particularly in the mining and durable manufacturing sectors. Australian mining output decreases by 12% relative to what it would otherwise be in 2030 and by 23% by 2050, and durable manufacturing output decreases by 5.5% by 2030 and by 9% by 2050 (Figure 6a). As Australian investment declines, capital flows out of Australia, and Australian dollar depreciates against other currencies (except the Chinese Yuan), which increases Australian exports to other countries (excluding China) in the short run. In the long run, as Chinese output decreases and hence prices increase, other countries substitute their

imports away from China to Australia, which increases Australian exports to other countries (excluding China). The negative impacts of China dominate the positive impacts of other countries in the mining and durable manufacturing sectors. For the energy, agricultural and non-durable manufacturing sectors, China's negative impacts on Australia are offset by other countries' positive impacts, leading to slight increases in the output of those sectors. The overall effects result in lower exports from Australia. Figures 6c-6h show that Australian exports with its major trading partners increase in all sectors while its exports to China all decrease. In particular, Australian services exports increase significantly in the long run, but this does not increase the output of the services sector because only 3% of Australian services output is exported.

As the Australian dollar depreciates, Australia reduces its imports of all goods from other economies, excluding China (Figures 6i-6l). Australia increases its imports of manufacturing goods from China in the short run because the Chinese Yuan depreciates more than the Australian dollar. In the long run, China's investment contraction increases Chinese goods prices, and this dominates the effect of Chinese currency depreciation, which reduces Australian imports from China. As capital flows out of Australia, total Australian imports decrease more than total exports, resulting in trade surpluses (Figure 6b).

(b) Ageing Developed Economies Demographic Change

Among ageing developed economies, Japan, Korea and Europe are the first, third and fifth-largest importer of Australian energy respectively, and they are the second, third and fourth-largest importer of Australian mining products. Europe is also a major importer of Australian agricultural, manufacturing goods and services. The demographic shock in ageing developed economies has notable negative impacts on Australian investment and output in the energy, mining and durable manufacturing sectors (Figure 7a). The outputs of energy, mining and durable manufacturing fall by 5.5%, 8.5% and 5.5% by 2030 respectively, and by 12%, 14% and 8% by 2050 respectively. As Australian investment falls, capital flows out of Australia and the Australian dollar depreciates against currencies in countries other than ageing developed economies. Thus, those countries increase their imports from Australia, particularly in agricultural, manufacturing and services sectors in the short run. In the long run, as investment and output decrease in ageing developed economies, other countries substitute their imports from ageing developed economies to Australia (Figures 7e, 7g and 7h). The overall effects result in decreasing total exports (Figure 7b).

As the Australian dollar appreciates relative to the currencies in ageing developed economies, Australia increases its imports from those economies in the short run. But in the long run, because their outputs decrease and prices increase, Australia reduces its imports from ageing developed economies. On the other hand, Australia reduces its imports from other economies in the short run because the Australian dollar depreciates relative to the currencies in those economies, and also in the long run because Australian investment decreases. As capital flows out of Australia, total Australian imports decrease more than total exports, resulting in trade surpluses (Figure 7b).

(c) Emerging Asia Demographic Change

Emerging Asia also has a close trading relationship with Australia. South Asia and Southeast Asia account for 10.8% and 9.6% of Australia's total trade in 2015, which are close to Japan (11%) and the United States (10.6%). Among emerging Asian economies, India is the fourth-largest market for exports of Australian energy and the fifth-largest importer of Australian mining products, and Indonesia is the second-largest importer of Australian agricultural products.

As most emerging Asian economies have increasing effective labour supply, their investment and economic growth increase significantly. Hence, their external demand for Australian energy, mining and durable manufacturing goods increase in both the short and long run. As emerging Asian investment increases, capital flows in. This capital inflow appreciates their currencies against all other currencies including the Australian dollar, which further increases their imports from Australia in the short run. The increase in external demand of emerging Asian stimulates Australian investment and output in the energy, mining and durable manufacturing sectors. Also, economic growth in emerging Asian increases the demand for energy, mining and manufacturing goods from China, Japan and Korea. The latter countries, in turn, increase the demand for those products from Australia in the long run (Figures 8c, 8d and 8f). In the short run, as Australian investment rises, capital flows into Australia, and Australian dollar appreciates against other currencies (except emerging Asian currencies), so China, Japan and Korea reduce their imports from Australia. Other countries (excluding emerging Asia, China, Japan and Korea) decrease imports from Australia in the short run because of Australian currency appreciation (Figure 8g), and also in the long run because those countries substitute their imports away from Australia to emerging Asia (Figure 8h). The overall effects result in larger exports from Australia (Figure 8b).

As the Australian dollar depreciates against emerging Asian currencies and also emerging Asian output expands, Australia increases its imports from emerging Asia (Figures 8i and 8l). Although the Australian dollar appreciates against other currencies, Australia increases its imports of energy and manufacturing products from those economies because Australian domestic and external demand for energy and manufacturing products increase. As capital flows into Australia, total Australian imports increase more than total exports, resulting in trade deficits (Figure 8b).

(d) US Demographic Change

US demographic change is mild, and thus has small impacts on Australian investment and output. Due to demographic change, the United States increases investment which increases external demand for energy, mining and durable manufacturing products from Australia in both the short and long run (Figure 9f). Capital flows into the United States, and all currencies depreciate against the US dollar, which further increases the US imports of all goods from Australia in the short run (Figures 9f-9h). The Australian dollar depreciates more than the currencies in Japan, China and Korea, so these countries also increase their imports from Australia (Figures 9c-9g). All these responses slightly increase Australian investment and hence output in the energy, mining and durable manufacturing sectors (Figure 9a). With US output expanding, other countries such as Africa and the Middle East (excluding Japan, China and Korea with depreciating currencies) substitutes their agricultural imports away from Australia to the United States (Figure 9e). US imports of non-durable manufacturing goods and services from Australia slightly increases in the short run because the US dollar appreciates, but decreases in the medium and long run because of the increase in US output (Figures 9g-9h).

On the import side, as Australian energy demand increases, Australia increases its energy imports, particularly from South Asia (Figure 9i). Also, Australia reduces its imports of all goods from the United States in the short run because the US dollar appreciates, but increases the imports in the long run because of the increase in US output (Figures 9j-9l). Australian total exports and imports both increase in the medium and long run, but the economy experiences trade surpluses as capital flows out (Figure 9b).

(e) Latin American Demographic Change

Latin America is a major mining exporter competing with Australia in the global mining market. Due to demographic change, Latin American effective labour supply increases slowly until 2040. Australian mining output slightly increases in the short and medium run, but slightly

decreases in the long run (Figure 10a). In the short run, Latin American investment increases, and capital flows into Latin America, appreciating Latin American currencies. The world switches their mining demand from Latin America to Australia (Figure 10d), and thus Australian investment and output in mining increase in the short and medium run. In the long run, Latin America increases the output in all sectors including mining and hence reduces the mining price offsetting the effect of currency appreciation. The world switches their mining demand back from Australia to Latin America (Figure 10d), resulting in lower mining output in Australia. As mining investment increases in Latin America, capital flows out of Australia, depreciating the Australian dollar. This further increases Australian mining exports to Japan, China and Korea in the short run (Figure 10d). Australian currency depreciation also increases exports of all other goods in the short run (Figures 10c-10h). In the long run, Latin America increases imports of energy from all around the world including Australia, increases imports of durable manufacturing goods from Japan, China and Korea, and increase imports of all goods from the US. Japan, China and Korea hence increase their imports of energy and manufacturing goods from Australia for their manufacturing production (Figure 10c). The US also increases its imports of durable manufacturing goods for its production (Figure 10f). In the long run, all countries particularly Europe, substitute their services imports away from Australia (Figure 10h).

In terms of imports, as the Australian dollar depreciates, Australia reduces its imports of all goods in the short run (Figures 10i-10l). In the medium and long run, as Australian production of energy and manufacturing goods increases, Australia increases its energy and manufacturing imports (Figure 10i). Australian total exports increase while total imports decrease in the short and medium run, resulting in trade surpluses as capital flows out. In the long run, Latin American effective labour supply starts to decline after 2040; all the patterns above start to reserve, which can be seen in Figure 10.

The channels through which this demographic change affects Australia are quite different from the above cases of regions which have close trading relationships with Australia. Latin America accounts for only 1.7% of Australia's total trade in 2015, so the impacts of Latin American demographic change on Australia through their direct bilateral trade are very small. The impacts occur mainly through two channels. First, the two regions compete in the world mining market. Second, Latin American demographic change has large impacts on major economies in Asia, and these Asian economies are Australia's major trading partners and their responses to Latin American demographic change affect Australia.

(f) African Demographic Change

Due to demographic change, Africa (and the Middle East) enjoy significant effective labour growth, with a growth rate of more than 150% by 2050 relative to 2015. Although Africa has a much more drastic demographic change than emerging Asia, it has smaller impacts on Australia because Australia has a much weaker trading relationship with Africa.

Africa increases investment significantly, and hence increases its imports of energy, mining and manufacturing products from around the world including Australia. As African investment increases, capital flows into Africa from other countries including Australia. The African Central Bank targets the exchange rate and loosens its monetary policy in response to capital flows. This increases the prices of African goods in the short run and reduces Australian imports from Africa. Australian trade responses with its major trading partners depend on the change of the Australian dollar relative to the currencies in those trading partners. The results suggest that the Australian dollar depreciates relative to the currencies in Europe, China, Korea and emerging Asia. The currency depreciation facilitates Australian exports to Europe and Asia (Figures 11c-11g). But the Australian dollar appreciates against the currencies in the US, Canada and New Zealand, reducing exports to these countries (Figures 11f-11h).

As the Australian dollar depreciates against the Euro and Asian currencies, Australian imports decrease in the short run. But in the long run, as African external demand increases Australian investment, Australia increases its imports of energy and manufacturing products from Europe and Asia. As capital flows out of Australia in the short run and flows into Australia in the long run, Australia first experiences trade surpluses and then trade deficits in the long run.

Similar to Latin America, Africa has a weak trading relationship with Australia, so the impacts of African demographic change on Australia through direct bilateral trade are also small. The impacts occur mostly through Australia's major trading partners in Asia which are affected by African demographic change.

To summarize, demographic shocks in different regions have different impacts both qualitatively and quantitatively on different sectors of the Australian economy. The different impacts depend on trade patterns between Australia and other regions and also between other regions. Energy, mining and durable manufacturing are the most affected sectors because these sectors have high export shares and their outputs are mostly used for investment and production rather than consumption. Thus growing economies require more investment while demographically shrinking countries undertake less investment.

(2) Global Demographic Change

When combining all regional shocks except Australia, we can obtain the impact of demographic change in the rest of the world on Australia. We then run the Australian demographic shock and combine the non-Australian and Australian shocks to obtain the overall impacts of global demographic change.

(a) Non-Australian Demographic Change

Figure 12 presents the impacts of the non-Australian demographic shock. The shock has large impacts on mining because the mining sector heavily depends on exports, with 74% of its output exported. China, Japan and Korea account for about 95% of Australian mining exports, and their demand contraction is the main driver of Australian mining decline. Energy output increases slightly over time. The energy sector is much less export-dependent, with 37% of its output exported, so it is less affected by the same external demand shock compared to the mining sector. China, Japan and Korea account for about 75% of Australian energy exports. On the one hand, the contraction of their energy demand has strong downward pressure on Australian energy investment and output. On the other hand, due to positive demographic shocks, emerging Asia, Latin America, Africa and the United States all increase their energy demand from Australia. More importantly, the investment in these regions increases their imports from China, Japan and Korea. The three countries, in turn, increase their energy imports from Australia for their production. The positive impacts dominate the negative impacts, resulting in higher energy output in Australia. The response of the energy sector is different from that of the mining sector because energy is an important input for all sectors. Still, mining products are input mainly for manufacturing sectors.

Durable manufacturing output decreases slowly over time, with a mild reduction of 6% by 2050. This sector has 36% of its output exported, and China, the United States and South Asia account for about 50% of its exports. The negative impacts of China, Japan, Korea and Europe on the durable manufacturing sector are offset by the positive impacts of South Asia and the United States. There are small impacts on agricultural output due to its consumption nature. In all regions, large shares of agricultural goods are used for consumption while large shares of energy, mining and durable manufacturing goods are used for production. Consumption responses are much smoother to demographic shocks than production. As the non-Australian shock is mild, the impacts on Australian agricultural output are small. The impacts on non-durable manufacturing and services are also negligible for two reasons. First, similar to

agricultural goods, large shares of non-durable manufacturing goods and services are used for consumption. Second, much smaller shares of non-durable manufacturing goods and services are exported, with a share of 17% and 3% exported respectively.

(b) Australian Demographic Change

Figure 13 presents the impacts of the Australian demographic shock. Due to domestic demographic change, Australia has increasing effective labour supply over time. Australia's effective labor supply is 24% larger by 2050 relative to 2015. Thus, Australian investment and output rise in all sectors. The durable manufacturing output increases by about 30% by 2030 and 50% by 2050, the agricultural output increases by about 20% by 2030 and 40% by 2050, and the outputs of other sectors all increase by about 10% by 2030 and 20% by 2050. Capital flows into Australia, and the Australian dollar appreciates, so exports decrease in the short run but increase in the long run because of output increases. On the other hand, imports increase in the short run. In the long run, imports of energy and durable manufacturing products increase for expanding production. But non-durable manufacturing goods and services decrease because domestic production increases to meet domestic consumption.

(c) Global Demographic Change

Figure 14 presents the impacts of global demographic change, which combines each of the shocks discussed above. The opposing impacts on mining are offsetting, leaving a moderate negative impact on mining output, with a reduction of 20%. The durable manufacturing sector increases substantially because the Australian and non-Australian shocks both have positive impacts, with a growth rate of 29% by 2030 and 46% by 2050. Greater investment in the world economy requires the production of more durable manufacturing goods which feed into the creation of the capital stock. Other sectors all increase to various extents. The overall effects on the agricultural, non-durable manufacturing and services sectors in Australia are mainly driven by Australia's demographic change.

5.3 Macroeconomic Impacts

Although the impacts on sectoral output and bilateral trade are quite different across regional shocks, the macroeconomic impacts are less heterogeneous. The regions with positive demographic shocks have qualitatively similar impacts across the regions on Australia macroeconomic variables. The macroeconomic impacts of negative demographic shocks are also qualitatively similar to each other across the regions experiencing negative shocks. We

consider China and emerging Asia as examples to illustrate the macroeconomic impacts of a negative and positive shock respectively.

(1) Regional Demographic Change

Figure 15 presents the impacts of all regional shocks on Australian macroeconomic variables. In the case of China, due to the contraction of Chinese demand for Australian exports, investment in Australia decreases and GDP also declines. As investment decreases, capital flows out of Australia, and the Australian dollar depreciates against the currencies in other countries (excluding China), resulting in trade surpluses. The real interest rate increases in the short and medium run but decreases in the long run. In the short run, the real interest rate is determined by the nominal interest rate and the expected inflation rate. As the Australian dollar depreciates, the inflation rate increases driven by the prices of imports, causing the Reserve Bank of Australia to increase the nominal interest rate. Due to the monetary policy, the expected inflation rate decreases. Therefore, the real interest rate increases in the short run until capital flows slow down and the inflation rate stabilizes. In the long run, the real interest rate is determined by the marginal product of capital. The marginal product of capital declines because China's external demand from Australia shrinks and there is excessive capital in Australia. As the external demand for Australian goods decreases, Australian goods become cheaper relative to the goods in other countries, so the real exchange rate in Australia depreciates. Real wages decline slightly because investment declines and thus the marginal product of labour falls. Consumption increases over time because both forward-looking and backward-looking households increase their consumption. As the interest rate decreases in the long run, human wealth increases, so forward-looking households increase their consumption. On the other hand, as firms reduce their investment, households receive higher dividend payment and thus have higher after-tax income, which increases their consumption.

