Achieving current account balance in long-run projections of the global economy in the dynamic GTAP model

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Abstract

A dynamic version of the GTAP model known as GDyn-FS, builds on the earlier GDyn model to, amongst other things, project a stable long-run baseline with non-convex adjustment costs and forward-looking consumers and producers. In a longer-term dynamic environment, however, without explicit modelling, current account balances across regions as a proportion of GDP can deviate beyond commonly regarded policy bounds of around 5 percent of GDP. This paper further develops the GDyn-FS model to ensure that current account balances as a proportion of GDP remain within a predetermined target range across projection periods reaching as far as 2100, while ensuring capital inflows are matched at a global level by capital outflows in each year. For this modelling, the reference (or target) values for current account balances across regions are drawn from historical experience and expectations regarding the course of economic development across countries or regions. The development provides a viable and policy focused method for the projection of long-run policy focused baselines inclusive of conventional foreign account constraints and the assessment of the progression of regional economies trade and investment through time. Some key areas for further research are identified.

JEL codes: C68, E17, E21, F11, F21, F43.
Keywords: Computable General Equilibrium Modelling, Trade Policy Analysis, Economic Growth, Foreign Investment, Dynamic Baselines.

1. Introduction

Accelerating economic transformation and diversification in the global economy can be accompanied by the build-up of current account imbalances. This potential is of policy and economic importance to discussions of how countries and regions may evolve to reach their longer-term growth potential while satisfying external balance constraints, and how effective trading and financial relations may evolve between countries and regions with differing social, legal and commercial traditions. This matter is of heightened importance as the balance of global economic gravity evolves.

Dynamic global computable general equilibrium (CGE) models provide a meaningful basis for analysing the potential impact of a changing trading and financial environment over the longer run. This study uses such a model to investigate possible paths for the evolution of the trade and current account balances as a proportion of GDP extending out to 2100. The model variant adopted is the GDyn-FS (Gretton 2021a). This model is an intertemporal version of the GTAP model adapted to ensure model stability in the longer run and extended to explicitly consider possible long-run paths for country and regional balances as a proportion of GDP,

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given prevailing growth assumptions. The modelling ensures capital inflows are matched at a global level by capital outflows in each year and global saving is equal to global investment. This study extends the analysis in Bekkers et al. (2020) which focuses on the trade account as the defining economic balance between countries/regions, while the longer-run focus complements policy assessments of short to medium-term financial vulnerabilities arising from current account imbalances (Carranza (2002), Davadas and Loayza (2018).

The long-run growth path adopted for the study reflects higher population and output growth in the developing world relative to the developed world according to SSP2 projections (Dellink et al. 2017). For the purpose of this study, this growth path is combined with two trade growth scenarios: (i) passive trade growth policies with trade growing broadly in proportion to output; and (ii) active trade growth policies with trade growing relative to output based on historical experience (Gretton 2021b). In this evolving environment, longer-run reference values for current account balances as a proportion of GDP across six systemically significant countries and regions are introduced, drawn from historical experience across those countries and regions. With the CAB determined by the balance of saving relative to investment ($S - I = CAB$), the saving rate and desirability of investing are considered as broad policy instruments for the determination of current account balances as a proportion of GDP.

This approach provides a viable and policy-focused method for the projection of long-run baselines inclusive of conventional foreign account constraints and the analysis of the progression of regional economies and trade and investment between regions through time. In doing so, it gives an additional perspective to the evolving national and global economic environment in which broad economic policy, and economic transformation and diversification strategies are formed.

The analysis indicates that even with passive trade growth policies, the CAB as a proportion of GDP can deviate materially from longer-term average relationships. Such deviations can become more prominent as trade grows relative to output with active trade growth policies. The analysis indicates that active policies toward national consumption-saving mixes or the desirability of investment would be required to realize CAB to GDP balances within conventional ranges (persistence) and/or achieve slowly declining imbalances towards country-specific ranges. Nevertheless, while it may be possible to bring CAB as a share of GDP to within a conventionally recognized target range of within 5 percent of GDP, specific target rates set in advance by reference to historical experience may not necessarily be realizable in the longer-term future. The analysis also indicates that there may be unanticipated flow-on effects to the BoT as a share of GDP with their own policy implications.

Further research would be worthwhile. Areas that may be fruitfully considered include: (i) the extension of the analysis to provide greater regional disaggregation than the six systemically important regions considered in this study; (ii) the veracity of underlying data used to calibrate historic validations scenarios and formulate longer-run modelling scenarios; and (iii) the influence in the immediate and longer terms of reinvested earnings (investment income that does not pass through the banking system) on the evolution of balances.

The GDyn-FS model used as the foundation for this study: (i) includes a capability to project a stable long-run base line with non-convex adjustment costs; (ii) allows imperfect mobility of capital and labour across activities within regions and for the trade in second had assets between activities; (iii) incorporates a rate-of-return rule for the allocation of saving between regions (capital-finance flows); (iv) relaxes the assumption of fixed shares (the Cobb-Douglas assumption) in the consumption-saving decisions of utility maximizing national households; (v) relaxes the Leontief technology assumption in intermediate input use; (vi) allows for exogenous national consumption-saving choices and trade intensities; and (vii) provides for the rebalancing of capital ownership between regions to allow for changes in

portfolio preferences, other structural changes and policy interventions not explicitly modelled. These features provide for model stability over the long run and enhance its usefulness as a tool for the analysis of structural change, and policy and other economic developments affecting the real economy at levels of sectoral and regional detail selected by the analyst. The tops-down methods developed in this paper provide additional capabilities for calibrating baseline trajectories and undertaking policy analysis. The model is solved using GEMPACK 12 software (Horridge et al. 2024).

The GDyn-FS model has to date been used in a range of policy related studies including: the effects of a decline in desirability of investing in Australia (Gretton 2021a), how vulnerable is Europe to severe climate-related natural disasters abroad? (Kuik *et. al.* 2022); projecting the long-run impacts of economic reform in Indonesia (Gupta *et al.* 2023); the multilateral context of EU-Australia economic cooperation (Gretton 2023); and the potential impacts of lower air transport prices in Australia (Gretton 2024).

Section 2 provides an historical perspective of the evolution of current account balances over time as background to the study while section 3 draws on recent policy and applied research concerning the implications and causal factors pertaining to current account imbalances. Section 4 then provides an overview of the longer-run modelling scenarios adopted while section 5 outlines the modelling framework including model enhancements and the models flexible dynamic lagged adjustment process. The lagged adjustment process approach allows key structural ratios to be targeted for an individual year (such as for historical validation) or over time (such as to reach long-run targets) according to user specification. This is followed in section 6 by a description of the database and enhancements made for the study. Section 7 then provides details of scenarios for the longer-run targeting of saving rates, trade shares and the CAB to GDP ratio. Section 8 elaborates on model closures used to implement the modelling across scenarios and phasing periods. Section 9 then reports key results focusing on the evolution of the CAB to GDP ratio over the historical validation period and the forward projection periods. Section 10 concludes the study.

2. Historical perspective

The growth in international trade in the post-World War 2 period has benefited from global institutions that have supported economic cooperation and development and domestic policies that have allowed countries' to open themselves to international trade and investment. This environment has allowed mutually beneficial trade with foreign firms competing in domestic markets, domestic firms growing through exports and the transfer of technology and ways of working between countries and regions.

The positive effects of global trade liberalization and domestic reform have seen the share of trade in global value added increase from around 12 percent in 1960 to 30 percent pre-GFC. Despite the signing of the WTO Bali Package in 2013 and the continued formation of bilateral and regional preferential trading agreements since the GFC, growth in trade has only just kept pace with the growth in global output. The current round of import tariff increases and barriers to trade recently initiated by the United States and the retaliatory action of trading partners' castes doubt about the future directions of global trade and associated economic benefits. These developments could have real and unexpected effects on current account balances and broader financial relations between countries. How these developments evolve and play out in measures affecting the current account balances between countries and associated net lending is uncertain.

This section provides an historical perspective on the modern evolution of current account balances across regions. It examines how countries current account balances have evolved over period 1990 to the pre-COVID year of 2019. Formally, the current account balance (CAB)

is defined as the difference between domestic saving and investment and is equal to the net lending (NL) from abroad, that is,

$$CAB = S - I = NL \quad (1)$$

where S and I are gross saving and investment, respectively.

National saving is also that part of gross national disposable income (GDY) that is not consumed (C), that is:

$$S = GDY - C \quad (2)$$

Noting GDP (Y) is the sum of domestic absorption ($C + I$) and net trade ($X - M$) and equal to gross disposable income (GDY) less net investment income (CR) less net other foreign income and current transfers (NT), that is,

$$C + I + X - M = GDP = GDY - CR - NT \quad (3)$$

Using 1, 2 and 3, the current account balance by component can be defined as:

$$S - I = CAB = X - M + CR + NT \quad (4)$$

If domestic saving were to exactly meet the requirements of domestic investment, the CAB (and NL) would be equal to zero. Net receipts from foreign trade, investment income and current account transactions ($X - M + CR + NT$) would also be zero. If domestic investment requirements exceeded domestic saving, the current account would be negative while if domestic saving went beyond domestic investment requirements, the current account balance would be positive. Actual balances in any one year would be influenced by longer term factors such as domestic investment opportunities relative to saving capabilities, the willingness of local and foreign investors to accumulate capital locally given sovereign risk, the evolution of technology and ways of working, demography, the demand and supply in the global economy and other environmental factors. In the short term, with the supply of factors and available technology largely fixed, the current account balance will be mainly influenced by current trading conditions, relative competitiveness in the trade, the body of net international finance upon which net foreign income accrues and the conditions governing transfers between jurisdictions. Given the interaction of longer-run and short-run factors, it would only be by coincidence that for any one country in any one year, the current account would be in balance. In the longer run, current account balances may be expected to gradually converge to country- specific values given national, regional and multilateral economic conditions.

World Development Indicators (WDI) data indicate the extent to which current account balances as a share of GDP (in current USD) have evolved across countries and across time. From this series, snap-shot values are taken for 115 countries[2] for which balances as a share of GDP are available in both 1990 and 2019, respectively (figure 1).

As noted, the 1990 reference year preceded the collapse of the Former Soviet Union, the 2004 enlargement of the European Union, and the accession of China to the WTO in 2001 as a non-market economy. The 2019 reference year precedes the impact of the COVID-19 global pandemic and recent trade tensions. The period also spans the Asian Financial Crisis and the Global Financial Crisis.

[2] Out of the 271 countries covered in the WDI database.