The impacts of the demographic shock in ageing developed economies on Australia are qualitatively similar to those of the Chinese shock because the trade structures between Australia and ageing developed economies (particularly Japan and Korea) are quite similar to the structures between Australia and China. Even the quantitative impacts of the two regional shocks are quite similar. However, it is worth noting a few quantitative differences. In the developed economies shock, the real interest rate decreases more rapidly in the medium and long run because the developed economies are ageing much faster than China. Also, the trade surplus is larger in the Chinese shock.

In the emerging Asian shock, the increase of external demand for Australian products stimulates Australia investment and hence increases GDP. As investment increases, capital flows into Australia, and the Australian dollar appreciates against the currencies in other countries (excluding emerging Asia), resulting in trade deficits. The real interest rate declines in the short run but increases in the long run. In the short run, as the Australian dollar appreciates, the inflation rate decreases, so the Reserve Bank of Australia decreases the nominal interest rate. Due to the monetary policy, the expected inflation rate increases. In the long run, the marginal product of capital increases because of investment increases. The real exchange rate appreciates because Australian external demand increases. Real wage slightly increases because investment increases which raise the marginal product of labour. But consumption slightly decreases because the real interest rate increases and human wealth decreases.

The impacts of the US shock are qualitatively similar to those of the emerging Asian shock but quantitatively much smaller given that US demographic change is mild. The impact of the Latin American shock is also qualitatively similar, but even smaller. Africa has a much more drastic demographic change than emerging Asia, but it has smaller impacts on Australia because Australia has a much weaker trading relationship with Africa.

The results of regional shocks suggest that the impacts can be qualitatively different across shocks depending on whether regional shocks are positive or negative, and can also be quantitatively different depending on Australian trade structures with the regions.

(2) Global Demographic Change

To create the global demographic shock, we combine the non-Australian shocks with the Australian demographic shock. Figure 16 presents the results of three shocks: the non-Australian shock (Non-AUS), the Australian shock (AUS) and the global shock (Global).

The total effective labour supply in the rest of the world is mildly increasing, so the non-Australian demographic change serves as a mild positive demographic shock. Capital flows out of Australia, and investment falls. GDP follows a similar pattern to investment, but the impacts are negligible. The Australian dollar depreciates, generating trade surpluses. The real interest rate increases and peaks after one decade before gradually declining. The real exchange rate slightly decreases. Real wage also slightly decreases. Consumption increases over time.

In the case of the Australian demographic shock, the effective labour supply in Australia is increasing, pushing up investment and resulting in higher economic growth. The marginal product of capital rises and hence increases the real interest rate, and capital flows in. Capital

flows appreciate the Australian dollar and generates trade deficits. The nominal exchange rate rises so the real exchange rate also rises in the short run. But in the long run, as production rises in Australia, Australian goods become cheaper relative to foreign goods, which reduces Australian real exchange rate. Real wage increases as investment rises.

Comparing the Australian shock and the non-Australian shock provides several insights. First, the impact of the non-Australian shock on Australian GDP is quantitatively negligible partly because the non-Australian shock is mild and partly because the impacts of a demographic shock on investment and trade go in opposite directions. But the impacts on the real interest rate and trade balances are pronounced. Second, the global demographic shock increases the real interest rate, notably in the next two decades because Australia and the rest of the world both importantly contribute to the real interest rate in the same direction. Australian consumption also increases notably because both shocks increase Australian consumption. Third, the demographic impacts of Australia and the rest of the world on Australian trade balances go in opposite directions, so the net effect is relatively small.

6. Conclusions

This paper has examined the impacts of global demographic change on the Australian economy at both the aggregate and sectoral levels in a global general equilibrium model. As demographics has been changing around the world, we simulated demographic shocks of six regions in the world economy to investigate their impacts on the Australian economy at both the aggregate and sectoral levels. We then combined them to obtain the overall impacts of all foreign demographic shocks on Australia. We further compared the impacts of the non-Australian shock with those of Australian own demographic shock, and then combined them to obtain the impacts of global demographic change.

At the sectoral level, demographic shocks in different regions have different impacts on sectors in Australia depending on trade patterns between Australia and other regions and also between other regions. The energy, mining and durable manufacturing sectors are most affected. Due to close trading relationships, demographic changes in China, Japan and Korea have significant negative impacts on Australia, but their impacts are partly offset by the favourable impacts of emerging Asia. Demographic changes in Latin America and Africa affect the Australian economy mainly through their impacts on Australia's major trading partners in Asia rather than through their direct bilateral trade with Australia. Latin American also affects the Australian economy through their competition in the world mining market.

At the aggregate level, the impact of the non-Australian shock on Australian GDP is quantitatively negligible, but the impacts on the real interest rate and trade balances are pronounced. The global demographic change increases the real interest rate notably in the next two decades because Australia and the rest of the world both importantly contribute in the same direction. The shocks in Australia and the rest of the world also both increase Australian consumption. The two shocks have opposing impacts on Australian trade balances, resulting in small net effects.

There are many assumptions built into the modelling exercise of the complexity undertaken in this paper. One of the limitations is the limited assessment of the impact of demographic change on the composition of consumption demand by different age cohorts. Future research will take into account the consumption patterns of different age cohorts.

Another issue to stress is that the modelling in this paper assumes that financial capital is allowed to flow from ageing economies into young emerging economies and are efficiently allocated within those economies, especially in Africa, Emerging Asia and Latin America. Any restrictions to this flow of capital or misallocation of the capital flows can dramatically change the global outcomes in this paper. This will be explored in future papers using the current modelling framework.

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Appendix A. G-Cubed Regions

Western Europe:

Germany, United Kingdom, France, Italy, Spain, Netherlands, Belgium, Luxemburg, Ireland, Greece, Austria, Portugal, Finland, Cyprus, Malta, Slovakia, Slovenia, Estonia, Norway, Sweden, Switzerland, Denmark, Iceland, Liechtenstein.

Rest of Advanced Economies:

Canada, New Zealand.

Other Asia:

Hong Kong, Singapore, Laos, Myanmar, Cambodia, Rest of East Asia, Rest of South East Asia, Bangladesh, Nepal, Pakistan, Sri Lanka, Rest of South Asia.

Latin America:

Argentina, Bolivia, Brazil, Chile, Costa Rica, Ecuador, Guatemala, Mexico, Nicaragua, Panama, Peru, Paraguay, Uruguay, El Salvador, Honduras, Venezuela, Caribbean, Rest of South America.

Sub-Sahara Africa:

Benin, Burkina Faso, Cameroon, Cote d'Ivoire, Ghana, Guinea, Nigeria, Senegal, Togo, Rest of Western Africa, Central Africa, South Central Africa, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Rwanda, Tanzania, Uganda, Zambia, Zimbabwe, Rest of Eastern Africa, Botswana, Namibia, South Africa, Rest of South African Customs Union.

Middle East and North Africa:

Egypt, Algeria, Morocco, Sudan, Tunisia, Libya, Iran, Bahrain, Israel, Jordan, Kuwait, , Oman, Qatar, Saudi Arabia, United Arab Emirates, Yemen, Turkey, Iraq, Lebanon, Palestinian Territory, Syria.

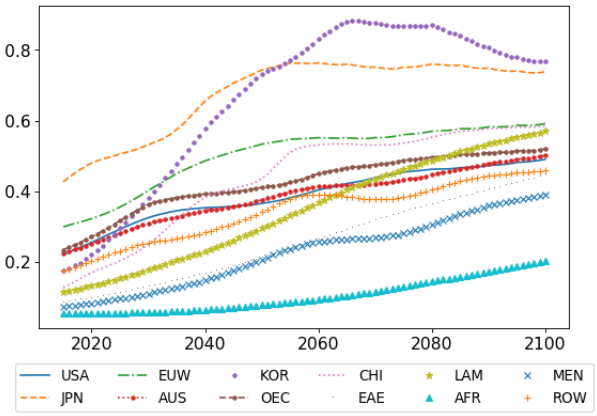
Rest of World:

All countries not included in other groups, mainly including Eastern Europe and Central Asia.

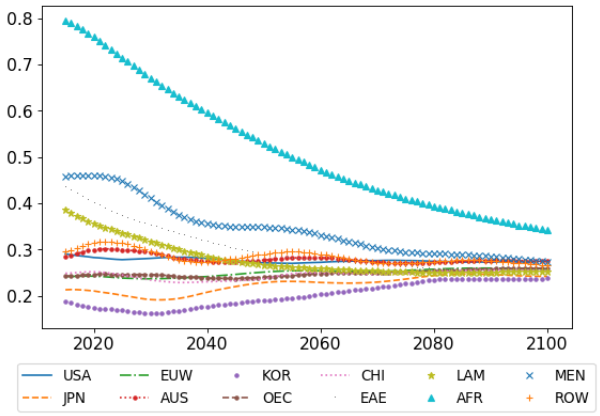
Appendix B. Figures

Figure 1 Demographic Trends

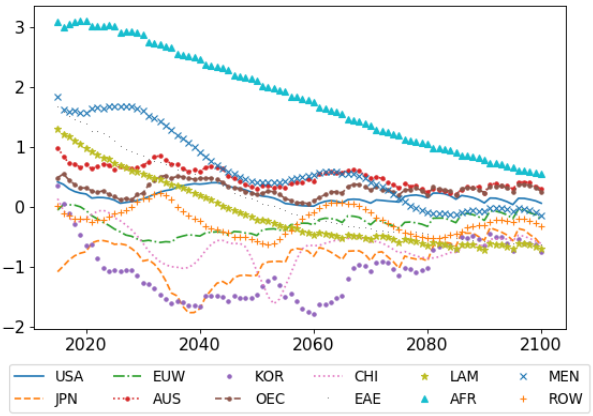
(a) Elderly Dependency



(b) Youth Dependency



(c) Working-Age Population Growth



(d) Total Population

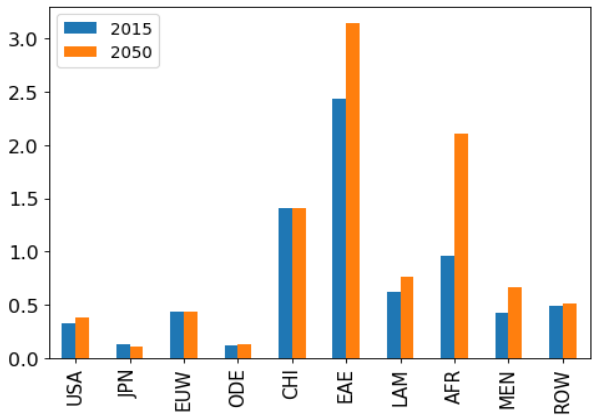


Figure 2 Australian Current Account (% GDP) (1990-2018)

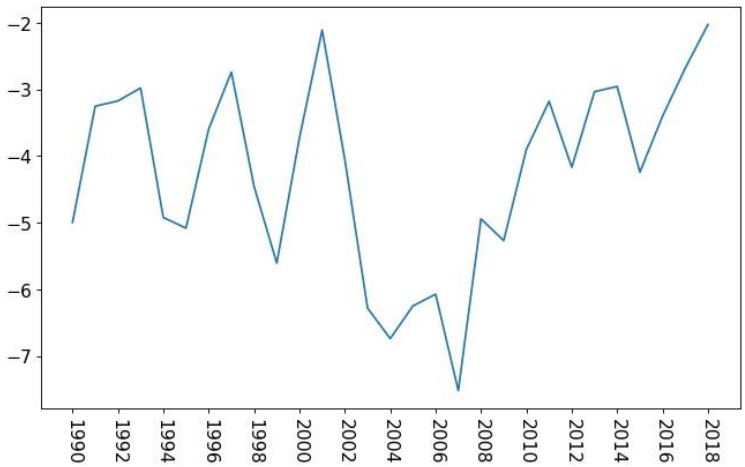
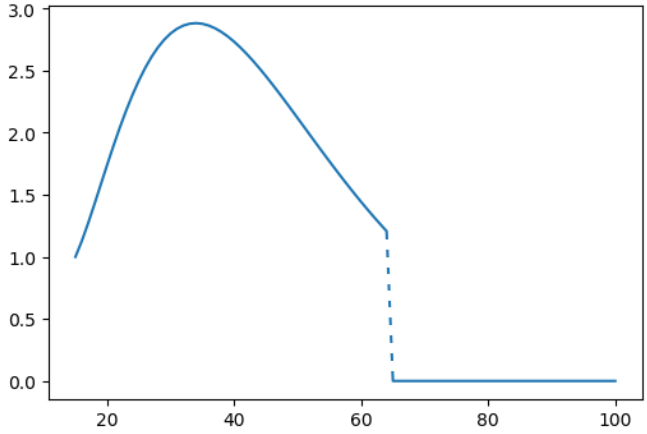
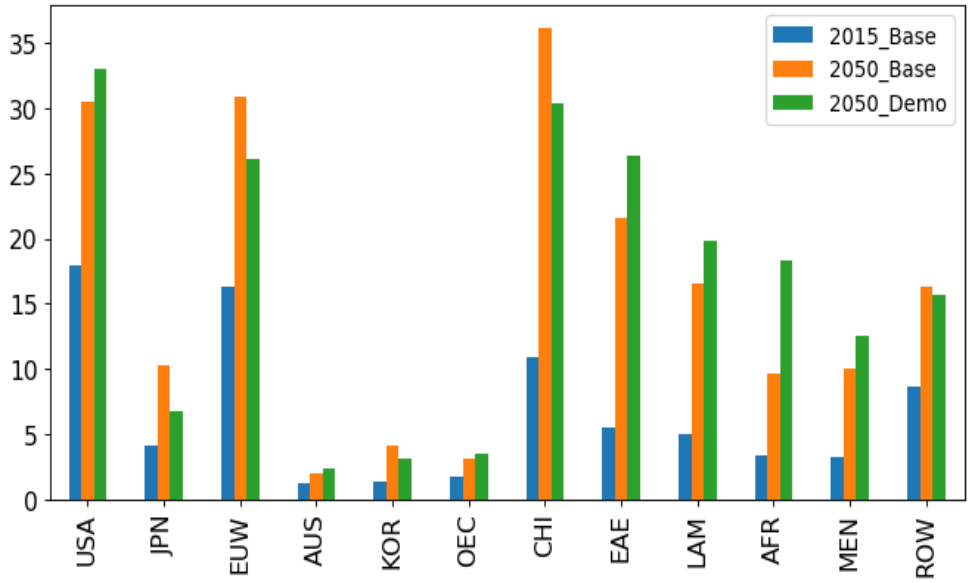


Figure 3 Individual Life-Cycle Productivity Over Age



Source: Authors' Calculation.

Figure 4 Global GDP: Baseline 2015, Baseline 2050 and Demographic Scenario 2050 (Billion, 2015 US $)

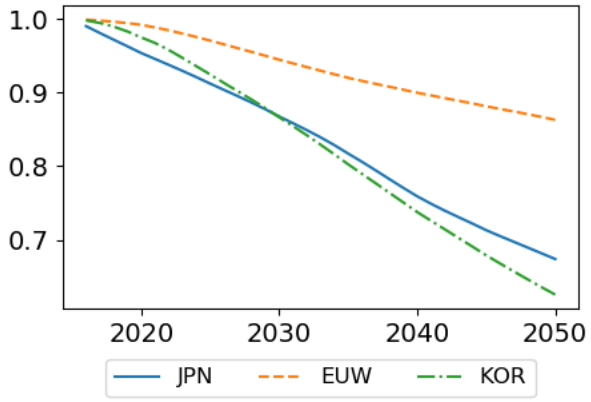


Source: G-Cubed Model GGG6M_v151

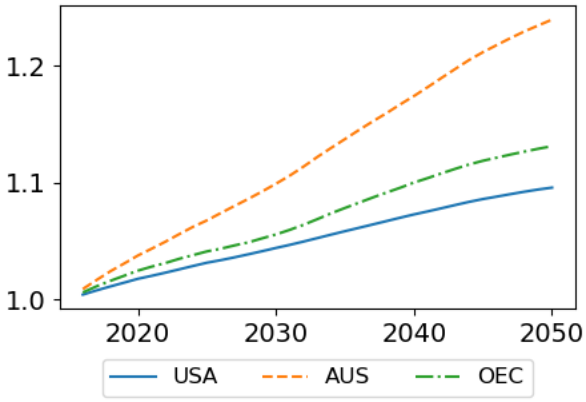
Figure 5 Total Effective Labour Supply

Source: Authors' Calculation.

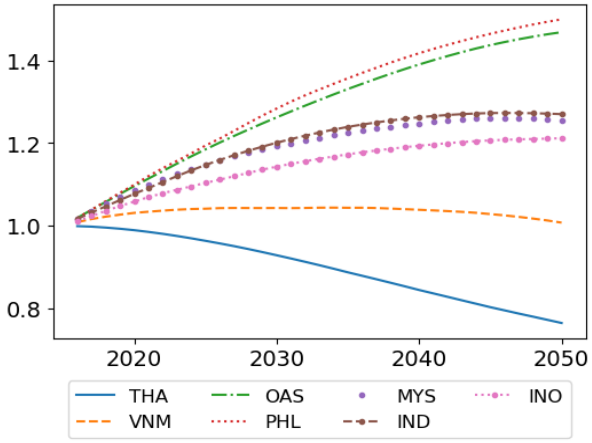
(a) Ageing Developed Economies



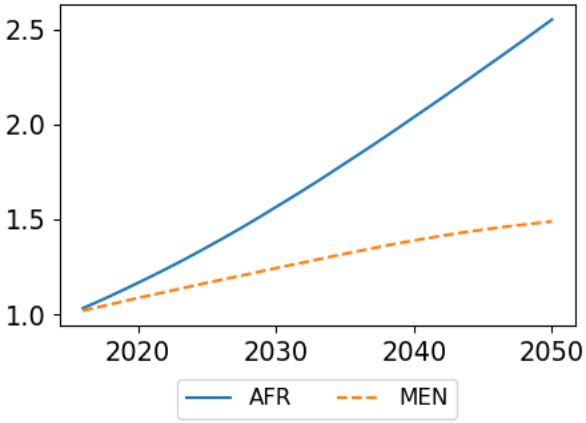
(b) Growing Developed Economies



(c) Emerging Asian Economies



(d) Africa and Middle East



(e) Other Regions

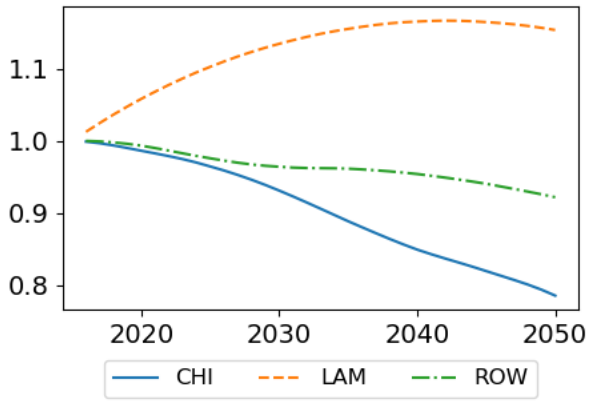
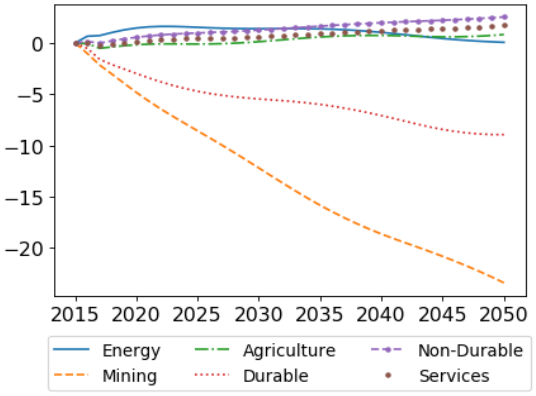
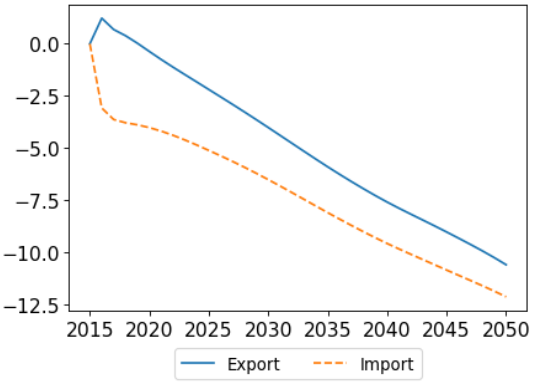


Figure 6 Impacts of Chinese Shock on Australian Sectoral Output and Trade

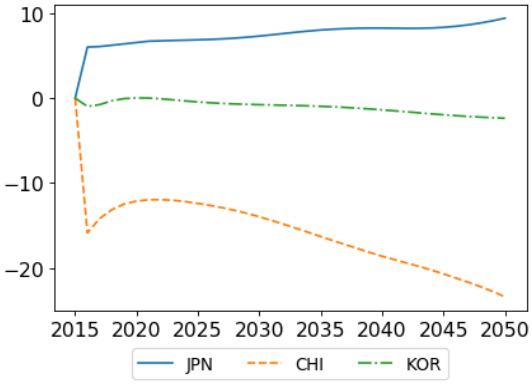
(a) Sectoral Output (%)



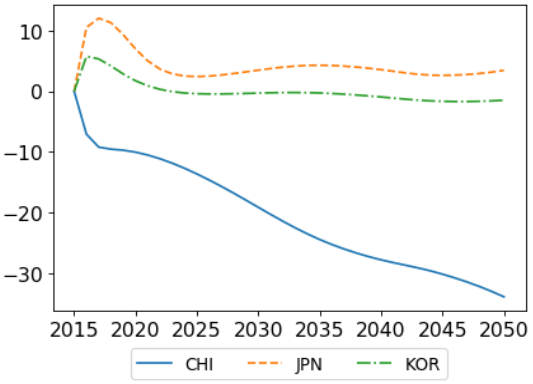
(b) Export and Import (%)



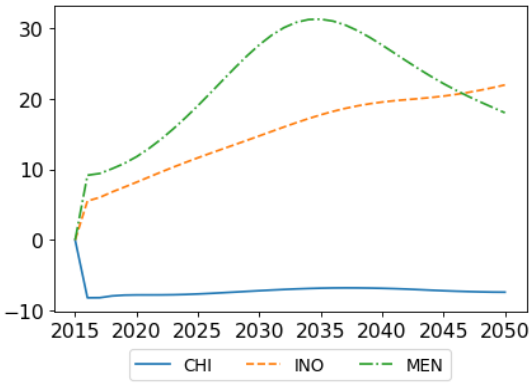
(c) Energy Export (%)



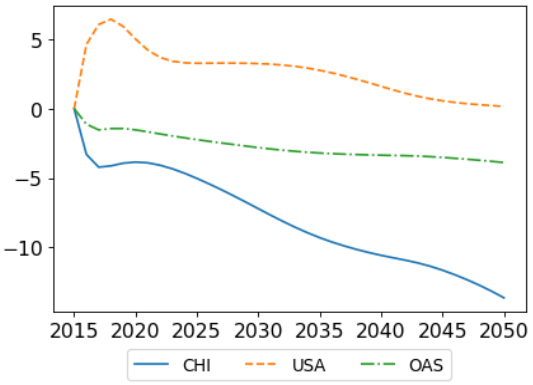
(d) Mining Export (%)



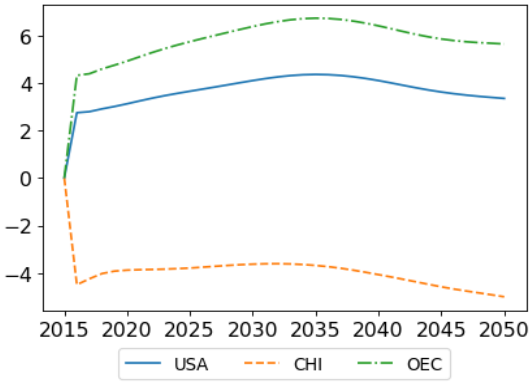
(e) Agricultural Export (%)



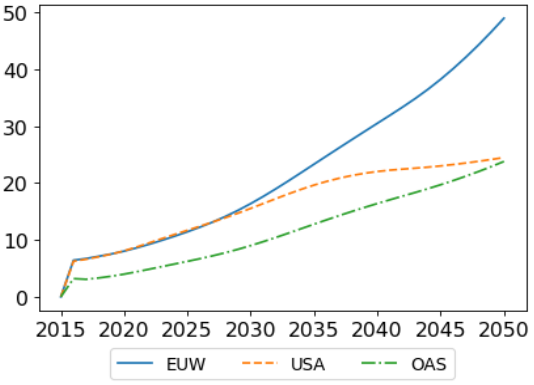
(f) Durable Manufacturing Export (%)



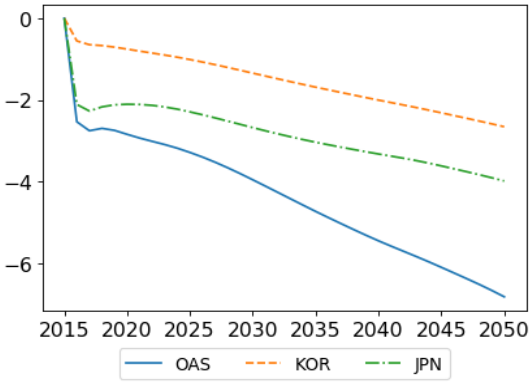
(g) Non-Durable Manufacturing Export (%)



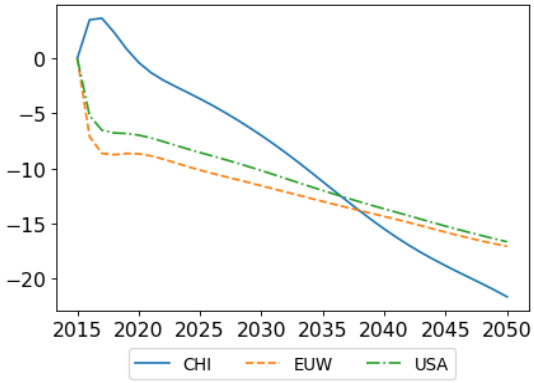
(h) Services Export (%)



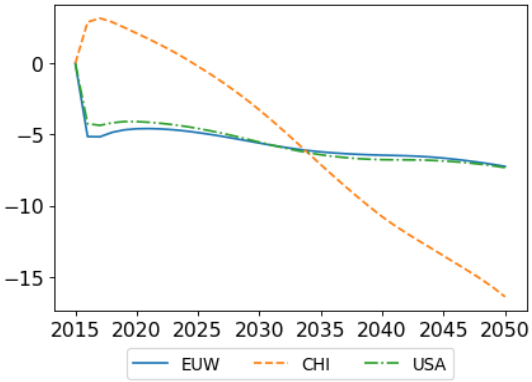
(i) Energy Import (%)



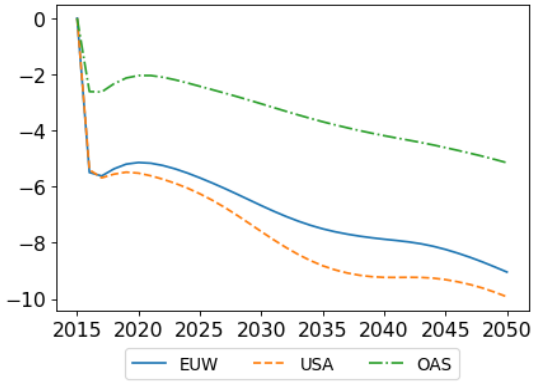
(j) Durable Manufacturing Import (%)



(k) Non-Durable Manufacturing Import (%)



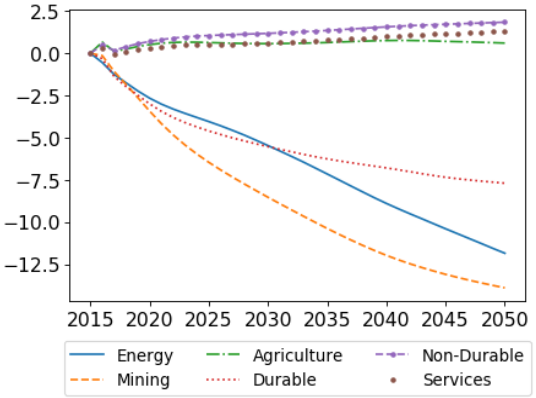
(l) Services Import (%)



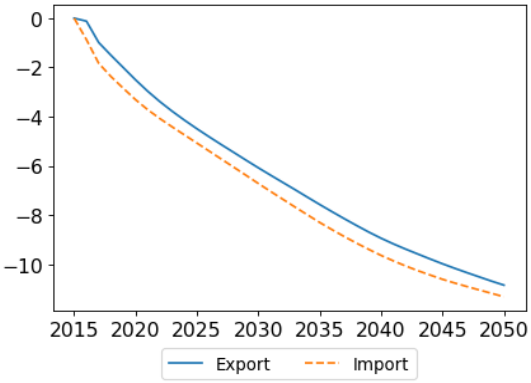
Source: G-Cubed Model GGG6M_v151

Figure 7 Impacts of Ageing Developed Economies Shock on
Australian Sectoral Output and Trade

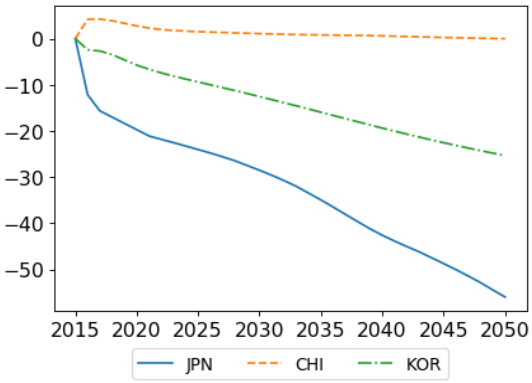
(a) Sectoral Output (%)



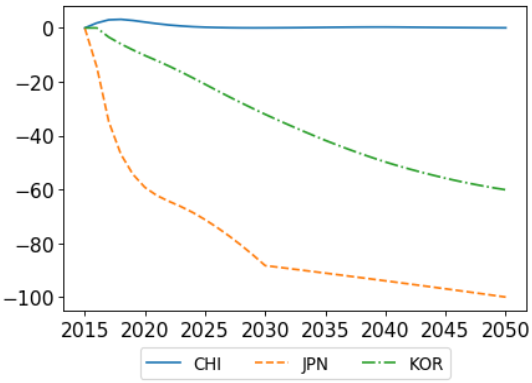
(b) Export and Import (%)