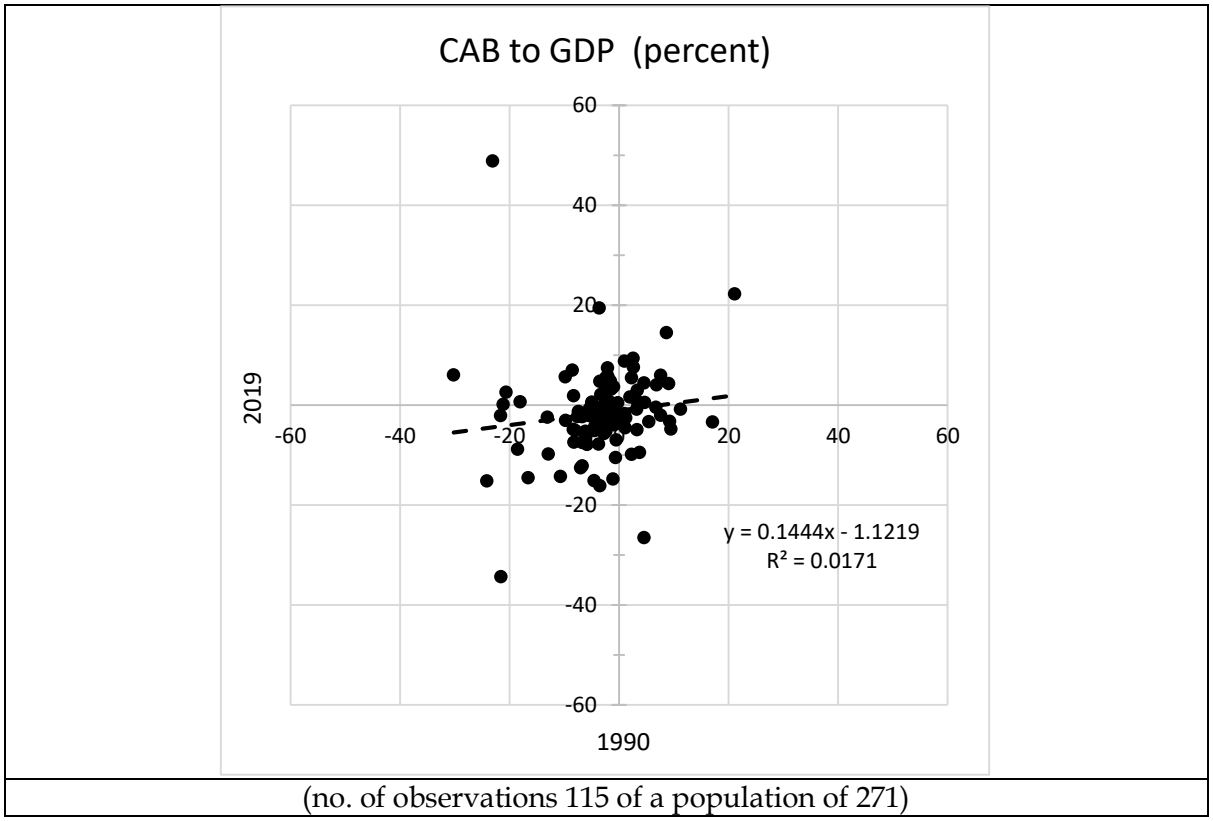
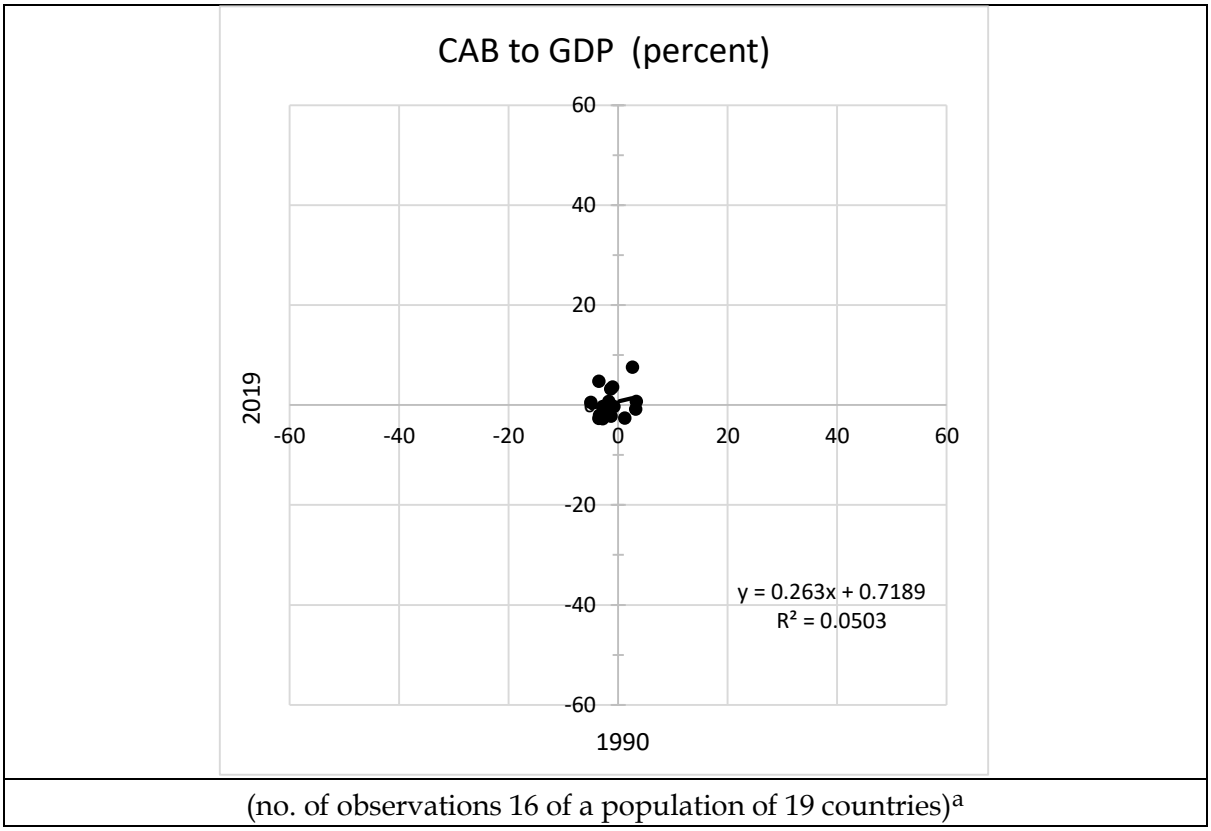


Figure 1: Current Account Balance to Gross Domestic Product by region (percent, current USD)

Source*: World Bank 2022, World Development Indicators. Author compilation.*

For the 115 countries for which data on the CAB to GDP are available in both years and notwithstanding the myriad of economic changes over the period, 76 (66 percent) had a balance with the same sign in both years — 62 negative in both years and 14 positive in both years — indicating a substantive degree of persistence across countries at least in respect of the direction of balance. There is also evidence of country concentration in both years around the origin with 86 percent of observed countries in 1990 and 87 percent countries in 2019 having balances falling within the range of plus or minus 10 percent of GDP. Within the observation group, 59 percent and 63 percent, respectively, had balances that fall within 5 percent of GDP. Nevertheless, country and year-specific factors are in evidence as indicated by a correlation between country values in the respective years of just 0.13 and an R-squared (coefficient of determination) of 0.0171 (figure 1).

Narrowing the cross-period comparison to sixteen of the G20 group representing the world's major and systematically important economies for which data are available in both years, it is found that nine (56 percent) had the same sign in both years — seven negative and two positive. All but one (Germany) had balances within 5 percent of the origin (figure 2), indicating a high degree of persistence and ordering in the economic management of factors determining the balance. Nevertheless, within this narrow range around the origin, country and year-specific factors are in evidence as indicated by a correlation between country values in the respective years of 0.22. Given the concentration of values with no visible trend, a low R-squared of 0.05 is reported (figure 2).



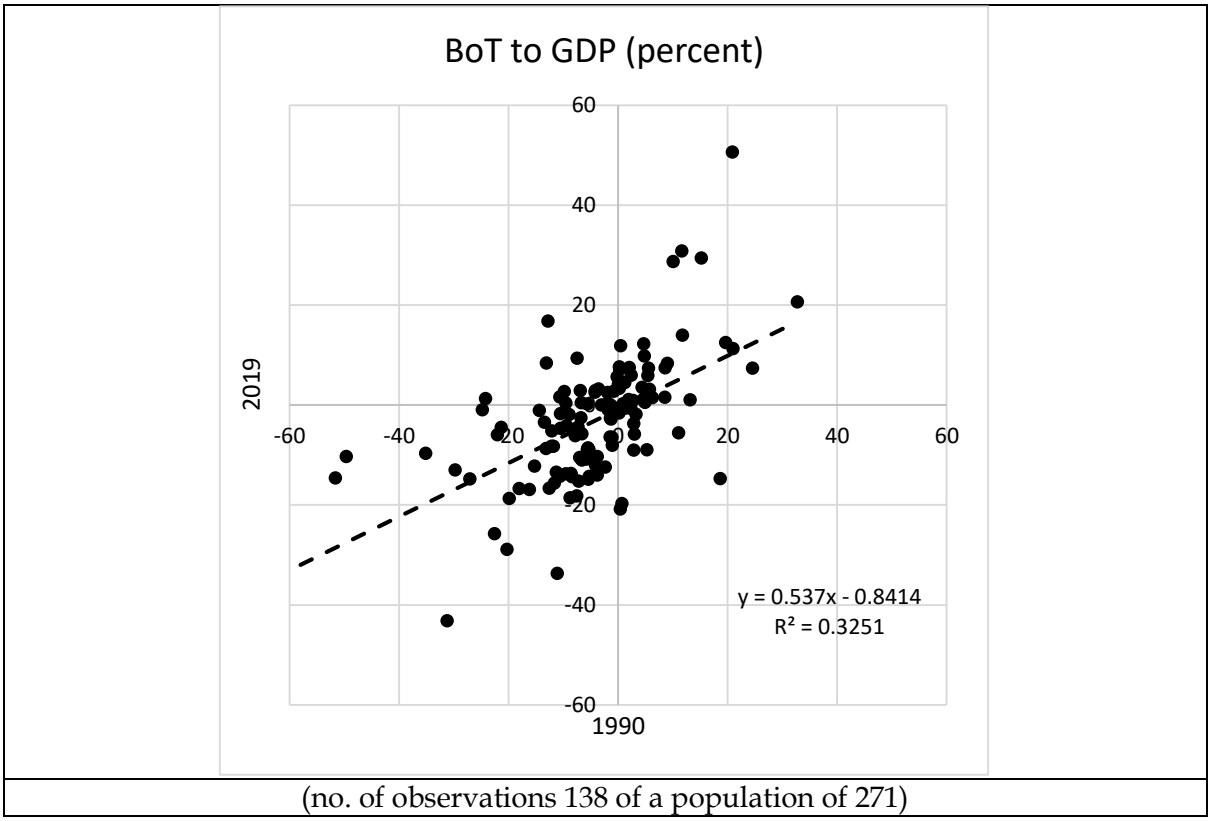
(no. of observations 16 of a population of 19 countries)[a]

Figure 2: Current Account Balance to Gross Domestic Product by G20 country (percent, current USD)

a G20 members include 19 countries (Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, Saudi Arabia, South Africa, South Korea, Turkey, the United Kingdom, and the United States), and the African Union and the European Union. Data for both sample years are not available for Brazil, Japan or Russia.

Source: World Bank 2022, World Development Indicators. Author compilation.

The balance of trade (BoT) is often linked to the broader concept of external balance of a country. In common with the CAB, historical data also indicate a substantial degree of persistence in the BoT as a share of GDP across countries between the observation years (figure 2). For the 138 countries for which data are available for both years, 103 (75 percent) had a balance with the same sign in both years — 68 negative and 35 positive. There is material dispersion around the origin for the observation group with only 67 percent of countries in 1990 and 64 percent of countries in 2019 having balances falling within the range of plus or minus 10 percent of GDP. If the range is extended to plus or minus 20 percent of GDP, it is found that 87 percent in 1990 and 91 percent in 2019 have balances within 20 percent of GDP. Despite this degree of dispersion, for countries with BoT to GDP estimates for both years, the presence of country-specific persistence, given the scale of estimates, is in evidence as indicated by a correlation of country values between the respective years of 0.57 and an R-squared (coefficient of determination) of 0.33 (figure 2).