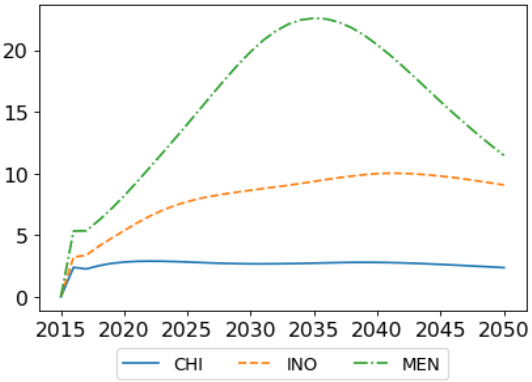
(c) Energy Export (%)



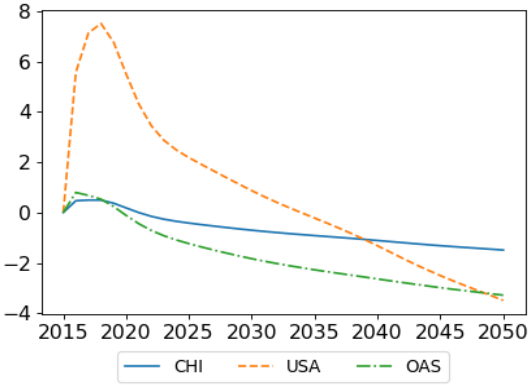
(d) Mining Export (%)



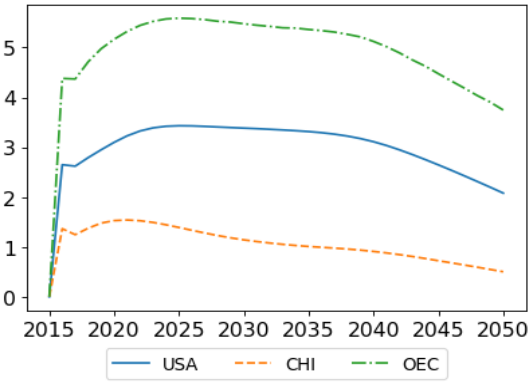
(e) Agricultural Export (%)



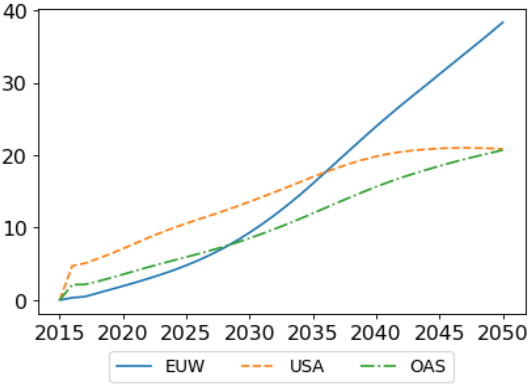
(f) Durable Manufacturing Export (%)



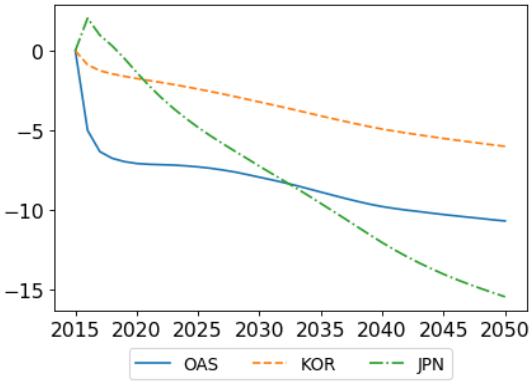
(g) Non-Durable Manufacturing Export (%)



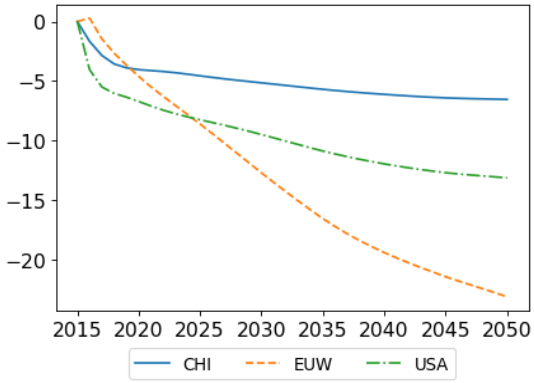
(h) Services Export (%)



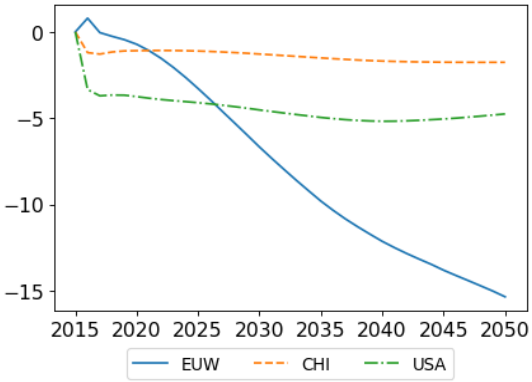
(i) Energy Import (%)



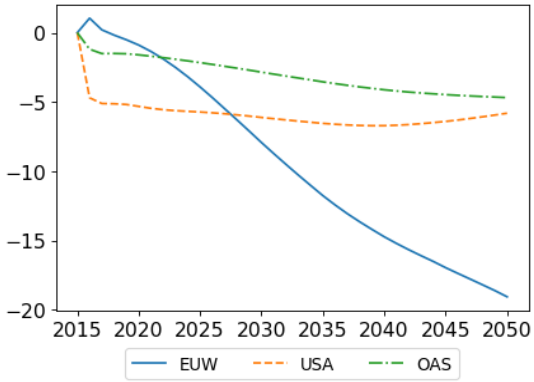
(j) Durable Manufacturing Import (%)



(k) Non-Durable Manufacturing Import (%)



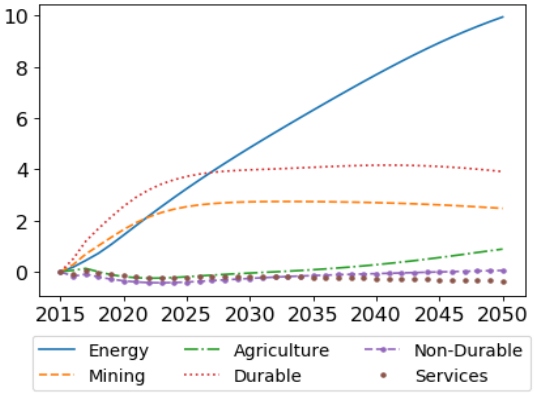
(l) Services Import (%)



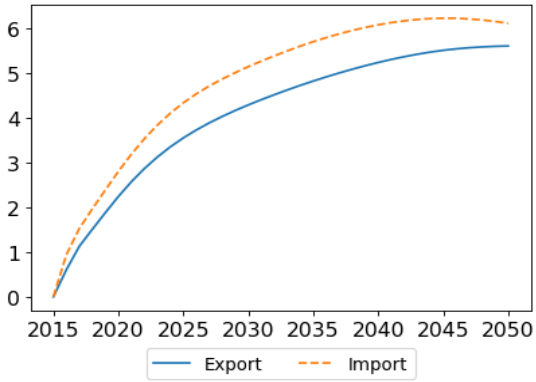
Source: G-Cubed Model GGG6M_v151

Figure 8 Impacts of Emerging Asian Shock on Australian Sectoral Output and Trade

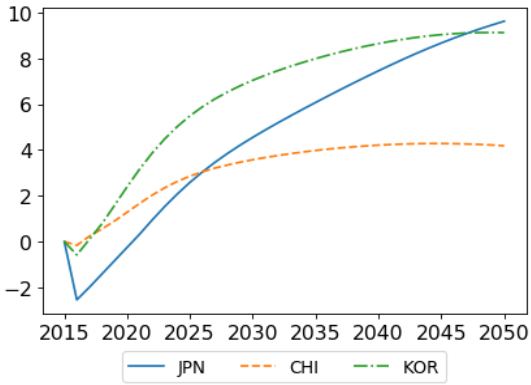
(a) Sectoral Output (%)



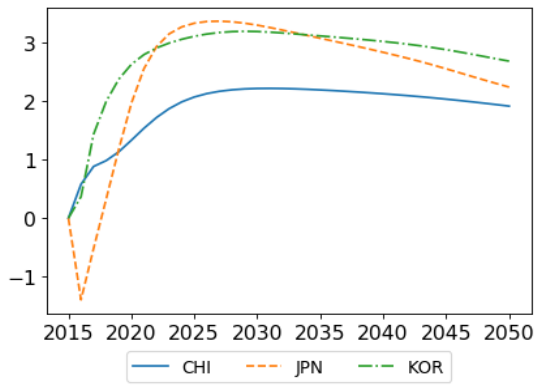
(b) Export and Import (%)



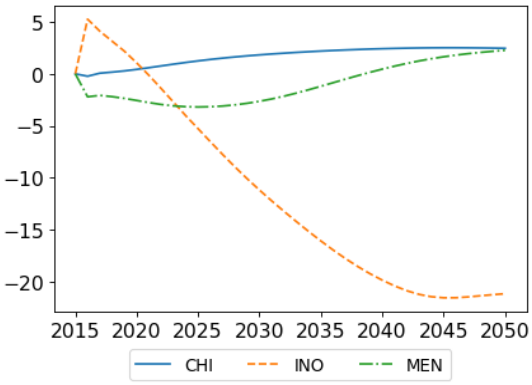
(c) Energy Export (%)



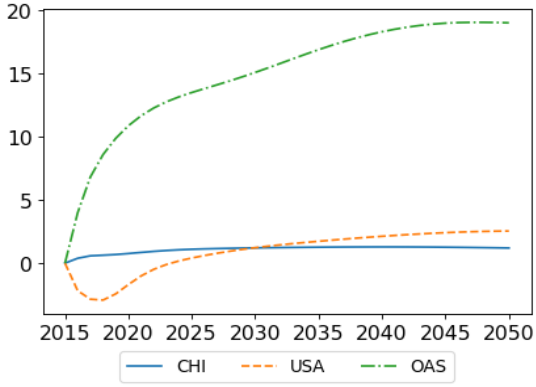
(d) Mining Export (%)



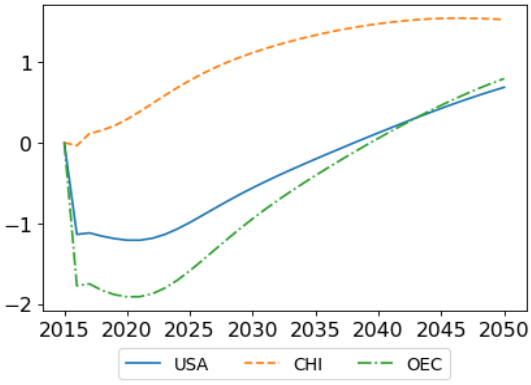
(e) Agricultural Export (%)



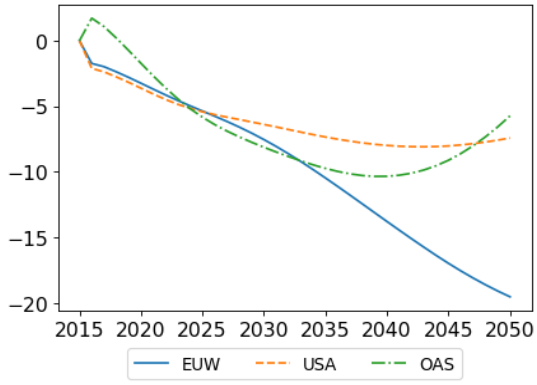
(f) Durable Manufacturing Export (%)



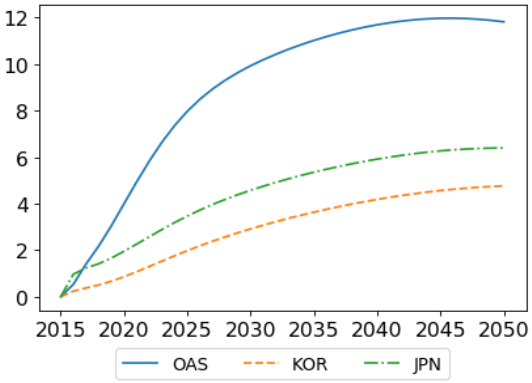
(g) Non-Durable Manufacturing Export (%)



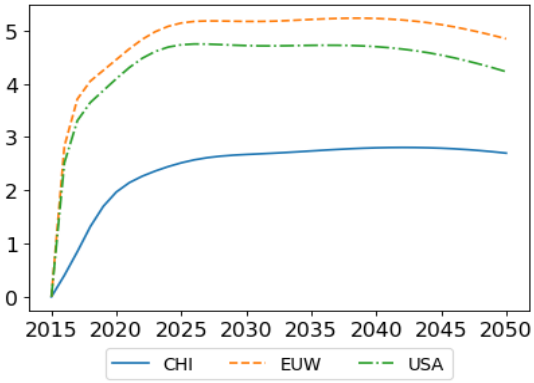
(h) Services Export (%)



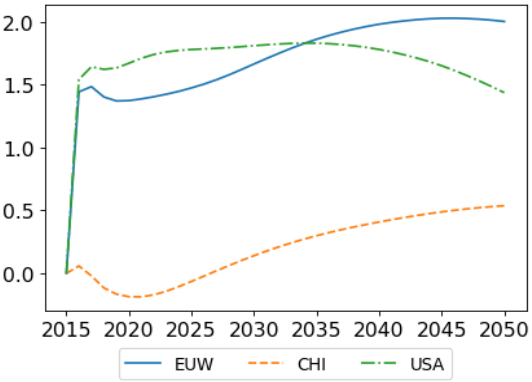
(i) Energy Import (%)



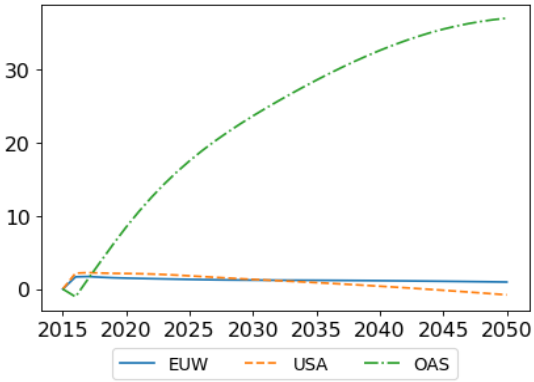
(j) Durable Manufacturing Import (%)



(k) Non-Durable Manufacturing Import (%)



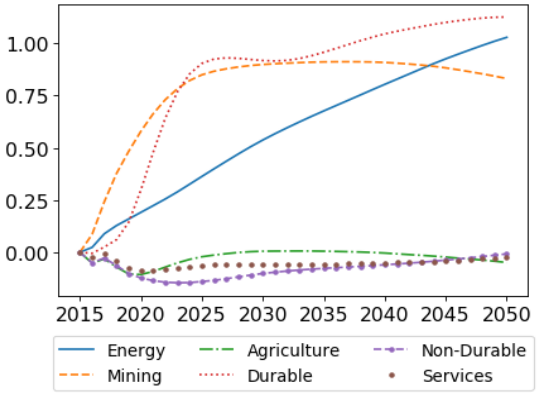
(l) Services Import (%)



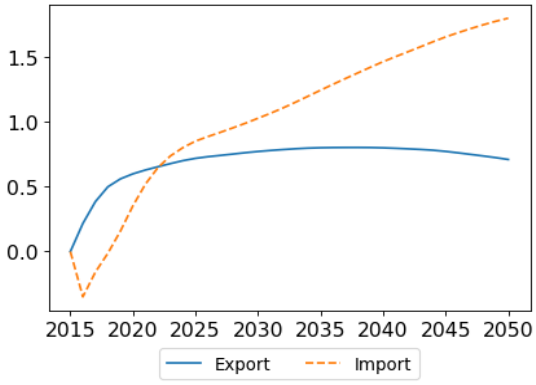
Source: G-Cubed Model GGG6M_v151

Figure 9 Impacts of US Shock on Australian Sectoral Output and Trade

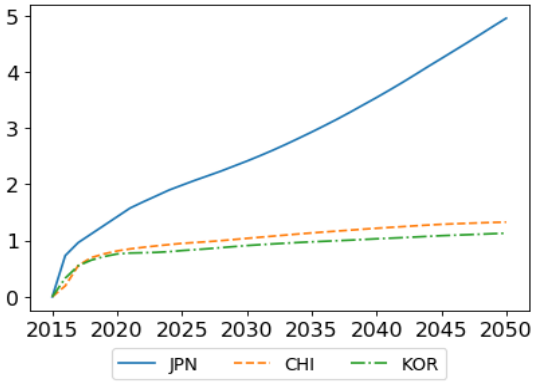
(a) Sectoral Output (%)



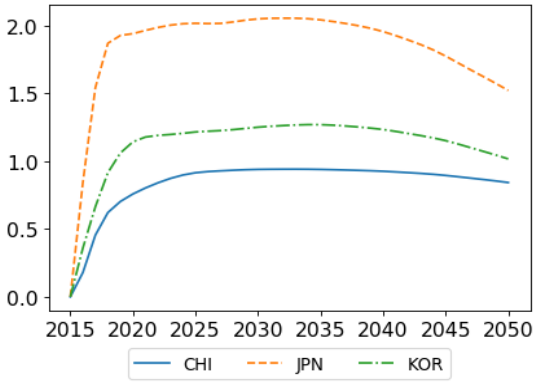
(b) Export and Import (%)



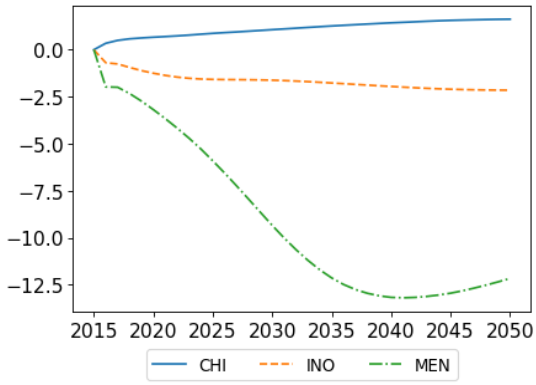
(c) Energy Export (%)



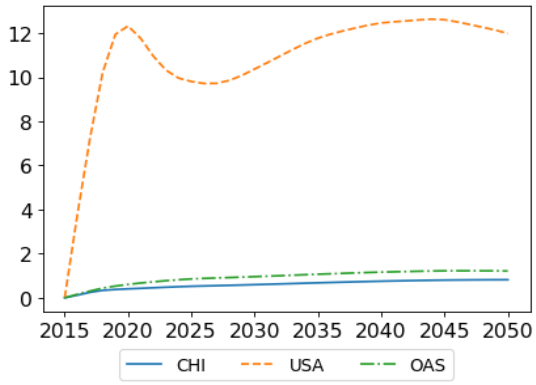
(d) Mining Export (%)



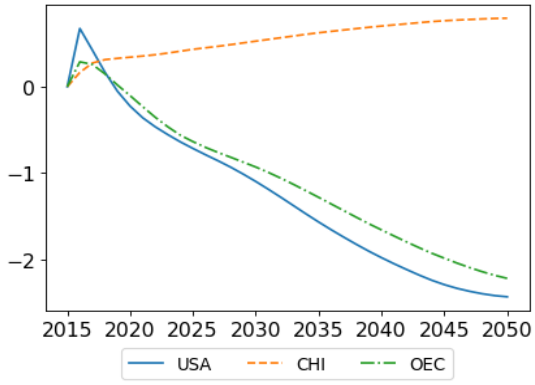
(e) Agricultural Export (%)



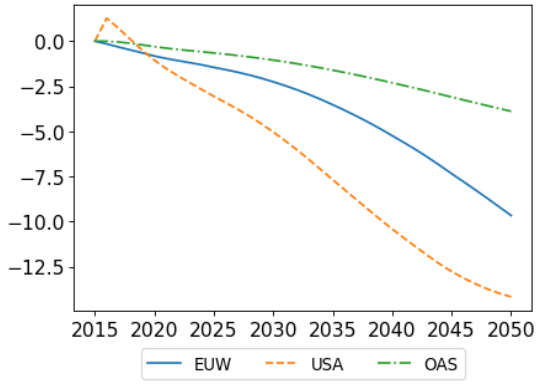
(f) Durable Manufacturing Export (%)



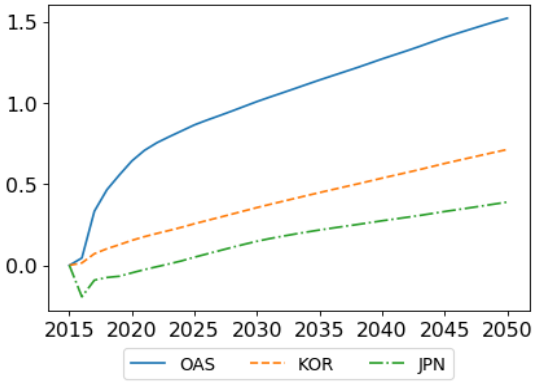
(g) Non-Durable Manufacturing Export (%)



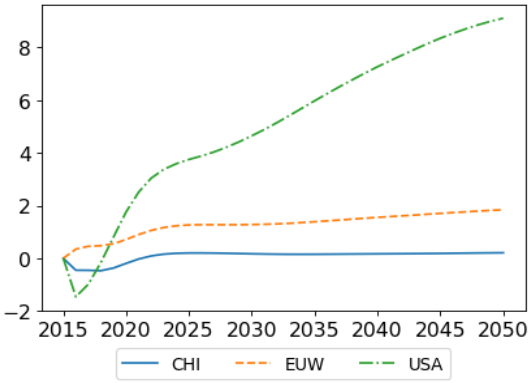
(h) Services Export (%)



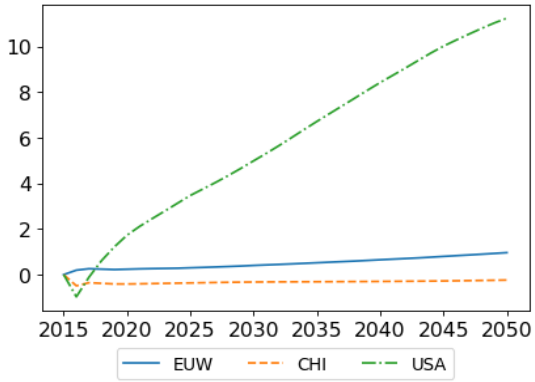
(i) Energy Import (%)



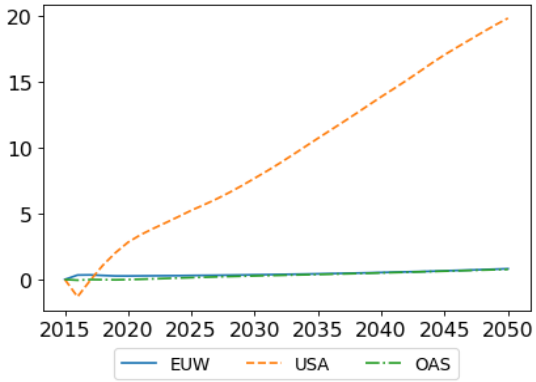
(j) Durable Manufacturing Import (%)



(k) Non-Durable Manufacturing Import (%)



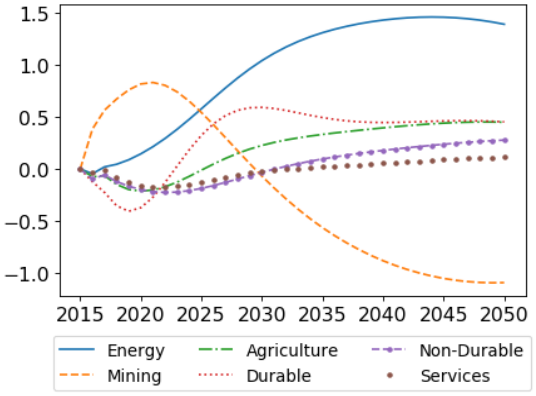
(l) Services Import (%)



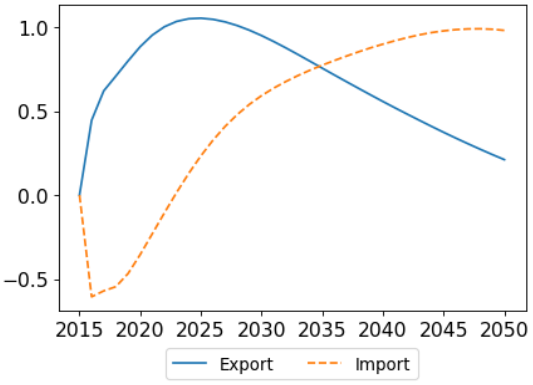
Source: G-Cubed Model GGG6M_v151

Figure 10 Impacts of Latin American Shock on Australian Sectoral Output and Trade

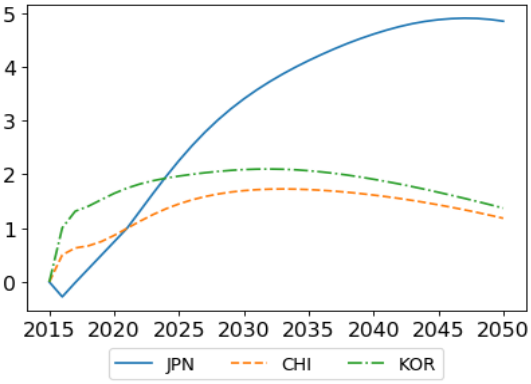
(a) Sectoral Output (%)



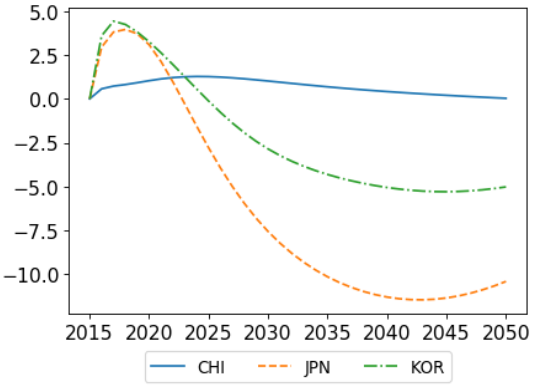
(b) Export and Import (%)



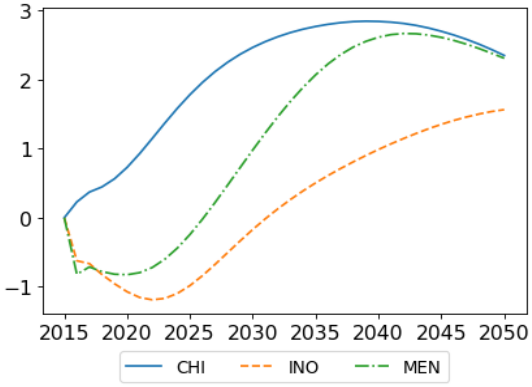
(c) Energy Export (%)



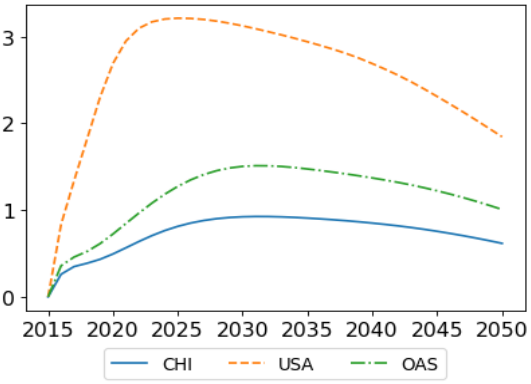
(d) Mining Export (%)



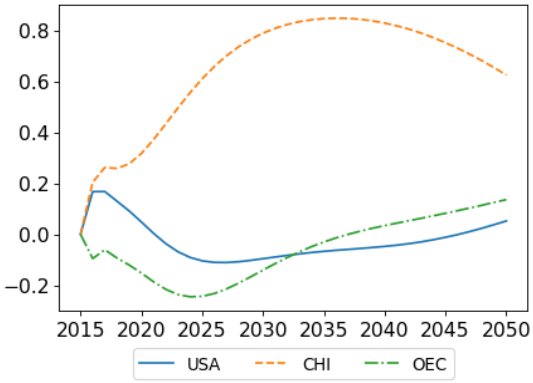
(e) Agricultural Export (%)



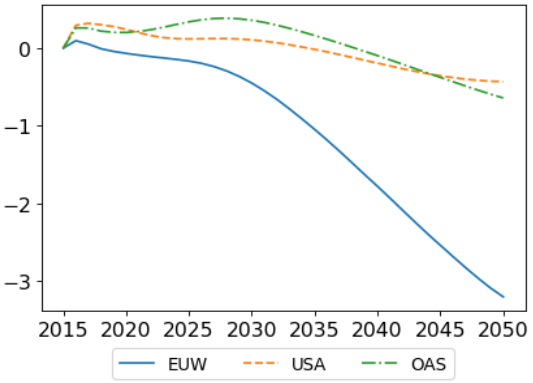
(f) Durable Manufacturing Export (%)



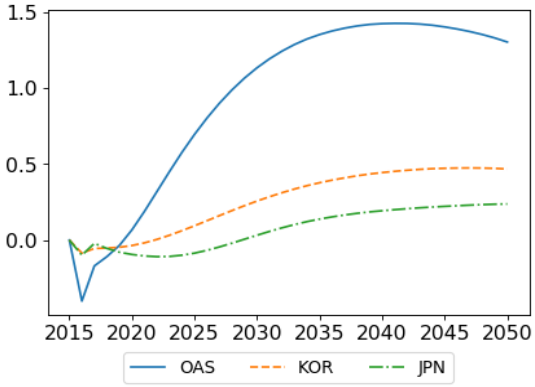
(g) Non-Durable Manufacturing Export (%)



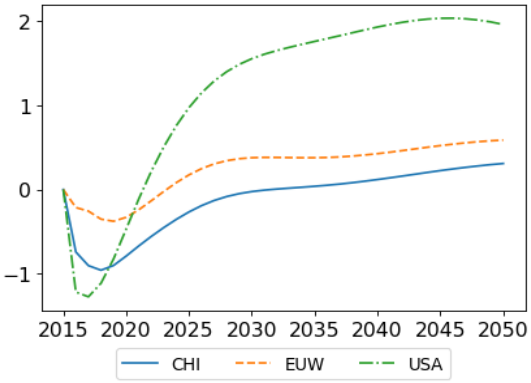
(h) Services Export (%)



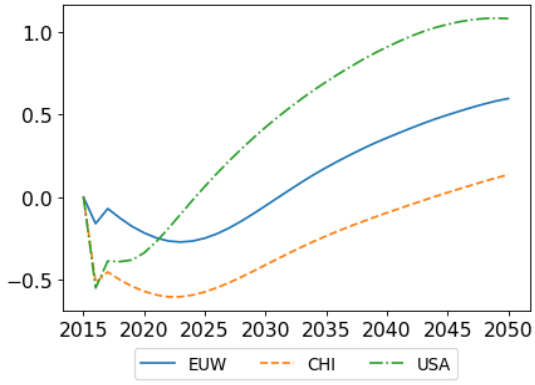
(i) Energy Import (%)