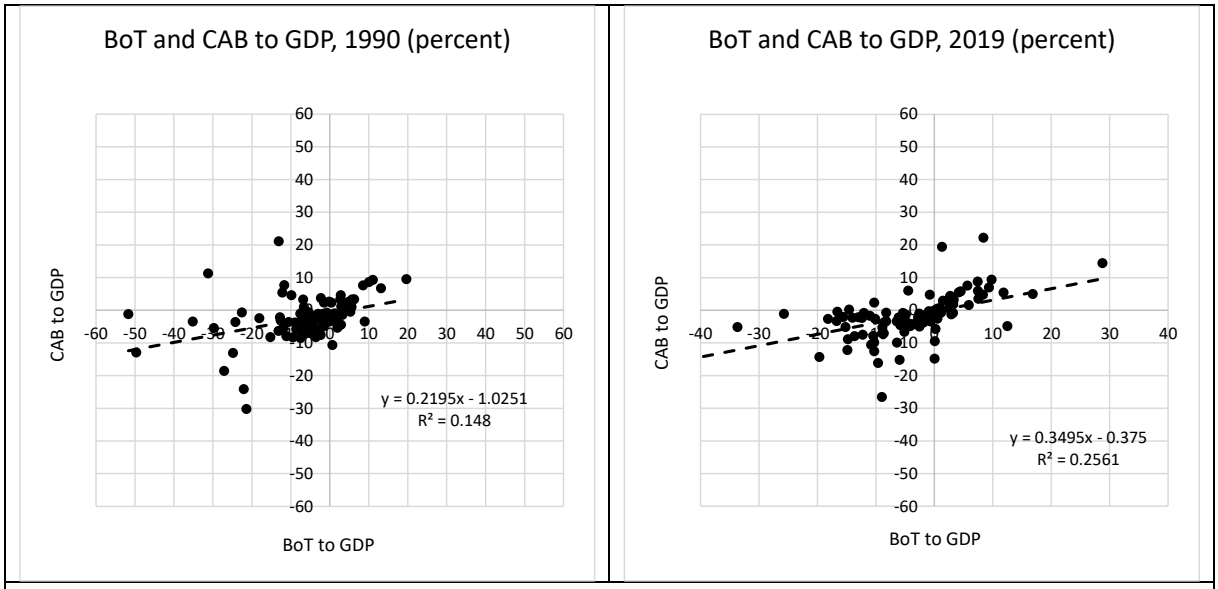


(no. of observations 138 of a population of 271)

Figure 2: Trade Balance to Gross Domestic Product by region (percent, current USD)

Source*: World Bank 2022, World Development Indicators. Author compilation*.

While the above country samples for the CAB to GDP and the BoT to GDP are not matched, it can be observed from the plots that BoT to GDP observations are more disbursed around the origin than the CAB to GDP observations. This observation is corroborated by a comparison between measures for 1990 and 2019 for 98 countries with data for both years (figure 3). Nevertheless, the relationship between the two indicators is slightly more regular in 2019 than in 1990 as indicated by correlation coefficients of 0.37 and 0.51 in 1990 and 2019, respectively, and coefficients of determination (R-squared) of 0.14 and 0.25 (figure 3). The deviation between measures in both years indicates that variation in foreign income and transfers is playing an additional and important role in defining the economic relationship between countries.



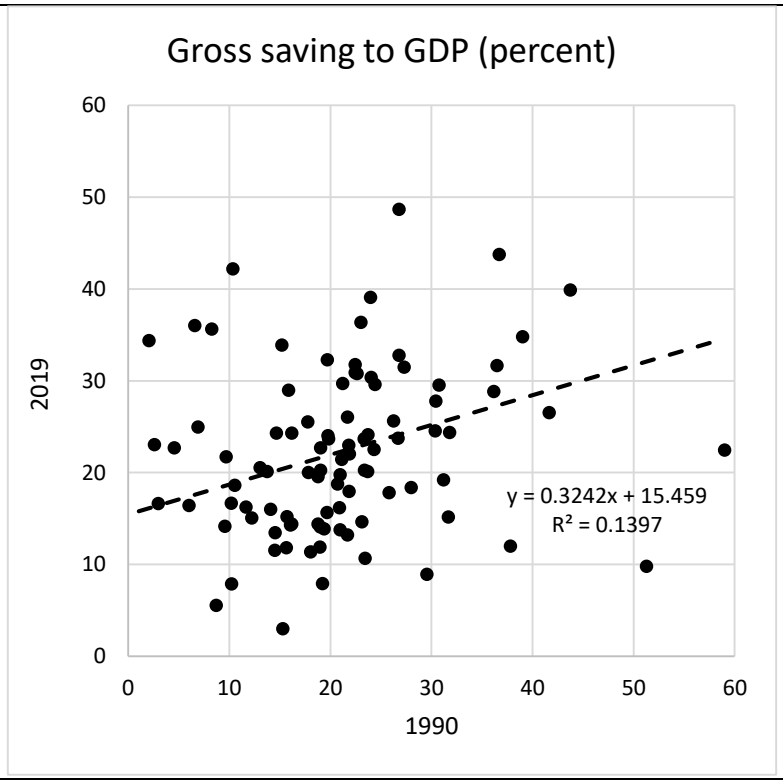
(no. of observations 98 of a population of 271)

Figure 3: Current Account Balance and Trade Balance to Gross Domestic Product by country, 1990 and 2019 (percent, current USD)

Source*: World Bank 2022, World Development Indicators. Author compilation.*

Savings generated through economic activity provides the financial resources for investment by resident households, firms and government both domestically and abroad. For a given level of domestic investment, saving also contributes positively to a country's current account balance (equation 1). A substantial degree of dispersion in rates between years is nevertheless, evident in the data (figure 4) indicating that this contribution is subject to country and year-specific factors. This between-year variation is reflected in the correlation coefficient for the sample of 0.37and a coefficient of determination (R-squared) of 0.13 (figure 4). While dispersion is marked, it may be noted that for the 97 countries for which data are available in both 1990 and 2019, 70 and 71 percent of countries were recorded with gross saving rates within the range of 10 to 30 percent of GDP, respectively. There is also a substantial representation of countries with relatively high gross saving rates, that is above 30 percent of GDP with 16 percent of countries in 1990 and 21 percent of countries in 2019 recording rates above that value. In the sample, five countries recorded saving rates above 30 percent of GDP in both years.

During periods of rapid growth value adding output has increased ahead of domestic consumption for some economies so that saving of national households as a proportion of output has risen substantially. This was so for Japan during its growth spurt during the 1960s and 1970s and for China particularly after its accession to the WTO in 2001. Where the additional saving has not been fully absorbed into domestic investment, and export led growth has been realized as balance of payments surpluses and foreign investment. While the saving rate for Japan has gradually moved to the neighbourhood of global averages, the latest estimates for China place its saving rate well above the historic average and above rates of other economies.

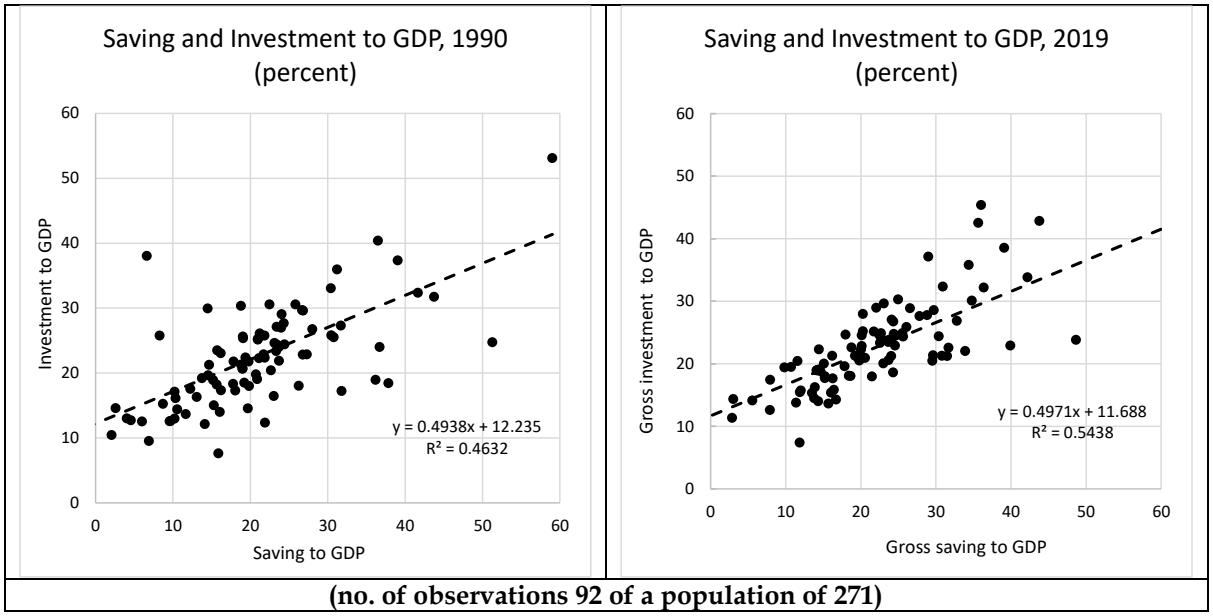


(no. of observations 97 of a population of 271)

Figure 4: Gross saving to Gross Domestic Product by region (percent, current USD)

Source*: World Bank 2022, World Development Indicators. Author estimates.*

Having observed the substantial variation in saving across countries and between years, the final determinant of the CAB is how investment varies with respect to saving. Feltstein and Horioka (1980) noted that in the case of perfect capital mobility an increase in saving in one country would lead to an increase in investment in all countries while with less than perfect capital mobility proportionately more incremental saving in each country would be absorbed by investment in that country. Their empirical study of saving and investment rates of 16 OECD countries in four-year segments over the period 1960-4 to 1970-4 provided support for the latter view. They concluded: '…Although there may be perfect arbitrage of short-term yields and substantial flows of long-term direct and portfolio investment, there appear to be sufficient rigidities and locational preferences to keep most of any incremental saving invested in the country of origin'. The snapshot data for the years 1990 and 2019 for countries with saving and investment as a proportion of GDP reported for both years, indicate a positive correlation coefficient between saving and investment to GDP of 0.68 in 1990 and 0.73 in 2019. The coefficient of determination (R-squared) between saving and investment to GDP is 0.46 and 0.54 respectively (figure 5). These broad data would appear to support a view that over a span of time most incremental saving is invested at home. But the data does not rule out country and year-specific factors that bring about saving and investment gaps, as can be seen in figure 1 and that these gaps can be persistent over extended periods depending on country circumstances and conditions.