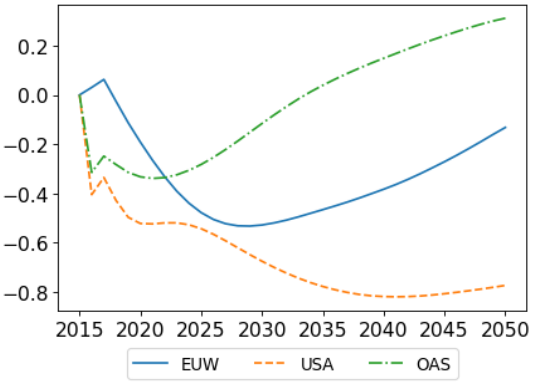
(j) Durable Manufacturing Import (%)



(k) Non-Durable Manufacturing Import (%)



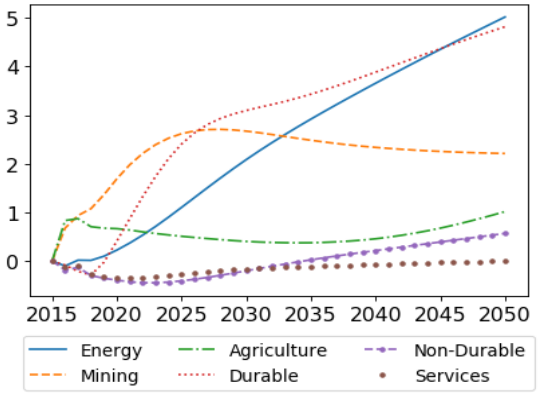
(l) Services Import (%)



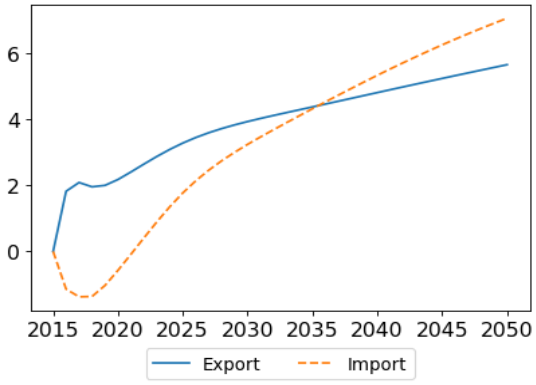
Source: G-Cubed Model GGG6M_v151

Figure 11 Impacts of African Shock on Australian Sectoral Output and Trade

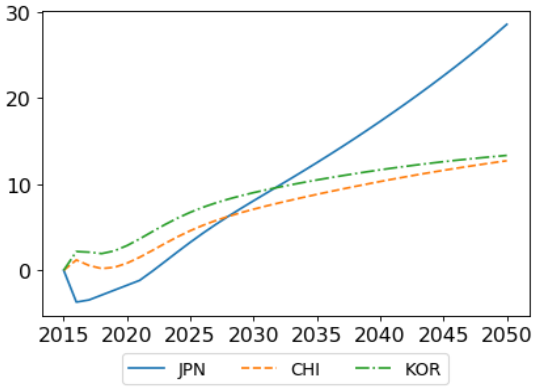
(a) Sectoral Output (%)



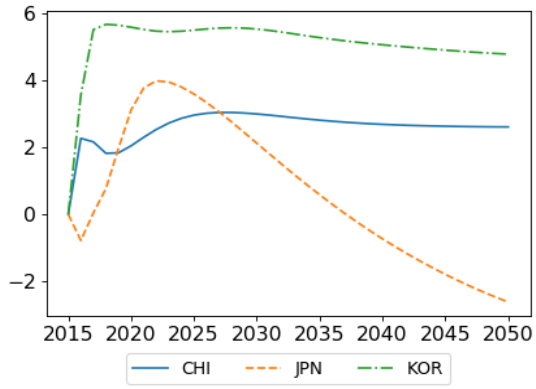
(b) Export and Import (%)



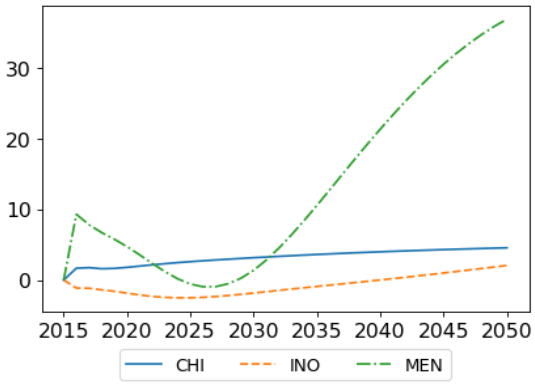
(c) Energy Export (%)



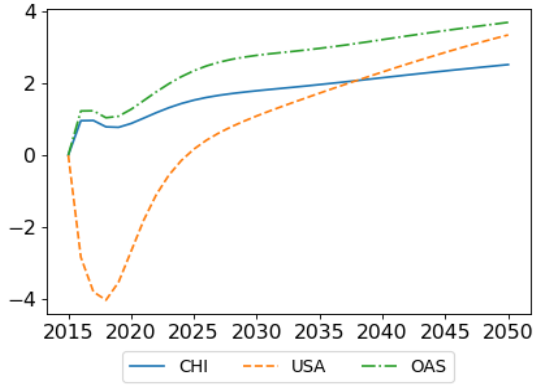
(d) Mining Export (%)



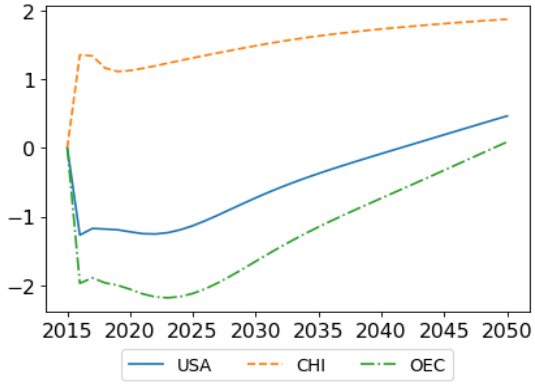
(e) Agricultural Export (%)



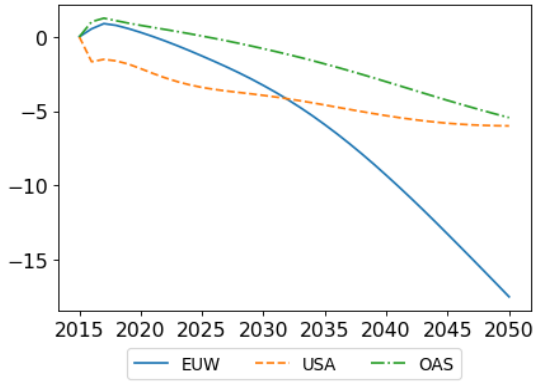
(f) Durable Manufacturing Export (%)



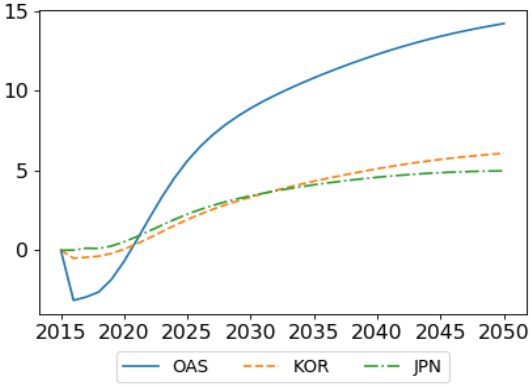
(g) Non-Durable Manufacturing Export (%)



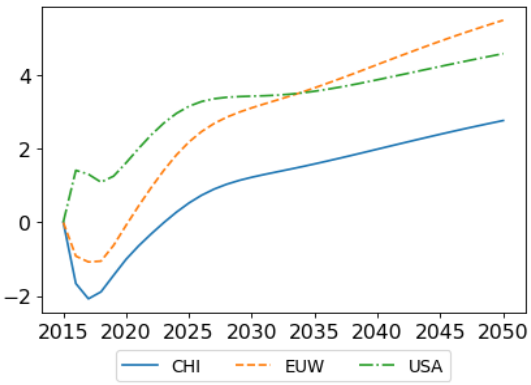
(h) Services Export (%)



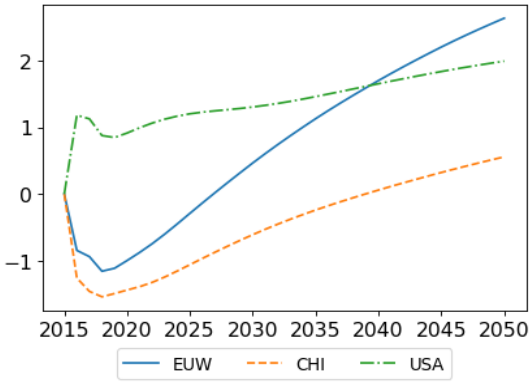
(i) Energy Import (%)



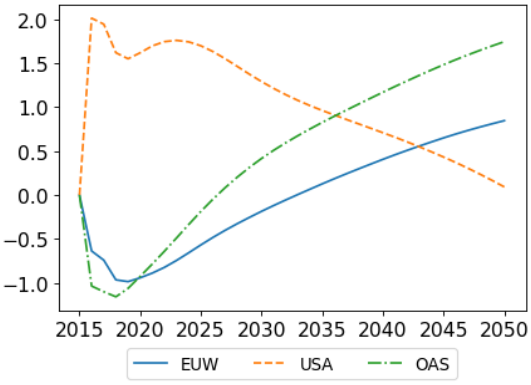
(j) Durable Manufacturing Import (%)



(k) Non-Durable Manufacturing Import (%)



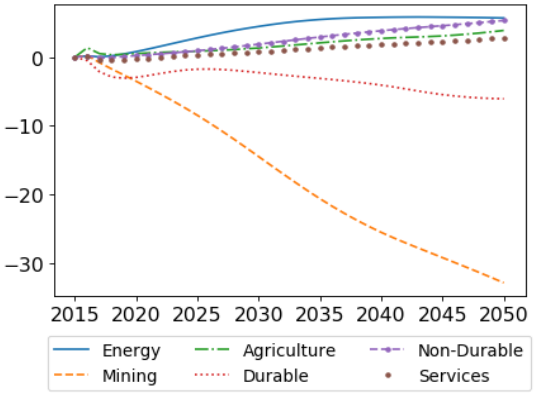
(l) Services Import (%)



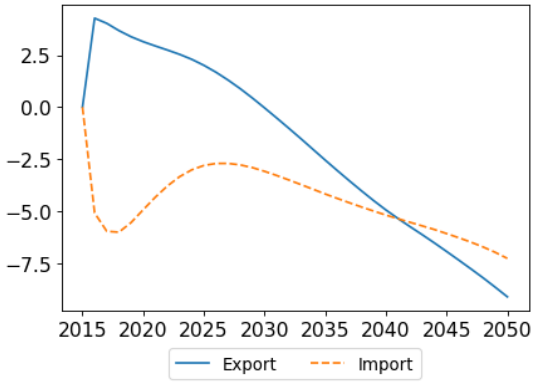
Source: G-Cubed Model GGG6M_v151

Figure 12 Impacts of Non-Australian Shocks on Australian Sectoral Output and Trade

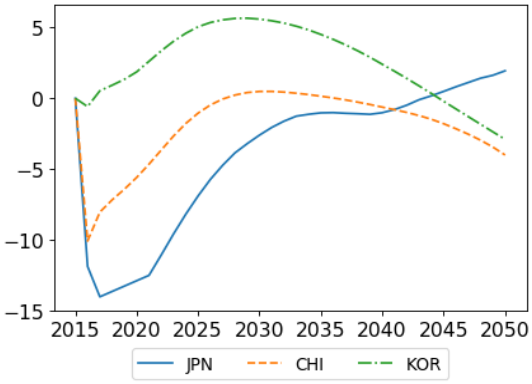
(a) Sectoral Output (%)



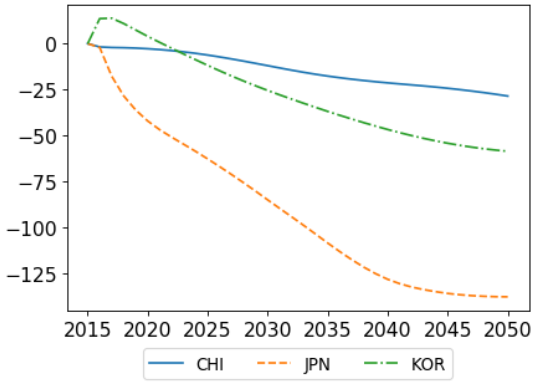
(b) Export and Import (%)



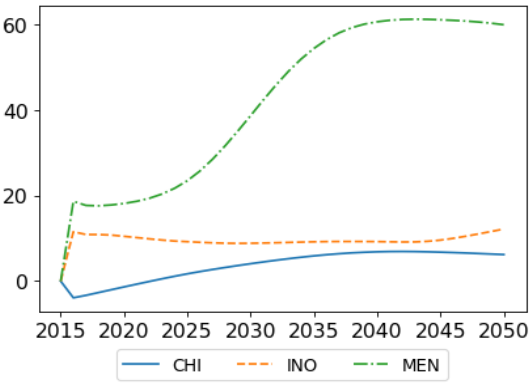
(c) Energy Export (%)



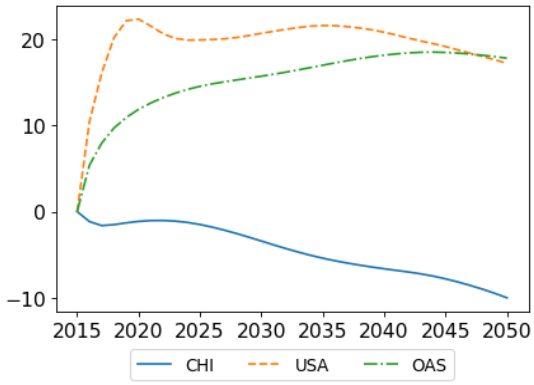
(d) Mining Export (%)



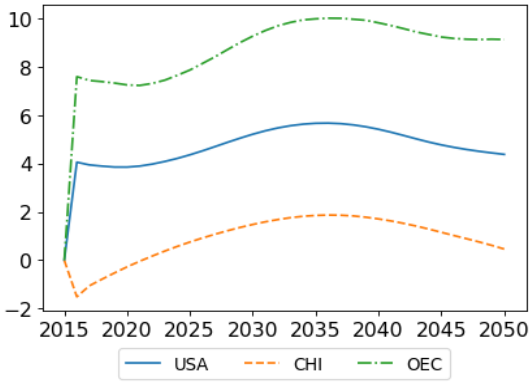
(e) Agricultural Export (%)



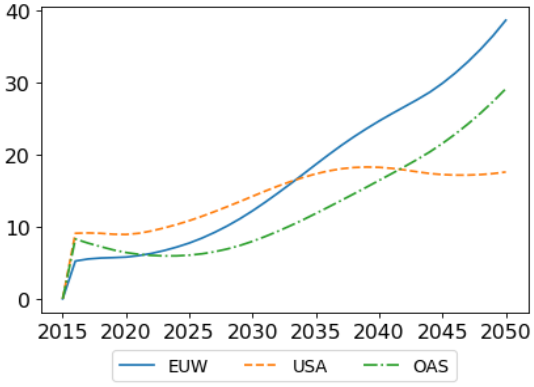
(f) Durable Manufacturing Export (%)



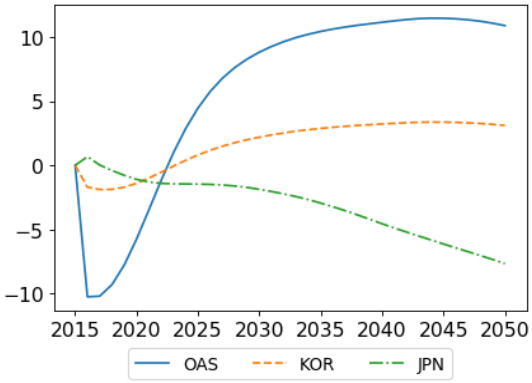
(g) Non-Durable Manufacturing Export (%)



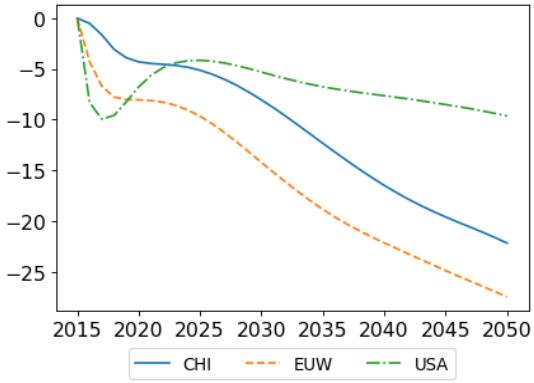
(h) Services Export (%)



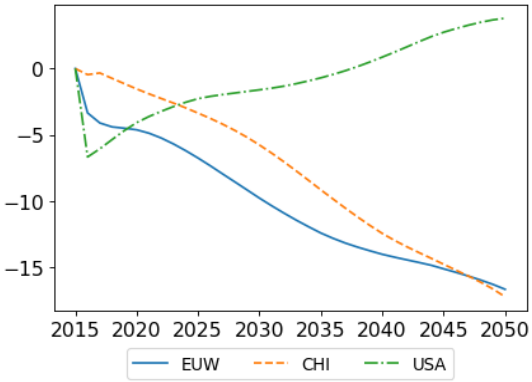
(i) Energy Import (%)



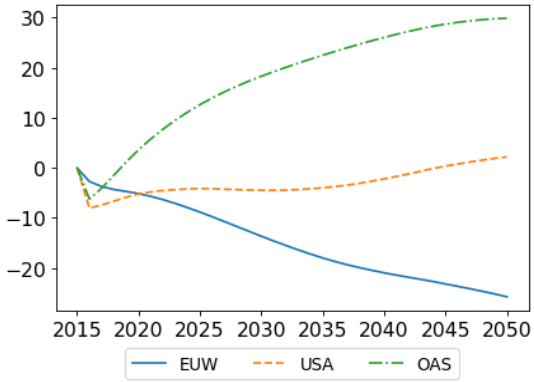
(j) Durable Manufacturing Import (%)



(k) Non-Durable Manufacturing Import (%)



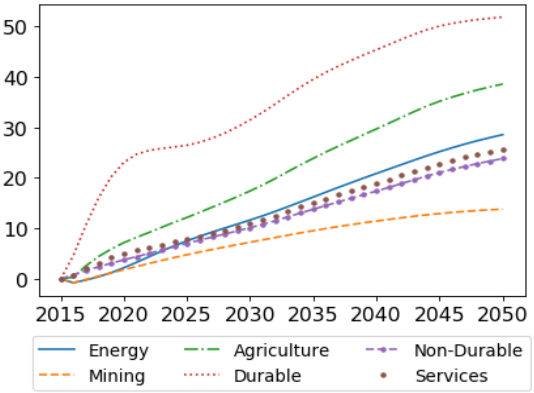
(l) Services Import (%)



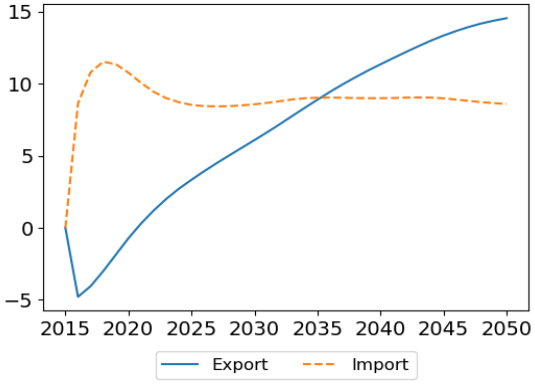
Source: G-Cubed Model GGG6M_v151

Figure 13 Impacts of Australian Shock on Australian Sectoral Output and Trade

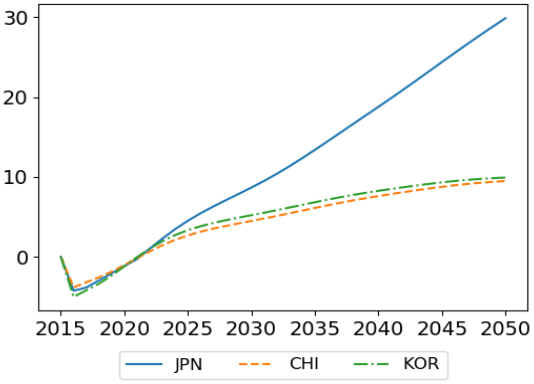
(a) Sectoral Output (%)



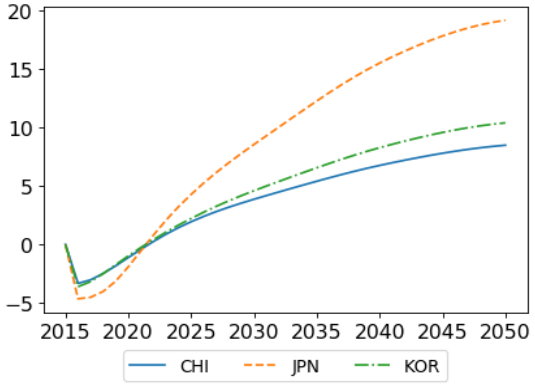
(b) Export and Import (%)



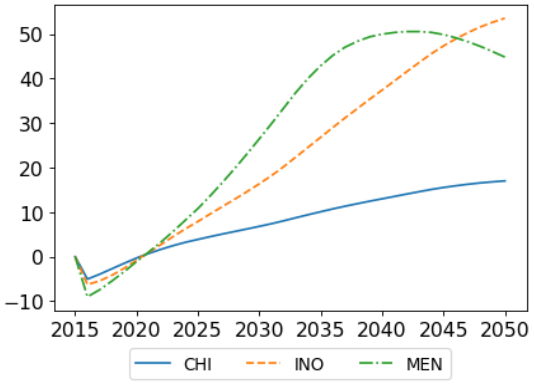
(c) Energy Export (%)



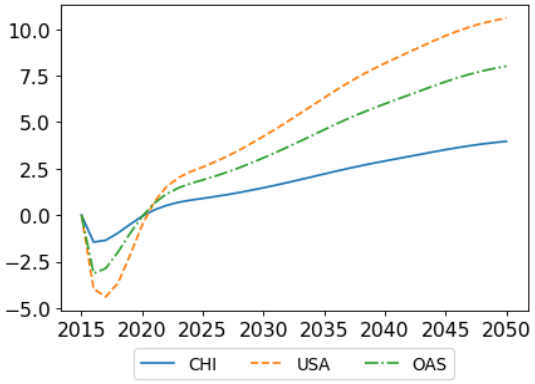
(d) Mining Export (%)



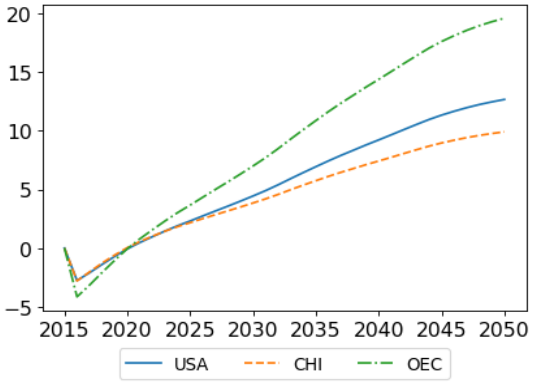
(e) Agricultural Export (%)



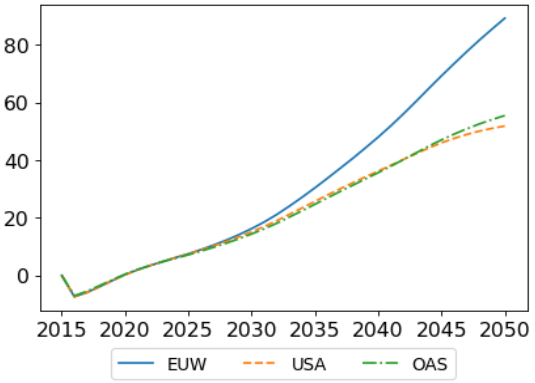
(f) Durable Manufacturing Export (%)



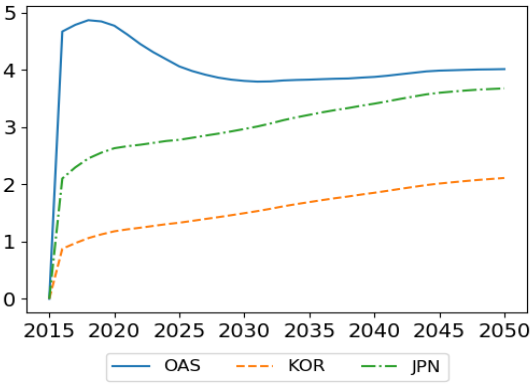
(g) Non-Durable Manufacturing Export (%)



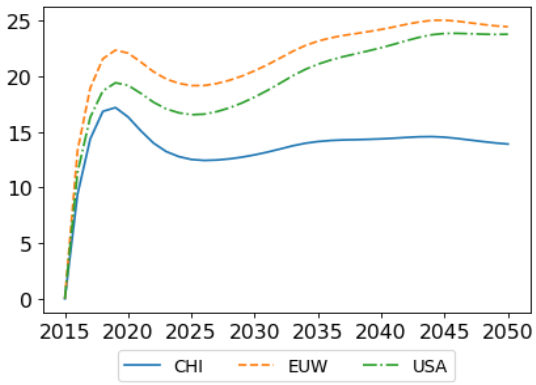
(h) Services Export (%)



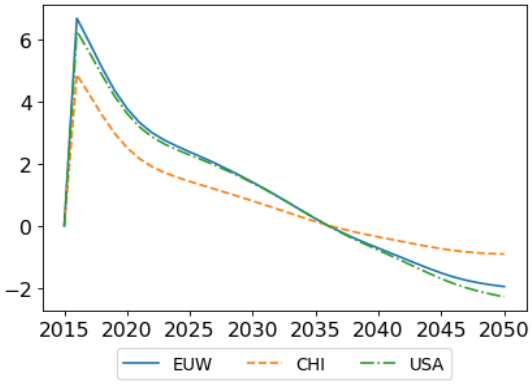
(i) Energy Import (%)



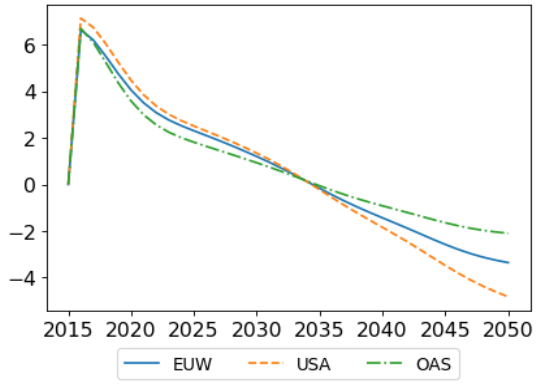
(j) Durable Manufacturing Import (%)



(k) Non-Durable Manufacturing Import (%)



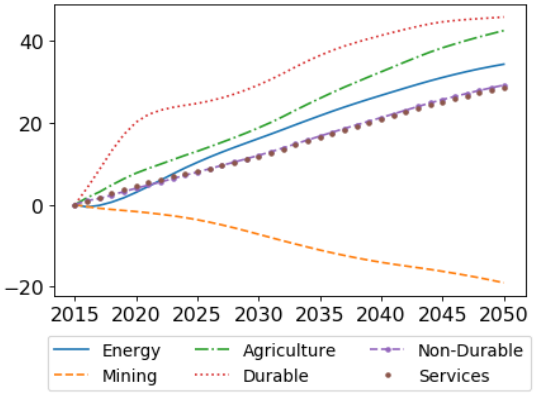
(l) Services Import (%)



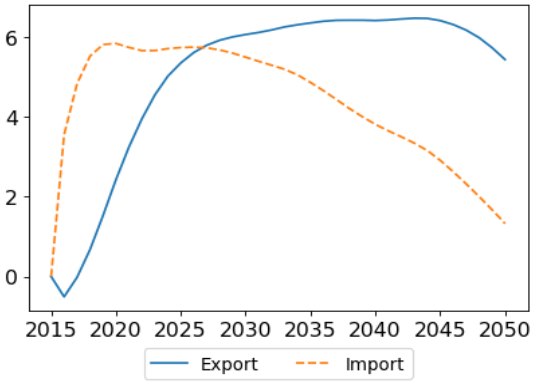
Source: G-Cubed Model GGG6M_v151

Figure 14 Impacts of Global Shocks on Australian Sectoral Output and Trade

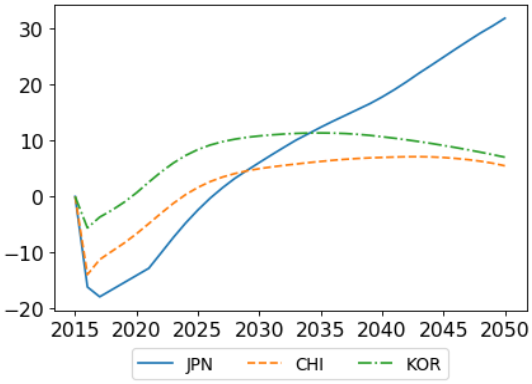
(a) Sectoral Output (%)



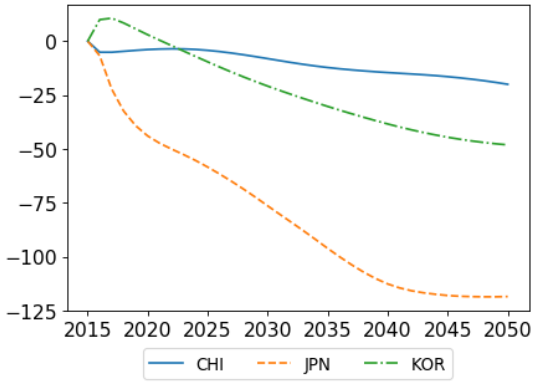
(b) Export and Import (%)



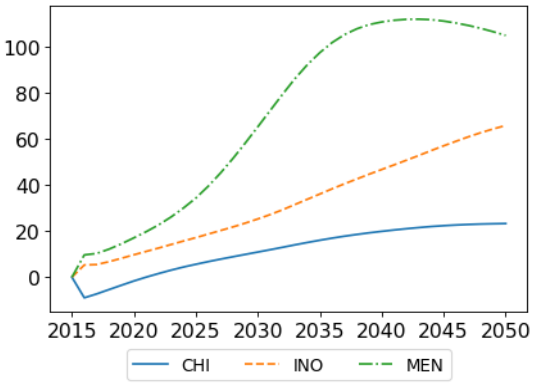
(c) Energy Export (%)