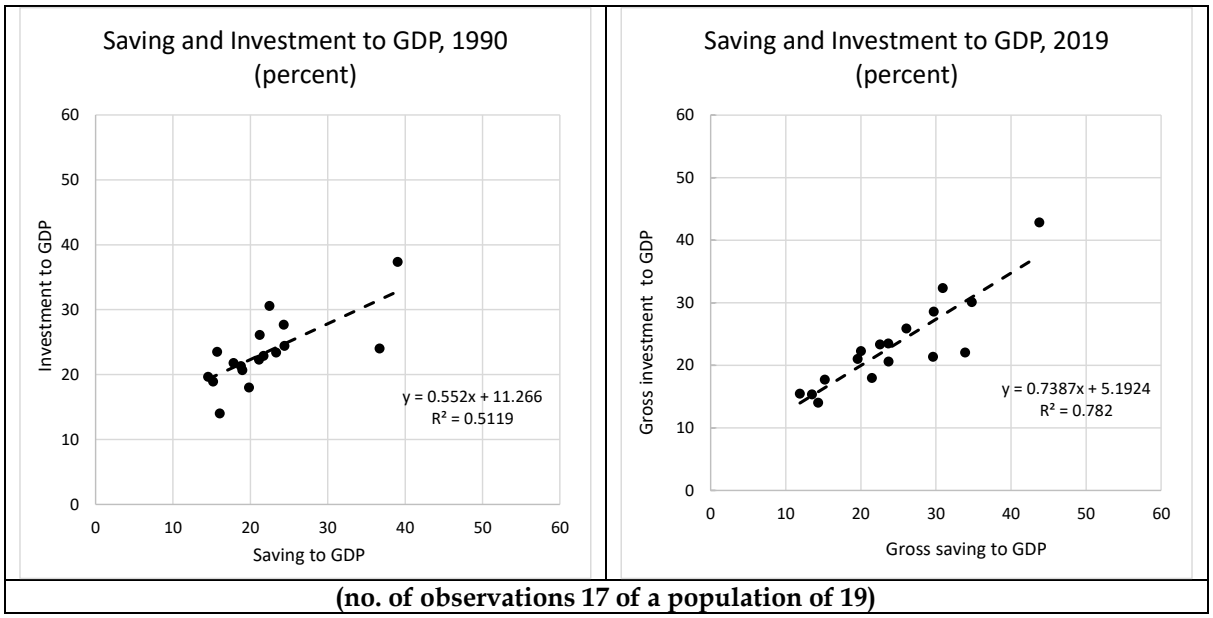


(no. of observations 92 of a population of 271)

Figure 5: Gross saving and Gross Investment to Gross Domestic Product by region, 1990 and 2019, (percent, current USD)

Source*: World Bank 2022, World Development Indicators. Author compilation.*

For the systemically important G20 countries, data are available for 17 member countries for both years. For these countries, the correlation coefficient between saving and investment to GDP is higher at 0.72 and 0.88, respectively for the two observation years while the coefficient of determination is also higher at 0.51 and 0.78, respectively (figure 6).



(no. of observations 17 of a population of 19)

Figure 6: Gross saving and Gross Investment to Gross Domestic Product for 17 G-20 countries,[a] (percent, current USD), 1990 and 2019

a G20 members not included are Japan and Russia.

Source*: World Bank 2022, World Development Indicators. Author compilation.*

The statistical snap-shot information indicates that it is unlikely that a country will be in current account balance in any one year other than by coincidence. It also indicates that country differences and year-specific factors will be in evidence across countries and over

time, and that there can be a degree of persistence as to the balance sustained by an individual country or country group. The data also indicates that for some country groups (such as the G20) noted above and selected OECD countries analysed by Feldstein and Horioka (1980) that a greater tendency towards balance is evident than for the wider community of countries.

3. Some observations from the literature

The policy and empirical literature focusing on the CAB separates the evolution of current account balances in times of economic crisis from the business-as-usual case. It also is not, as might be expected from the data, prescriptive about the level of a current account balance as a share of GDP, other than a prevailing balance or trend that does not in itself, lead to economic crisis. The literature is also not prescriptive as to an appropriate balance that may be displayed by an economy over time although, consistent with the data, it does suggest that current account positions are likely to be moderately persistent or slow moving over time with actual levels determined by country characteristics.

Carranza (2002) observed that the empirical literature considers persistent deficits above 5 percent of GDP to be unsustainable in the long run, although, notwithstanding this, Carranza (2002) observed that some countries had run persistently large current account deficits without facing external financing problems. In assessing tractability of current account deficits, Carranza (2002) reported that the literature has adopted two main approaches: (i) a solvency approach, whereby at any time the net present value of future surpluses on the external balance of goods and services (called primary surpluses) is greater than or equal to outstanding external indebtedness; and (ii) the willingness to invest approach, whereby at any time international investors are willing to lend to the country given country prospects and its current policy stance. Carranza (2002) suggested that because current account balances come from the interaction of both private agents' intertemporal decisions and government policies, such deficits are not necessarily of concern. Nevertheless, because of the potential economic harm that may arise from an unsustainable deficit, Carranza (2002) observes that a large body of the empirical literature has been devoted to finding variables highly correlated with external crises. Variables posited to be associated with crises include policy settings and structural factors such as economic growth relative to debt-servicing obligations, a deterioration of external solvency arising from a widening of an investment-saving gap, a degree of economic openness and trade patterns that increases vulnerability to external shocks, and a size and composition of external liabilities and financial structure that raises the risk of destabilizing capital outflows.

Sadiku *et al.* (2015) in a later review of the empirical literature regarding the determinants of current account balances observed that some empirical studies have analyzed the determinants of the current account balance to ascertain whether a balance can be considered as 'regular' for a state, based on macroeconomic and structural attributes. Sadiku *et al.* (2015), report that studies focusing on short-term current account fluctuations are based on the assumption that current account acts as a buffer against temporary shocks to income and to smooth consumption whereas studies with a medium to longer term adopt a saving-investment perspective.

Devadas and Loayza (2018) focus on the question of the circumstances under which a current account balance to GDP is in itself 'bad'. They suggest that this is likely to be the case when the deficit is: (i) persistently large; (ii) supports domestic consumption rather than investment; (iii) occurs alongside domestic credit growth; (iv) follows an overvalued nominal exchange rate; or (v) accompanied by unconstrained fiscal deficits (excessive government consumption). Devadas and Loayza (2018) also suggest a current account deficit can be optimal when: (i) there is high productivity or average output growth; (ii) there is capital deepening in the early stages of development; and (iii) the age-dependency ratio is high. They

observe that the first two characteristics can be associated with high domestic investment relative to saving and foreshadow increases in potential future output and capacity to service foreign debt. The third can be associated with drawing on accumulated saving embodied in domestic and foreign assets generated in the past.

At the country level, Carranza (2002) provided case studies of episodes of rising current account deficits as a share of GDP over the 1970s to the 1990s for five countries – Canada, Argentina, Chile, Mexico and Thailand. On one hand, Canada's ability to maintain continued access to international credit markets with a current account deficit as a share of GDP without economic crisis was attributed to consistent government adherence to a policy mix with serviceable fiscal deficits and strong real sector performance. On the other hand, Argentina, Chile, Mexico and Thailand were identified as experiencing marked rises in country current account deficits as a share of GDP associated with economic crisis on account of: unsustainable fiscal deficits (Argentina); real currency overvaluation and financial system weakness (Chile); adverse economic shocks and misalignment of nominal and real exchange rates (Mexico); and over investment, a poorly regulated financial system, untenable composition of external debt and deteriorating external conditions (Thailand).

Sadiku *et al.* (2015) apply an autoregressive distributed lag (ARDL) model, to explain the evolution of the current account as a share of GDP for the Former Yugoslav Republic of Macedonia (FYROM) – a country that had been continually in deficit. Using data for the period 1998 to 2013, Sadiku *et al.* (2015) find that financial development (represented by M2 as a share of GDP), the fiscal balance and terms of trade are positively correlated with the current account balance, while openness to international trade (measured by exports plus imports as a share of GDP) is negatively correlated with the current account balance. Through a lagged adjustment process they confirm persistence in current account deficits for the FYROM.

Altayligil and Cetrez (2020) use panel data for the period 1986 and 2013 of 97 countries (53 classified as developing and 44 developed) to estimate the determinants of current account balances as a proportion of GDP. Altayligil and Cetrez (2020) found that across the sample a rise in the growth rate, real effective exchange rate, fiscal deficit, trade openness, institutional quality, financial market development and stage of development are associated with larger current account deficits (lower surpluses) as a proportion of GDP. On the other hand, a rise in terms of trade, the inflation rate (representing macroeconomic stability) and crude oil exporting are associated with lower current account deficits (higher surpluses). For industrial countries[3] within the sample, macroeconomic stability and growth were found to be associated with lower deficits (higher surpluses), the opposite to the full sample.

The main guidance that seems to be afforded by the literature for the formation of longer-run baselines inclusive of CAB to GDP target ranges is that country-specific factors are the main determinants of country or regional values that may be adopted and that a broad policy bound of around 5 percent of GDP provides a reasonable, but not necessarily binding, bound against which to assess country or regional values.

4. Baseline and longer-run scenarios

The contemporary trade tensions between countries and emerging pressures to source locally place the development strategy based on openness at risk. The incentives to shift to domestic production would afford shelter to industry support and protectionist trade policies. While securing domestic supplies would increase the incentives for domestic inventiveness, erosion of trade openness would likely reduce the flow of disembodied and embodied technologies between countries and regions, lowering growth potential across regions.

[3] Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Holland, New Zealand, Norway, Portugal, Spain, Sweden, Swiss, UK, USA.

These and other factors suggest that there is considerable uncertainty about likely trends in trading relations between countries into the immediate term and into the longer-run future. How these tensions play out will provide the backdrop for the evolution of current account balances as a proportion of GDP. To illustrate possible future directions in global trade and provide a meaningful backdrop, this study considers the impact on the intensity of trade between regions for two trade growth scenarios, namely, (i) a status quo benchmark and (ii) a historically-based trade-growth scenario. In both scenarios, the trade balance as a share of GDP is assumed to persist at historical levels. Country-specific saving rates are projected to converge to country-specific rates based on historical data, cross country comparisons and theory. In particular, the saving rate for China is projected to converge to the neighborhood of rates for other regions.

Against the backdrop of these two trade-saving scenarios, the evolution of current account balances as a proportion of GDP is observed to 2050 for each scenario. From 2050 to 2100, the current account balance as a proportion of GDP is assumed to gradually converge to rates suggested by the historical data with the trade ratios varying (that is, slack).

The analysis is supported by a number of model enhancements and an historical validation of the model over the period 2011 to 2021. These years correspond to the benchmark year of the modelling and a year that takes into account the early effects of COVID-19. It also covers the post-GFC period of flat growth in global trade as a share of global product and the emergence trade and economic tensions (figure 7).

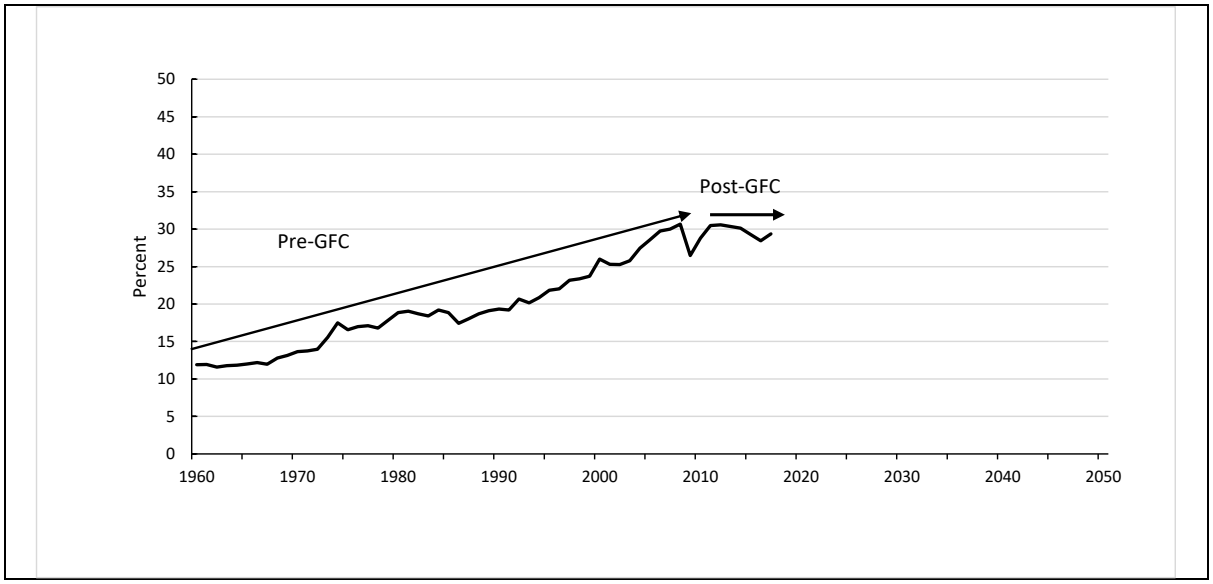


Figure 7: Global Exports to Global Product (percent, current USD)

Source: World Bank 2022, World Development Indicators. Author compilation.