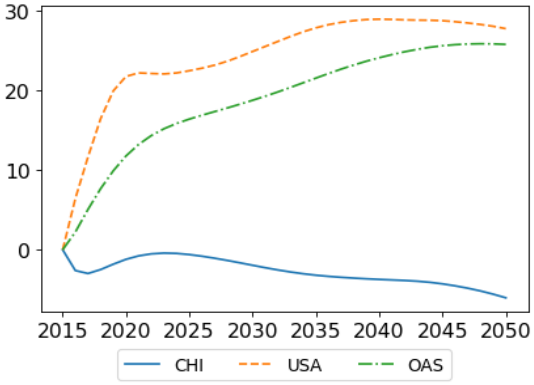
(d) Mining Export (%)



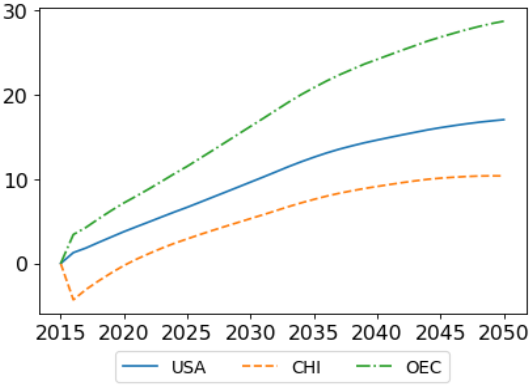
(e) Agricultural Export (%)



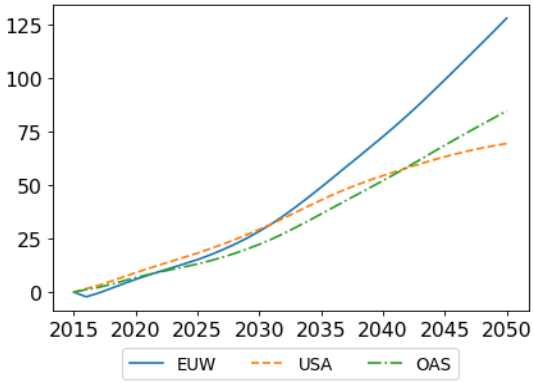
(f) Durable Manufacturing Export (%)



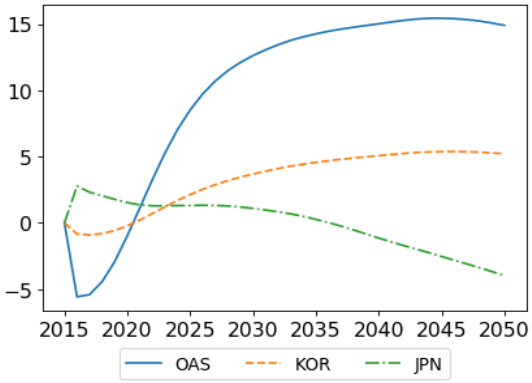
(g) Non-Durable Manufacturing Export (%)



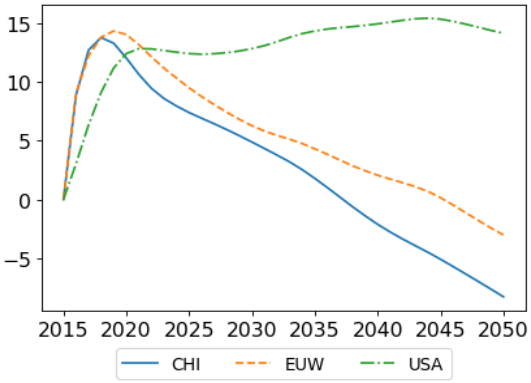
(h) Services Export (%)



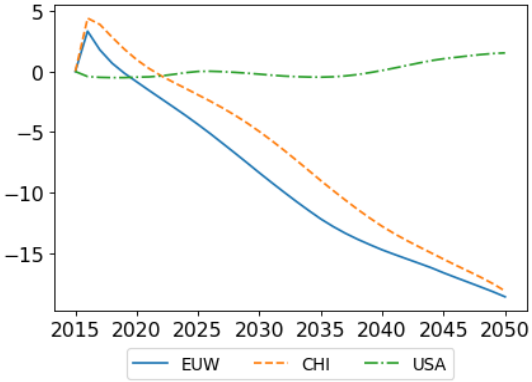
(i) Energy Import (%)



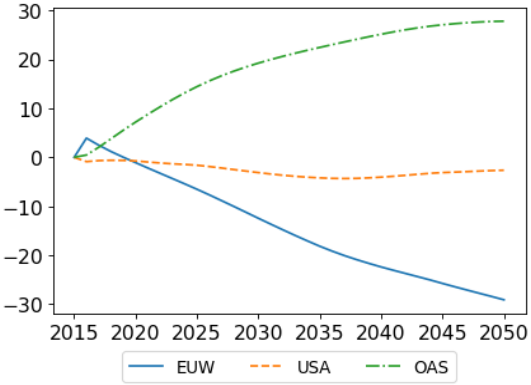
(j) Durable Manufacturing Import (%)



(k) Non-Durable Manufacturing Import (%)



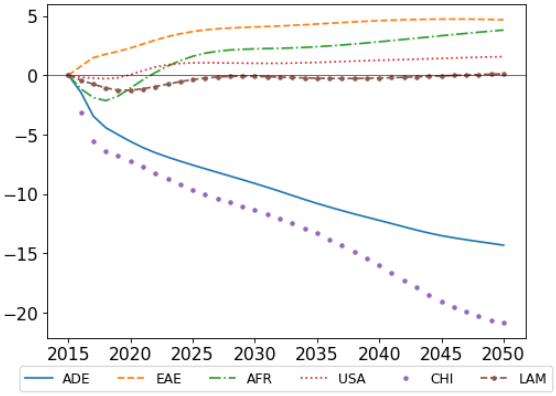
(l) Services Import (%)



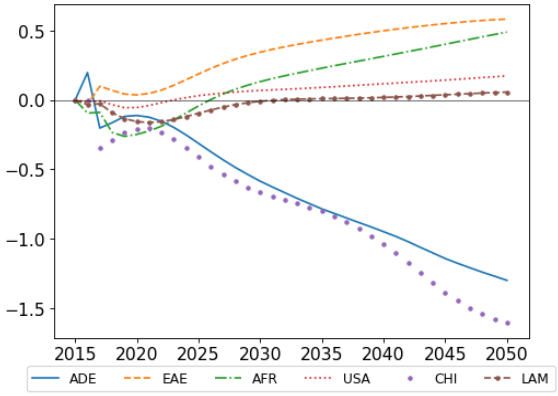
Source: G-Cubed Model GGG6M_v151

Figure 15 Macroeconomic Impacts of Regional Shocks on Australian

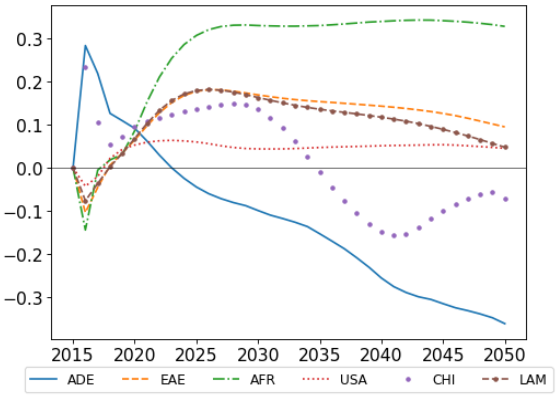
(a) Investment (%)



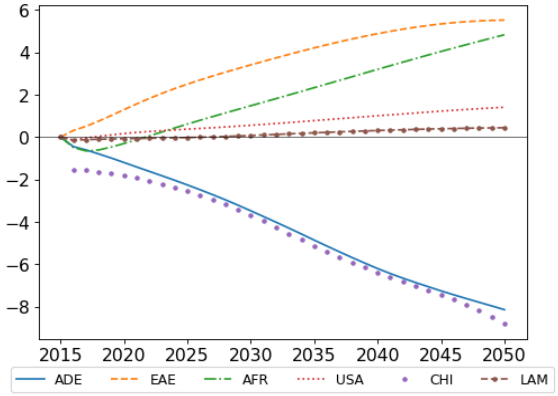
(b) GDP (%)



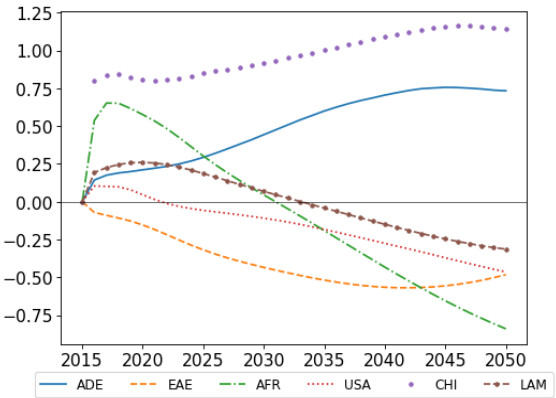
(c) Real Interest Rate (Percentage Point)



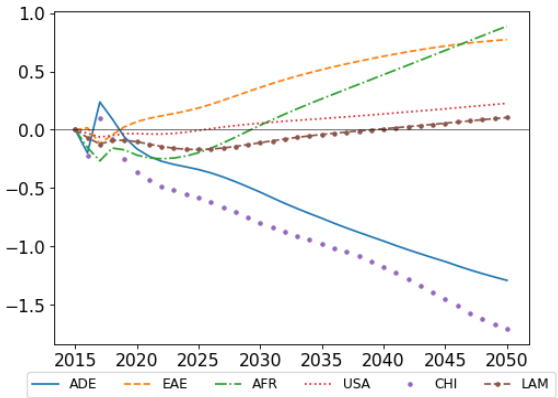
(d) Real Exchange Rate (%)



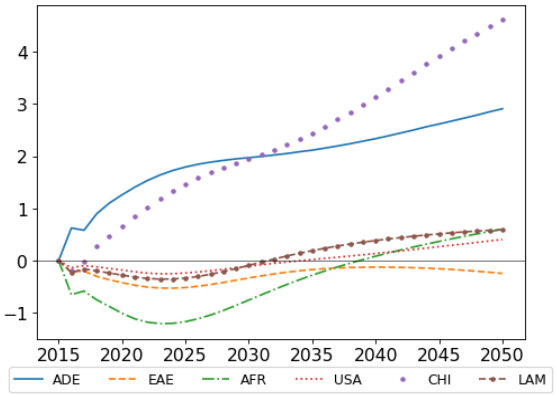
(e) Trade Balance (% of GDP)



(f) Real Wage (%)



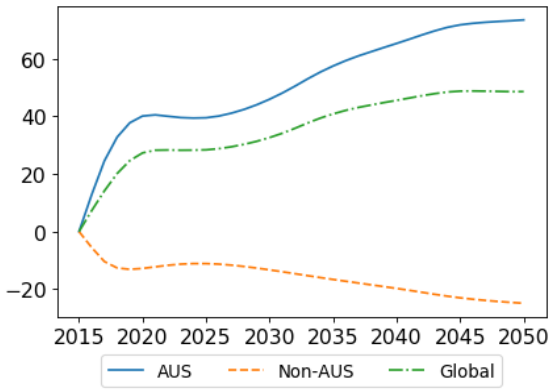
(f) Consumption (%)



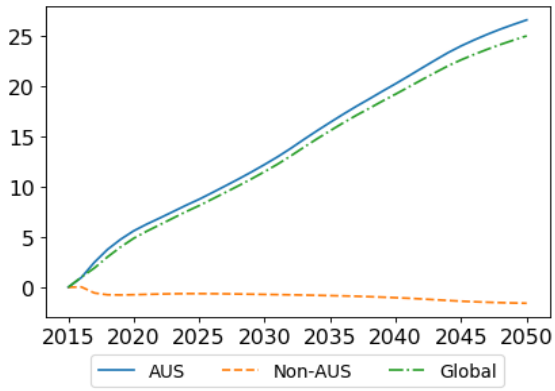
Source: G-Cubed Model GGG6M_v151

Figure 16 Macroeconomic Impacts of Global Shocks on Australia

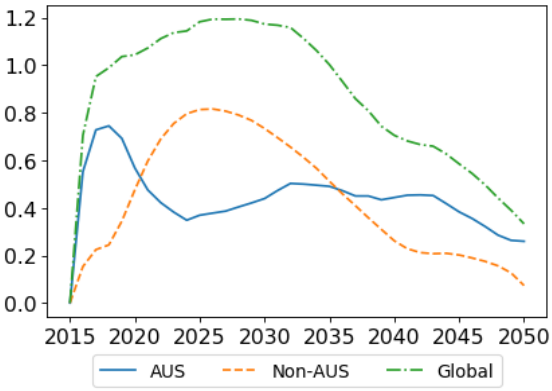
(a) Investment (%)



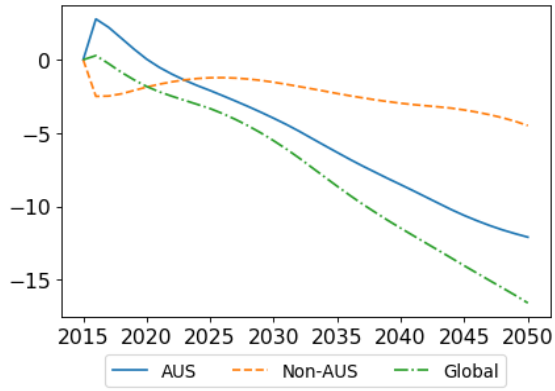
(b) GDP (%)



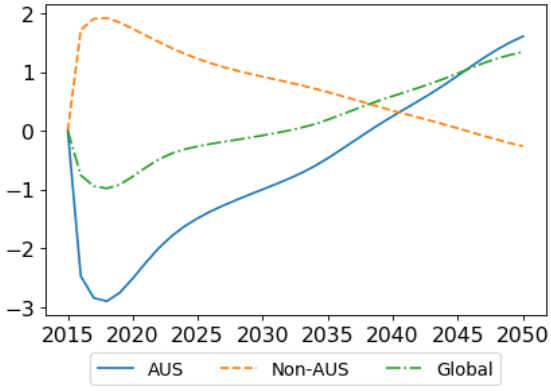
(c) Real Interest Rate (Percentage Point)



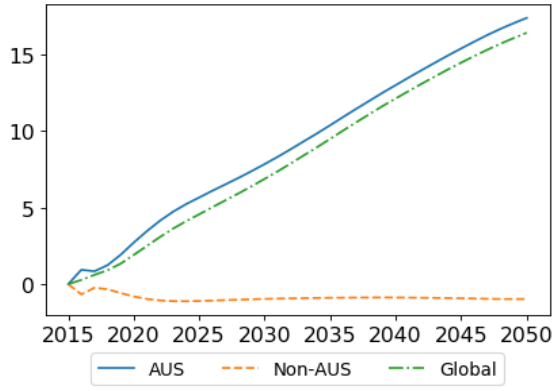
(d) Real Exchange Rate (%)



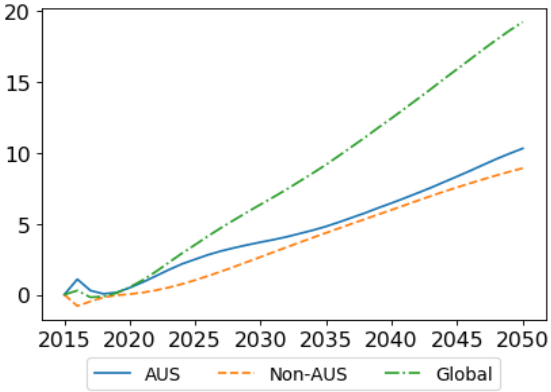
(e) Trade Balance(% of GDP)



(f) Real Wage (%)



(f) Consumption (%)



Source: G-Cubed Model GGG6M_v151