The simulations use a database with 6 diverse systemically important regions — Australia, China, Japan, the United States, Europe-28 and the Rest-of-the-World (ROW) — and 13 industry sectors — two agriculture, one mining, four manufacturing, five services plus ownership of dwellings (Gretton 2018, 2019, 2021a,b, 2022). Five primary factor inputs are modelled — land, natural resources, skilled labour, unskilled labour and (produced) physical capital. The database reference year is 2011. As noted, the illustrative application is reported to 2100.

Following Gretton (2021), the model data base is projected from 2011 to 2021 using estimates of GDP growth, population and skilled and unskilled labour drawn from World Bank World Development Indicators and ILO labour market data, plus investment growth (not in Gretton 2021). Over the forward period, projections are drawn from IMF World

Economic Outlook (to 2027) (IMF 2022), ILO labour market projections (to 2022) (ILO 2020) together with long-run projections that follow the medium growth scenario of Shared Socioeconomic Pathway projections (SSP2) (Dellink *et al.* 2017) as annualized by van der Mensbrugge (2013), aggregated according to Aguiar (2019) and spliced for this study with the ILO labour market data. The SSP2 growth scenario adopted assumes medium growth across the global TFP frontier, gradual convergence of economies toward that frontier, transition to openness, population, labour force, human capital and fossil fuel resource use and prices.

Under the SSP2 growth assumptions, global population is projected to reach 8.3 billion in 2030 and 9.3 billion in 2050, broadly in line with UNDESA projections of 8.5 and 9.7 billion at 2030 and 2050, respectively (UNDESA 2022). Population and population growth to 2050 (and beyond) is projected to be concentrated in the ROW region.

5. Modelling framework

5.1 Overview of simulation model

The GDyn-FS model is a multi-sector, multi-region recursive dynamic computable general equilibrium (CGE) model of the world economy. It combines the economies of individual regions through multilateral trade, associated transport services and the capital-finance flows. GDyn extends the comparative static version of GTAP (Hertel and Tsigas 1997, Corong et al. 2017) by the inclusion of imperfect mobility of capital finance between regions, endogenous capital accumulation and an adaptive expectations theory of investment (Ianchovichina and McDougall 2012 in Ianchovichina and Walmsley 2012). The GDyn-FS model used as the foundation for this study, develops the originating model to: (i) include a capability to project a stable long-run base line with non-convex adjustment costs;[4] (ii) reflect imperfect mobility of capital and labour across industries; (iii) introduce a rate-of-return rule for the allocation of saving between regions (capital-finance flows), (iv) relax the assumption of fixed shares (the Cobb-Douglas assumption) in the consumption-saving decisions of national households; (v) through imperfect mobility of capital across activities within regions, allow for the trade in secondhand assets between sectors; (vi) relax the Leontief technology assumption in intermediate input use; (vii) include exogenous national consumption-saving choices and trade intensities; and (viii) provide for the rebalancing of capital ownership between regions to allow for changes in portfolio preferences, other structural changes and policy interventions not explicitly modelled. These features provide for model stability over the long run and enhance its usefulness as a tool for the analysis of structural change, and policy and other economic developments affecting the real economy at levels of sectoral and regional detail selected by the analyst (Gretton 2018, 2019).[5]

In the core of the model, producers in each region are divided into industries that are assumed to minimize costs subject to a constant returns to scale technology. In the GDyn-FS model, capital and labour are, as noted, treated as being imperfectly mobile between industries while agricultural land and natural resources are assumed to be only used by rural and extractive industries, respectively. Industries are treated as having flexibility in the use of intermediate and value adding inputs.

The representative regional household receives income generated from labour services and the ownership of local and foreign-located capital, land and natural resources. Income from product and factor taxes also accrues to the regional household. With this income, regional

[4] The condition for long-run stability in GDyn-FS requires the convergence of the model rates of return so that $RORGROSS = RORGEXP = RORGTARG$ and $rorg = rorge = rorgt = 0$ by region in the longer run, where RORGROSS is the gross rate of return, RORGEXP is the inter-period expected rate of return and RORGTARG is the target (long-run risk adjusted) required rate of return. rorg, rorge, and rorgt are the percentage changes in the respective coefficients (Gretton 2018).

[5] GDyn-FS conforms to model homogeneity and market clearing conventions (Appendix B).

households maximize utility through private consumption, government consumption and savings. Total household consumption is distributed across products in accordance with product price and aggregate consumption expenditure while government consumption is distributed across products in fixed proportions. Regional household savings are distributed back to investment at home and abroad (via foreign investment in a 'global trust' which acts as a notional clearing house for foreign investment across regions).

Products used as intermediate inputs, consumption and investment are sourced domestically and from imports (by product and region). The demand for international transport services is attached to international trade flows with supply by region being pooled in constant proportions. Cost minimizing regional firms' source finance from the regional household and from global saving (via the 'global trust').

As a real-economy model, GDyn-FS does not include money or bond markets, and assumes that all real changes are accommodated by broader monetary policies. While the model separately delineates government consumption and taxes on products and primary factors of production, it does not model the net fiscal position of governments and associated impacts on bond markets.

5.2 Simulation environment and model enhancements

Simulations begin with an observed database for the initial period. It would only be by coincidence that this database is representative of future periods. Baselines are therefore simulated in order to provide a reference case against which the impacts of policy or other economic change may be assessed. Reference cases in modelling generally incorporate standard assumptions about population, productivity and consumer tastes. They may also include changes in investment, structural changes and factors related to changes in the physical environment. Under a dynamic approach, 'policy' scenarios then apply shocks to the baseline to project the potential impacts of the policy or other change being assessed. The difference between the policy scenario and the baseline represents the economic effect of the change over time.

To support analysis of evolving saving and trade intensities within a baseline (and in a policy simulations if desired), the GDyn-FS model incorporates a flexible lagged adjustment processes to: (i) target the gross saving rate and trade intensities over the historical period; and (ii) gradually adjust to longer-run target measures based on historical trends and theory Gretton (2021). To facilitate the targeting of gross saving on a System of National Accounts basis, savings were adjusted from a GTAP basis (Hertel and Tsigas 1997:53, McDougall et al. 2012:131, Corong et al. 2017:8) to a System of National Accounts basis consistent with benchmark estimates of the CAB to GDP provided in World Development indicators (see below).

This paper extends Gretton (2021) by incorporating a flexible lagged adjustment process to target the current account balance (CAB) as a proportion of GDP. To facilitate the targeting of the current account balance on a System of National Accounts basis, the database has been augmented by non-investment foreign income and transfer inflows and outflows in such a way as to reconcile CAB to GDP estimates in the model database with World Development Indicator estimates.

The application of these extensions, data revisions and parameter choices are detailed below.

Flexible dynamic lagged adjustment process

As noted, the GDyn-FS model adopts a flexible dynamic lagged adjustment process to draw coefficients on structural ratios to a reference (or target) value. To date the coefficients so targeted in GDyn-FS are: exports, imports and the balance of trade (BoT) to GDP and gross saving to GDP. This study extends the analysis to target the Current Account Balance to GDP.

The flexible dynamic adjustment process includes two components. In the first component, it is assumed that the gap between the simulated and the target values for the respective coefficients closes gradually, such that:

$$RG\_R_r = \left(\frac{RTARG_r}{R_r}\right)^{\lambda_r} \quad \textbf{(7)}$$

where the RG_R_r represents required growth in coefficient R_r – a coefficient of interest in region r, $RTARG_r$ represents the reference (target) value of coefficient R_r and λ_r represents a region-specific adjustment parameter with values $\mathbf{0} < \boldsymbol{\lambda_r} < \mathbf{1}$. In the second component, it is assumed that the gap between the simulated ratio and the target value closes as far as possible in one year, such that,

$$RG\_R_r = \left(\frac{RTARG_r}{R_r}\right) \quad (8)$$

This element applies in particular to historic validation simulations in steps of one year, that is, implicitly with $\boldsymbol{\lambda_r} = \mathbf{1}$. The form taken in a simulation, is determine by a coefficient-specific flag such that $IF\ FLAG_r = 1$ equation (7) would apply and if IF F$LAG_r = 0$ equation (8) would apply. The partial adjustment theory is implemented in the model for all targeted coefficients in the percentage change form, that is:

$$RRG\_R_r = 100 * \lambda_r * ln\left(\frac{RTARG_r}{R_r}\right). \quad (9)$$

Building on this partial adjustment theory, a number of adaptations are made to: (i) align model theory to reference data; (ii) align model theory to reference data with negative coefficient values; and (iii) allow for the co-determination of the numerator and the denominator of coefficients in a simulation year. First, reference information on saving as a share of GDP used to determine target values ($RSAVEGTARG$) are provided on a gross basis (that is inclusive of the value of depreciation), whereas the model theory determines the disposition of income on a net basis (that is, after deducting depreciation). To align the indicator information to the model data, it is necessary to convert gross saving to GDP targets to a net basis ($RSAVEYTARG_r$), that is:

$$RSAVEYTARG_r = \left((RSAVEGTARG_r * GDP_r) - VDEP_r\right) \Big/ INCOME_r \quad (10)$$

where $RSAVEGTARG_r$ is the target gross rate of saving in region r determined from supporting data and theory, GDP_r is gross domestic product, $VDEP_r$ is the value of depreciation and $INCOME_r$ is net national income. Second, because saving is simultaneously determined with income, to enable the use of the saving rate to be endogenously determined for example in the targeting of the CAB to GDP (the focus of this paper), it is necessary to lag the target gross saving rate by one year. Under this approach the rate for year $t + 1$ is included as a dummy coefficient $DRSAVEGTARG_r$ in year t in the model database. For example, the designated target rate for 2012, the first year for the baseline simulation in this study, is included in the input files for the first period of the base case, that is, 2011. This recording convention is also applied to the BoT, investment and the CAB as shares of GDP, but not exports or imports.

Next, as coefficient values for net saving,[6] the BoT and the CAB may be negative in any one year, a treatment that allows for such values is needed. For saving, this is done using (eqn 10) and by re-expressing the argument in the dynamic adjustment process (eqn 9) in terms of consumption, that is:

$$ARGLOGCON_r = (1 - RSAVEYTARG_r) \Big/ (1 - RSAVEY_r) \quad \textbf{11}$$

where $ARGLOGCON_r$ is the argument for region r of the logarithmic function in (9), $RSAVEYTARG_r$ is as defined in (10) and $RSAVEY_r$ is the net rate of saving for a period.

[6] For example, there are 17 instances of negative net saving appearing in the 141 region 2011 standard GTAP database.

For the BoT and CAB, respectively, this is done by indexing the relevant shares to unity, that is,

$$ARGLOGTBALG_r = {(1 + TBTOGDPTARG_r)}/{(1 + TBTOGDP_r)} \quad 12$$

and

$$ARGLOGTCABG_r = {(1 + CABTOGDPTARG_r)}/{(1 + CABTOGDP_r)} \quad \mathbf{13}$$

where $ARGLOGTBALG_r$ is the argument on the BoT share in GDP in region r, $TBTOGDPTARG_r$ the target BoT share and $TBTOGDP_r$ is the estimated share for the period. Similarly, $ARGLOGTCABG_r$ is the argument on the CAB share in GDP in region r, $CABTOGDPTARG_r$ is the target CAB share and $CABTOGDP_r$ is the estimated share for the period. Gross investment to GDP is assumed to be always positive.

The long-run stability conditions for each of the structural variables so targeted are:

$$\begin{gathered} EXPTOGDPTARG_r = EXPTOGDP_r \\ IMPTOGDPTARG_r = IMPTOGDP_r \\ TBTOGDPTARG_r = TBTOGDP_r \\ RSAVEGTARG_r = RSAVEG_r \\ RINVGTARG_r = RINVG_r \\ CABTOGDPTARG_r = CABTOGGDP_r \end{gathered} \quad 14$$

Parameter settings

Following Gretton (2021a), the model adopts the standard trade and production technology parameters provided in the standard GDyn database with two modification: (i) the Leontief fixed real input technology assumption is relaxed to allow input substitution in response to relative price changes and gradual change in input shares with an elasticity value of 1.2 across sectors; and (ii) labour and capital are treated as immobile between sectors (that is, sluggish) between years in place of the assumption of perfect mobility, with a CET elasticity value of -20 for labour and -10 for capital. The settings afford stickiness in the short run and a steady transition approaching full adjustment after about 20 years. Foreign-domestic investment parameters have been set to reflect a home-country bias associated with the Felstein-Horioka (1980) hypothesis and consumption-saving CES elasticities relax the fixed share assumption of the original model to allow a limited degree of substitution between consumption now and in the future. The fixed share assumption is maintained between private and government consumption.

The coefficient share parameters on the trade ($LAMBEXPG$, $LAMBIMPG$ and $LAMBTBALG$), saving ($LAMBSAVG$), investment ($LAMBINVG$) and the CAB ($LAMBGABG$) in GDP determine the rate at which the respective shares in current value GDP (in database USD) converge toward the relevant target rates by region. Following Gretton (2021b), partial adjustment parameter values of 0.075 are adopted. This parameter value affords a half-life of 7 years with full adjustment approximated after about 50 years.

6. Database

The GDyn database release R9.0__2011_May2015 is used in this study. Adoption of the 2011 reference year provides a benchmark upon which to base historical validation simulations over the period for which statistical data are available. The end of the validation period marks the first year of the forward-simulation period. The focus of the historical validation and forward looking simulations is, as noted, on the key structure ratios to GDP, namely, gross saving, exports, imports, the balance of trade and the current account balance. To benchmark the projections of these structural ratios, the WDI estimates of the key economic

coefficients are integrated into the base-period suit of data files for 2011. This integration occurs in series of interrelated steps.

In the first step, WDI-based estimates for EXP/GDP, IMP/GDP, BoT/GDP are derived from underlying flow information by region and included in the base period database as 'target' values (coefficients $EXPTOGDPTARG$, $IMPTOGDPTARG$, $TBTOGDPTARG$, respectively). The target values so derived may differ from values derived directly from the GDyn database. The new target ratios are entered in a simulation-specific supplementary data file gdgdatextra.har. Both the database and WDI-based target values satisfy the identity $EXP/GDP - IMP/GDP = BoT/GDP$ by region (to one decimal place) (table 1). The scale of coefficients in both sets of estimates are also broadly similar. The largest differences in proportional terms are evident in the BoT/GDP for China and EU28 for which moderate proportional differences in components carry over to constitute larger proportional differences in trade balance item.

Table 1: Base-year data compared with WDI-based reference values – Trade account, 2011 (percent, current USD)

	EXP/GDP		IMP/GDP		BoT/GDP		Implicit BoT/GDP	
	Database	WDI reference	Database	WDI reference	Database	WDI reference	Database	WDI reference
1 AUS	20.3	21.5	18.6	20.4	1.7	1.0	1.7	1.0
2 CHN	26.7	26.6	22.6	24.2	4.1	2.4	4.1	2.4
3 JPN	16.0	14.8	16.2	15.4	-0.2	-0.7	-0.2	-0.7
4 USA	12.1	13.6	17.2	17.3	-5.1	-3.7	-5.1	-3.7
5 EU28	39.3	41.3	40.3	40.1	-0.9	1.3	-0.9	1.3
6 ROW	34.4	37.5	31.7	34.1	2.7	3.4	2.7	3.4

Sources: World Bank 2022, World Development Indicators; GDyn database; Author compilation.

In the second step, the database is augmented by two new balance of payments-based current account coefficients relating to foreign income and current transfer payments and receipts, labelled $\boldsymbol{YQFR}$ and $\boldsymbol{YQFP}$, respectively. Values for these items are imputed to satisfy the condition that the model based ratio CAB to GDP by region aligns as closely as possible with the WDI reference values for the 2011 reference year.[7] That is for each region,

$$CAB = EXP - IMP + (YQHT - YQTF) + (YQFR - YQFP)$$

such that

$$CAB/_{GDP} = WDICAB/_{WDIGDP} \text{ and } \sum_r CAB = 0$$

where EXP and IMP are exports fob and imports cif in region r, respectively, $YQHT$ and $YQTF$ are foreign investment income receipts of households and investment income payments by domestic firms by region. The estimate of $YQFR$ for the ROW region is calibrated to meet the condition that CAB's sum to zero across all regions. GDP is sourced to values in the published GDyn database while $WDICAB$ and $WDIGDP$ are derived from WDI information. The value calculated for the CAB to GDP for each region is implicitly the 'target' value by region ($CABTOGDPTARG$) for the base year. These values along with the values for the new

[7] The payments item YQFP is assumed to be 1.25 percent of GDP for all regions. The receipt item for each region is given a value to align CAB to GDP for all regions with WDI estimates for each regions except the ROW which is imputed to satisfied the constraint that the sum of CABs across regions is zero.

coefficients $YQFR$ and $YQFP$ are entered into the new data file gdgdatextra.har. (The completed values are shown in appendix A.) Values for $YQFR$ and $YQFP$ are embodied in the originating GDyn database estimate of net saving (the coefficient $SAVE$).

The third step in adapting the GDyn database therefore is to recalibrate the original value of $\boldsymbol{SAVE}$ by the value of net other foreign income and transfers, that is, $SAVE = SAVE' + YQFR - YQFP$, where $SAVE'$ is the original value.[8] While the value of net saving affords consistency in the structural ratio CAB to GDP between database and the WDI-based estimates, it does not necessarily afford a gross saving to GDP ratio aligned with a WDI-based value. A 'target' gross saving rate by region ($RSAVEGTARG$) based directly on WDI data is therefore included in the database.[9] A WDI-based target gross saving rate for the next period (in this case 2012) required for the application of the partial adjustment method (see above) is also entered in the base period data base (as $DRSAVEGTARG$**)**.

Finally, it would only be by coincidence that a value for the structural ratio for gross investment to GDP (RINVG) derived from the database aligned precisely with those derived from WDI data or the difference between the target gross saving rate and the current account balance as a share of GDP calculated in steps 2 and 3 above. Consistent with the principle of calibrating target values to WDI data, Step 4 involves the calculation of gross investment to GDP from WDI data and entering the values so calculated into the database as target values ($RINVGTARG$ and $DRSAVEGTARG$).[10]

Under the above procedures, the database and WDI indicator-based target values for the CAB to GDP for the base year 2011 are aligned by assumption, except for the ROW region which is calculated as a residual to satisfy the constraint that the sum of the CAB's across regions is equal to zero (table 2, cols e and f). The ratio can also be calculated from the respective components using the identity $SAVEG/GDP - INVG/GDP = CAB/GDP$. The results so calculated are reported in the right-hand columns (cols g and h) of table 2 under the heading 'Implicit CAB/GDP'. Given the balancing procedures outlined above, the implicit values for the CAB to GDP ratio almost exactly align with the database and WDI-reference values as expected. However, this is not the case for the WDI-based estimates which differ to varying degrees because of inconsistencies between the components and totals in the originating data. The largest differences are evident for China (CHN), Europe28 (EU28) and the ROW regions. The gap for China reflects the combined effect of differences between database and WDI reference estimates in both the saving and investment components. The gap for EU28 also reflects the effects of gaps in each component, but in this case, the effects are opposing. In the case of the ROW region, the difference in the database and WDI reference values for the saving component is the main reason for the difference between the WDI reference and the implicit values. This difference is likely affected by gaps the WDI data for the respective components.

[8] The new value of saving is entered in the database file gdgdat...har.
[9] The derived value is entered in the base data file gdgdatextra…har)
[10] The values so calculated are entered in the gdgdatextra…har data file.

Table 2: Base-year database and WDI-based reference values – capital account, 2011
(percent, current USD)

	SAVEG/GDP		INVG/GDP		CAB/GDP		Implicit CAB/GDP	
	Database	WDI reference	Database	WDI reference	Database	WDI reference	Database	WDI-based
	a	b	c	d	e	f	g=a-c	h=b-d
1 AUS	23.50	23.34	26.70	26.03	-3.18	-3.18	-3.20	-2.69
2 CHN	47.90	49.23	46.10	43.86	1.80	1.80	1.80	5.37
3 JPN	22.46	25.58	20.40	23.35	2.08	2.08	2.06	2.23
4 USA	15.59	16.26	18.50	18.74	-2.92	-2.92	-2.91	-2.48
5 EU28	19.46	21.28	19.00	20.06	0.46	0.46	0.46	1.22
6 ROW	24.41	26.07	23.70	23.25	0.68	1.44	0.71	2.82

Sources: World Bank 2022, World Development Indicators; GDyn database; Author compilation.

7. Baseline scenarios

The saving rate, trade balances to GDP and the CAB to GDP are naturally endogenous in dynamic simulations using the GDyn-FS model. The respective target rates are normally exogenous, that is, unless shocked they will remain unchanged over the simulation period. To achieve convergence of the projected coefficients towards the target coefficients, it is necessary to change model closure settings. It is also necessary to set the convergence flags to indicate whether the value is to be targeted in a simulation year as in the historical simulations or whether the simulated value of the target coefficient is to be gradually drawn to the target value as in the forward simulation period.

7.1 Forward targeting of gross saving rates

For five of the six regions considered, WDI data indicate that the gross saving rate is flat or trending slightly up or down across a span of years. For China, the rate increased to a peak of around 50 percent of GDP in 2008 and has been trending downwards since. On the other hand, rates for Japan, the USA and Europe28, have tended to rise in the post-2010 period.

Based on historical and first-approximation theoretical estimates[11], longer-run target rates of gross saving are set to values in the 20 to 30 percent range (Table 3). As noted in Gretton (2021b), these estimates are close to historical averages for the countries/regions considered, apart from China. For China, the target rate represents a reversion from historically high values to a value in the neighbourhood of other economies. With the exception of China and the USA, the longer-run target rates are of a similar order of magnitude to those projected by Foure et al. (2010)[12] and Fontagne et al. (2021) for 2050.[13] In the case of China, Foure et al. (2010) and Fontagne (2021) projected a reversion to a rate of

[11] The first approximation is based on the theoretical relation $s^* = \alpha * (x + n + \delta)/(\delta + \rho + \theta x)$ where α is the capital input share of gross value added, $x + n$ are technological and population growth, respectively, δ is the depreciation rate, ρ is the rate of time preference and θ is the inverse of the intertemporal elasticity of substitution (Barro and Sala-i-Martin 1995, p.78).

[12] Incorporated in Chappuis and Walmsley (2011).

[13] In both studies, national savings rates are projected based on the estimation of a life-cycle model of the gross savings' rate in which saving rates depend on the age structure of the population, the distance from the leader country in terms of GDP-per-capita, and country fixed effects.

around that pertaining in the early 1980s, that is, around 35 percent of GDP. In the case of the USA, Foure *et al.* (2010) and Fontagne *et al.* (2021) projected rates of around 15 percent which are below the historical average and rates suggested by the first approximation method (Table 3). The estimate for China is also within the neighbourhood of projections by Heller and Symansky (1997).

Table 3: Illustrative long-run target saving rates by country/region, circa 2050 (percent)

Country/ region	Rule for illustrative long-run target saving rate	**Illustr at-ive target LR rate adopt ed**	Average 1980 to 2019	First approx. with targeted pop. growth (a,b)	First approx.. with targeted pop. growth & higher depn.(c)
Australia	Illustrative target rate set to be around historical average over the period 1980 to 2019	22.0	21.9	25.1	27.3
China	Illustrative target rate set to be around the first approximation to the LR rate (upper bound) and in neighbourhood of the average across economies in the rest of the world region	27.0	41.8	22.7	26.6
Japan	Illustrative target rate set to be around historical average and in the neighbourhood of the first approximation of LR rate (upper bound)	27.0	27.7	21.5	25.6
USA	Illustrative target rate set to be around the historical average rounded up to the first approximation of LR rate (upper bound).	20.0	19.1	18.1	20.0
Europe 28	Illustrative target rate set to be around the historical average and first approximation of LR rate (lower bound).	22.0	21.6	21.8	25.6
ROW	Illustrative target rate set close to estimates of the period average and in the neighbourhood of the illustrative target for China.	26.0	25.6	18.4	22.1

(a) The first approximation is based on the assumptions that the α is represented by the year-specific capital input share of gross value added at factor cost in the GTAP 10 data base for 2014, x is technological growth assumed to be 2 percent per year, n is projected population growth in 2050 (see note (b)), δ is the depreciation rate assumed to be 4 percent of the value of fixed capital, ρ is the rate of time preference represented by the net returns on fixed capital in the GTAP database, and θ is the inverse of the intertemporal elasticity of consumption assumed to be neutral and given the value of 1.
(b) Projected population growth rates adopted: 0.86 percent for Australia, -0.7 percent for China, - 0.57 percent for Japan, 0.46 percent for the USA, 0.5 percent for Europe 28, 0.55 percent for ROW.
(c) Scenario (a) with the depreciation rate set at 6 percent.
Sources: World Bank World Development Indicators (accessed December 2020); Gretton 2021.

7.2 Forward targeting of trade shares

Using 2011 as the base year for baseline simulations, the trade shares provided by the World Bank World Development Indicators are adopted as the target values for the simulation years 2012 to 2021. Over this historical projection period, modelled trade shares are projected to align as closely as possible with target values. For years in the forward projection period, target conjectures are made about possible trade shares by reference to historical data and practices in other studies.

For each of the six regions considered, WDI data indicate that regional exports and imports as shares of regional GDP have increased but at varying rates and with substantial year-to-year variation. For China, exports and imports as a share of GDP increased to peaks of around 35 and 30 percent of GDP in 2008 following accession to the WTO in 2001, with a downwards path since. On the other hand, the trade shares for Australia, Japan, the USA, EU28 and the ROW tended to continue on an upward path in the post-2010 period, albeit at different rates. Because in any one year the share of a region's exports to GDP is not equal to the share of imports to GDP for that region, regional balances of trade exhibit either surpluses or deficits as a share of their GDP. Notwithstanding substantial year-to-year variation, the regions covered have tended to record either a deficit or surplus, particularly since 1980s. Of the regions covered, Australia and the USA have tended to record deficits while the other four regions have tended to record surpluses.

Using the precedence provided by historical data, two baseline trade scenarios are considered: (i) passive trade growth policies whereby trade, the trade balance and the current account balance evolve given population, employment and output growth and the saving rate assumptions of the underlying baseline; and (ii) a moderate trade growth policy scenario equivalent to the 2019 export share value uplifted by 10 percent (table 4). Within the moderate trade scenario, separate treatments for China and the multi-country ROW region are adopted. For China, the export share is projected to tend towards a value between Japan and the USA. This would accord with domestic policies that favour expansion of the domestic market and an increasing presence in global trade of other developing economies (Yu and Zhong 2020). For the ROW region, the scenario incorporates the uplift of the 2019 value by **10** percent *plus* the closure of half of the projected gap with multi-country EU28 region. This represents an increasing presence in global trade both within the (broad) regional group and between the group and other regions. [14]

[14] Using the precedence provided by historical data, Gretton (2021) reported reported on three baseline trade scenarios for targeting trade shares in the forward projection period are considered: (i) a **medium increase** in potential trade openness equivalent to the 2019 export share value uplifted by 10 percent; (ii) a **lower increase** in potential trade openness equivalent to the 2019 export share value uplifted by 2.5 percent; and (iii) a **higher increase** in potential trade openness equivalent to the 2019 export share value uplifted by 20 percent. The medium-growth scenario (scenario (i)) corresponds to the moderate trade growth policies scenario reported on in this paper.

Table 4: Potential increase in trade openness – three scenarios considered

Scenario 1: Medium potential increase – the central case

- Export shares
  - Common criteria except China and ROW: 2019 value *uplifted by* **10**%
  - China: Export share converges towards the average of Japan and the USA
  - ROW: the 2019 value *uplifted by* **10** percent PLUS close half projected gap with EU28
- BoT share: Average across data years (circa)1960 to 2019
- Import share: Target Export share *less* target LR BoT share

Source: Gretton 2021b.

The target trade balance share in GDP in the moderate trade growth policy scenario is based on regional averages over the period 1970 to 2019 and reflects the fact that some regions have tended to have persistent deficits such as Australia and the USA while others have tended to have persistent surpluses including China, Japan, Europe 28 and the ROW region. The target import shares for the forward projection period then are those implied by the target export and trade balance shares. Having set the targets across the three values (table 5), it is the import shares and the balance of trade shares that are directly targeted in the forward projection period to 2050, so that economic openness evidenced by lower-cost imports and the macroeconomic constraint of the target trade-balance share will determine, subject to other model constraints, export share projections. As noted, at least one degree of freedom in the trade balance share is required to avoid over determination in model simulations. The region freed is ROW.

Table 5: Illustrative long-run target trade shares in GDP by country/region across scenarios towards 2050, (percent, current USD)

	Passive trade-growth policies		Active trade-growth policies		
Country/ region	Trade shares	BoT share	Export share	Import share	BoT share
Australia	No targeting	No targeting	26.5	27.4	-0.9
China			16.6	15.2	1.5
Japan			20.4	19.4	1.0
USA			12.9	15.0	-2.1
EU28			51.2	50.6	0.6
ROW			45.2	44.2	1.0

Source: Author specification, Gretton 2021b.

7.3 Forward targeting of the current account balance to GDP

For the years in the forward projection period 2050 to 2100, conjectures are made about possible longer-run shares of the CAB to GDP by reference to historical data and the policy leaning that such balances should lie within 5 percent of GDP.

Historical data drawn from the WDI database indicates that longer-run averages fall within this framework for the five systemically significant regions considered and across all other countries combined in the ROW region (table 6). Australia which historically has been characterized as a region for which investment opportunities have exceeded domestic saving capabilities (Gretton 2021) shows a CAB to GDP ratio approaching but not reaching the policy benchmark. The above discussion (section 2) also indicates that there are a number of countries not explicitly modelled in this study that approach or fall outside this benchmark.

In forming the longer-run target rates and in line with historical relativities, the USA and Australia are suggested as regions potentially attracting net capital inflows (indicated by negative target rates in table 6 right hand column) while the other regions are suggested as affording net capital outflows on average over the longer term (indicated by positive rates). As will be shown below in the reporting of results, however, these rates while historically-based targets are not necessarily binding in the longer-run, given other assumptions about evolution of the regional economies.

Table 6: WDI-based reference values – CAB to GDP, 2021 (percent, current USD)

	WDI benchmark data				2100 conjecture
	1980 to 2019	2004 to 2019	2011	2019	Based on historical average 1980-2019)
1 AUS	-4.17	-4.14	-3.18	0.55	-4.17
2 CHN	2.17	3.78	1.80	0.72	2.17
3 JPN	2.79	2.99	2.08	3.45	2.79
4 USA	-2.52	-3.27	-2.92	-2.21	-2.52
5 EU28	0.22	0.84	0.46	2.19	0.23
6 ROW	0.19	1.33	1.44	0.30	0.19

Sources: World Bank World Development Indicators (accessed December 2022); Author conjectures.

8. Model closure

The model closure identifies those variables that are exogenous in a simulation, that is, determined by factors outside of the model, and associated endogenous (or slack) variables that are determined in a model simulation given the exogenous variable and the theory of the model. In addition to the general closure settings for simulations using GDyn-FS, specific model closure conventions are defined for the four phases of the baseline simulations undertaken, namely: (i) the historical validation period from 2012 to 2021; the medium run forward projection period from 2022 to 2027; (iii) the trade focused longer run forward projection period from 2028 to 2050; and (iv) the CAB focused forward projection period 2051 to 2100 (Appendix D). In GDyn-FS, growth in regional populations and labour inputs are naturally exogenous.[15] With GDP usually determined by the model, that is, naturally endogenous, it is necessary to swap this activity variable with another in baseline simulations. Following Walmsley *et al*. (2012) and longer run steady-state growth theory (for example Barro and Sala-I-Martin (1995:33), across the longer-run forward projection period (that is from 2028 to 2100), GDP by region is swapped with the region-specific technological change variable for 'non-accumulable endowment commodities', that is, land, natural resources and labour.[16] Under this treatment, technological change is determined endogenously in baseline simulations. In the historical projection period, GDP by region is swapped with the region-specific technological variable for multi-factor technological change, that is, non-accumulable

[15] Through model variables: pop, $qfactsup[SkLab]$ and $qfactsup[UnskLab]$.

[16] Technological change in non-accumulable endowment commodities is represented by the model variable $afenareg$. The model closure swap is therefore: $\boldsymbol{Swap}\ afenareg\ =\ qgdp$; $!en = ex$.

endowment commodities *plus* accumulable endowment commodities.[17] Under this treatment, the 'technology' variable absorbs slack in changes in factor utilization over the historical reference period as well as underlying technological change, as does the multifactor productivity term in growth-accounting calculations. Gross investment is also determined endogenously in the forward projection period by the investment theory of the model whereby forward looking regional firms adjust gross regional investment adaptively to: eliminate errors in expectations; align actual and target rates of return; and gradually align the actual with the 'normal' rate of capital growth. In the historical period, the normally endogenous gross investment is determined exogenously with the longer-run target gross rate of return faced by forward looking investors determined endogenously. This treatment is applied in all years in the historical reference period except 2020 and 2021 when the change in the expected rate of return (that is, from the previously expected rate of return given differences between actual and normal capital growth and errors in expectations) to reflect the 'surprise' of COVID-19.

In regard to trade which is targeted over the historical validation and forward projection period to 2050, total factor output augmenting technological change ($aoreg$) is treated as the relevant slack variable when targeting either the export share in GDP or the balance of trade share in GDP. This convention reflects the assumption that it is the total cost structure of domestic firms that determines competitiveness in global markets (or the capability of maintaining the balance of trade within policy bound). For imports as a share of GDP the slack variable invoked is import augmenting technological change (ams_ir), given global cost structures. This convention reflects an assumption that firms within economies are price takers in the global market and that there is a gap or margin between export and import prices.

In the historical projection period and forward projection period to 2050, as outlined above, gross saving as a share of GDP is targeted by reference to conjected saving intensities. The targeting is achieved by assuming a convergence of national household consumption-saving preferences towards the conjectured target value. The relevant endogenous (slack) variable in this case is the consumption-saving twist term in the model's CES national household utility function ($twistcs$) (Gretton 2021).

From 2051, the focus of the simulations is on CAB balances as a share of GDP. In this phase, trade shares and saving rates are not targeted but rather determined endogenously given the theory of the model, growth assumptions and the transition of CAB's as a share of GDP towards conjectured target values. Two scenarios are considered around the identity $S - I = CAB$. In the first longer-run scenario, with the CAB to GDP targeted, the gross saving rate is assumed to adjust via a consumption-saving shift (with $twistcs$ endogenous). In the second scenario, the investment rate is treated as endogenous by varying the long-run reference rate of return ($RORGTARG$) faced by forward-looking investors. Although it would be possible to devise and simulate a combination of these two effect, for the comparative purpose of this study they are treated separately.

9. Simulation results

The baseline simulations out to 2100 confirm the stability of the GDyn-FS model over the long-run. The baseline simulations have also confirmed that it is possible to: (i) closely track year-by-year changes in key structural ratios across an historical simulation period; and (ii) closely target those ratios over the forward projection period (Gretton 2021,3). This section focuses on the new projections relating to the historical validation of CAB shares in GDP and incorporation of such shares in longer-run baseline simulations. As noted, all the model

[17] Technological change in all endowment commodities is represented by the model variable $avareg(r)$. The model closure swap is therefore: $\boldsymbol{swap}\ avareg\ =\ qgdp$; $!en = ex$.

results reported were obtained using the GEMPACK economic modelling software (Horridge *et al*. 2024).

9.1 CAB to GDP data and projections over the historical period

The baseline historical projections of the CAB to GDP follow the path of the WDI estimates for the period 2012 to 2021 (figure 8). However, although both sets of estimates fall within the 5 percent band suggested by policy guidance (see above), there is an evident difference in the scale of the two series for all regions except Japan for which the series closely align. The projections for Australia and China tend to undershoot the WDI benchmark while the estimates for the USA and the EU28 region tend to overshoot the benchmark.

In the historical simulation, the CAB is not directly targeted but rather derived as a residual with demographic and activity variables, trade shares and the gross saving rate exogenous and targeted. Because the CAB is a residual item, inconsistencies between exogenous and targeted items and the reference value for the CAB to GDP could translate into material differences between projected and reference values. Also, because the ROW region is slack in the projections of the trade account, any inconsistencies in benchmark data affecting projections of the trade account, potentially feed into inconsistencies between CAB to GDP projections for the ROW and reference estimates. A further source of possible misalignment is country coverage of regions embodied in the ROW simulation region. Some evidence of these factors, comes to the fore by the fact that while projections for the USA and the EU28 region are above the reference estimates, the projections for the ROW region (and China) fall below the reference estimates. While it is not practicable within the scope of the current study to isolate all reference data reasons for differences in the projected and reference ratios, it is possible to look at the consistency of capital account components to the CAB to GDP structural ratio. Table 3 above indicates the scope for substantial inconsistencies between capital account components and the summary CAB measure for 2011 that required simplifying assumptions to complete the base-year database reference values. Similarly, table 7 indicates a degree of misalignment between component and summary ratios at 2021, the last year in the historical validation period. The implicit estimate (derived by applying the identity $S - I = CAB$) implies a reference (target) value closer to the projected estimate for Australia, the USA, the EU28, but further away for China and Japan, and the ROW region.

This simple comparison does indicate the potential for reference data differences manifesting in deviations between reference and simulated values of summary aggregates. Possibly more importantly for the historical projections is that the direction of change between the reference and projected values align and both sets of estimates lie with a policy preferred range. In doing so, the historical simulation provides a credible basis upon which to consider longer-run baseline simulation scenarios focused on targeting the CAB as a share of GDP, that is, in the case of this study to 2100.

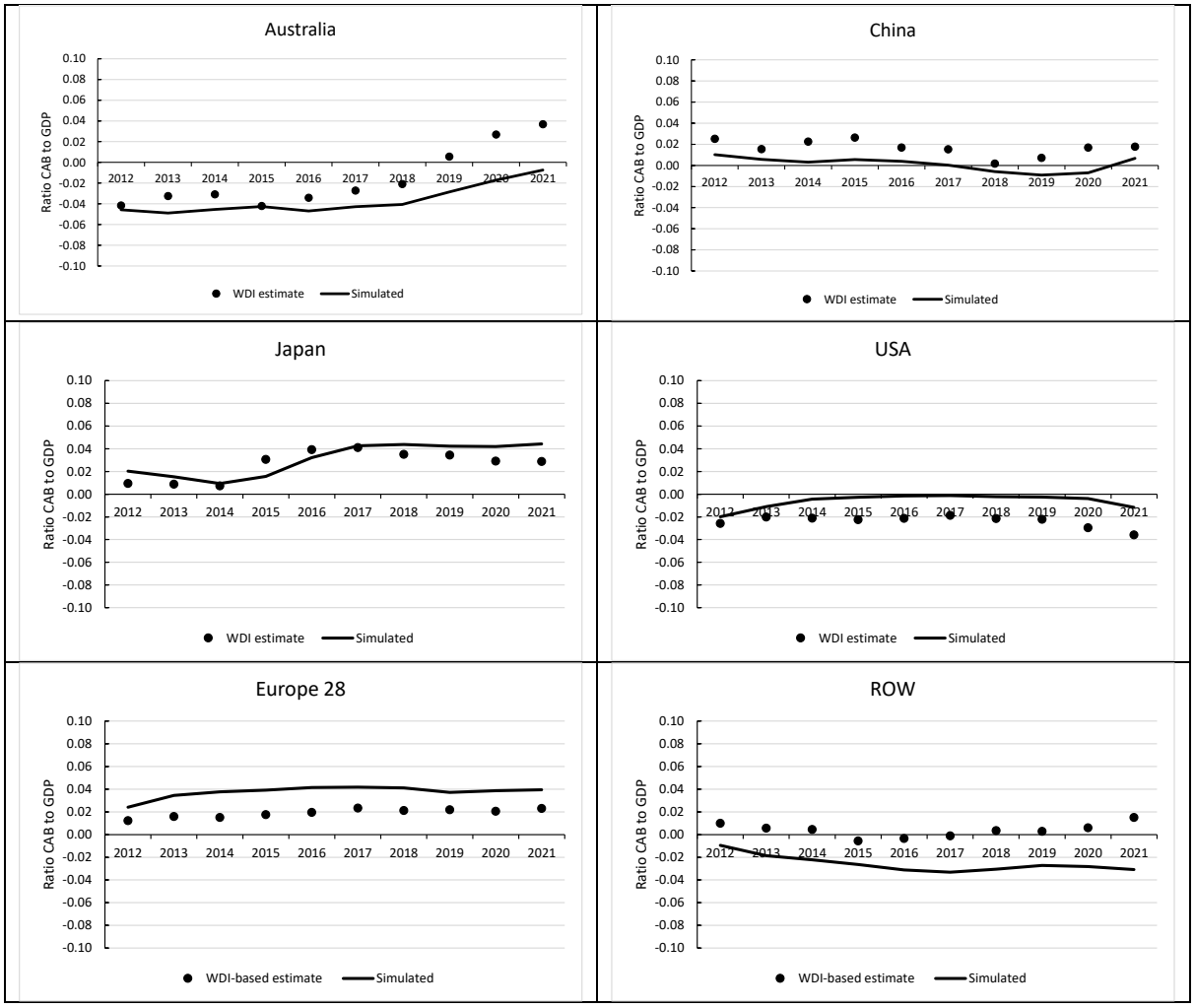


Figure 8: CAB to GDP by region, 2012-2021 (ratio, USD)

Source*: World Bank 2022, World Development Indicators. GDyn-FS projections.*

Table 7: Illustrative CAB/GDP target values by component, 2021 (percent, current USD)

	Target values				
	SAVEG/GDP	INVG/GDP	CAB/GDP	Implicit CAB/GDP	Difference (Implicit less Target)
	a	b	c	d=a-b	e=d-c
1 AUS	25.78	22.42	3.67	3.36	-0.32
2 CHN	45.47	42.49	1.79	2.98	1.19
3 JPN	29.55	25.36	2.89	4.19	1.30
4 USA	18.16	21.44	-3.57	-3.28	0.29
5 EU28	24.27	21.27	2.31	3.00	0.69
6 ROW	26.00	21.35	1.52	4.65	3.13

Sources: World Bank World Development Indicators (accessed December 2022); Author calculations.

9.2 Evolving CAB to GDP with passive CAB policies

With passive trade growth policies, exports as a share of global product are projected to remain relatively unchanged over the projection period (figure 9, left col.). In terms of the BoT and CAB as shares of GDP some variability between regions is projected. Turning to the BoT as a share of GDP (figure 9, centre panel), the projections show a persistent and substantial decline in the BoT as a share of GDP for Japan over the projection period. This projection reflects declining exports as a share of GDP from the slower growing Japanese economy, and given its evolving income levels, an increasing tendency to draw on imported supplies. The combined effects of these two tendencies is realized in an increase in the BoT deficit as a share of GDP (figure 9, left centre panel). The terms of trade for Japan is projected to rise as export prices rise by more than import prices (Appendix C, table C1). China, on the other hand, is projected to experience a rise in its BoT as a share of GDP particularly from the historical period to the 2030s. This rise mainly reflects a decline in imports as a share of GDP (paralleling the baseline assumption of a decline in domestic saving as a share of GDP). China's terms of trade are projected to decline as import prices rise against declining export prices. For the ROW region, there is a tendency for exports as a share of GDP to rise ahead of imports, so that the BoT as a share of GDP also rises. For the USA and EU28 the opposite is the case. For Australia, a slight BoT deficit as a share of GDP in line with historical experience is projected. The interaction of supply and demand sees the terms of trade decline for the ROW as import price growth exceeds the rise in export prices, as is the case for the USA. For the EU28 region the opposite is the case. For Australia, export prices rise ahead of import prices to afford a projected rise in the terms of trade.

Projections of the CAB as a share of GDP show relative stable paths although the declining trade position for Japan is reflected in a declining CAB position relative to GDP (figure 9, bottom left panel).

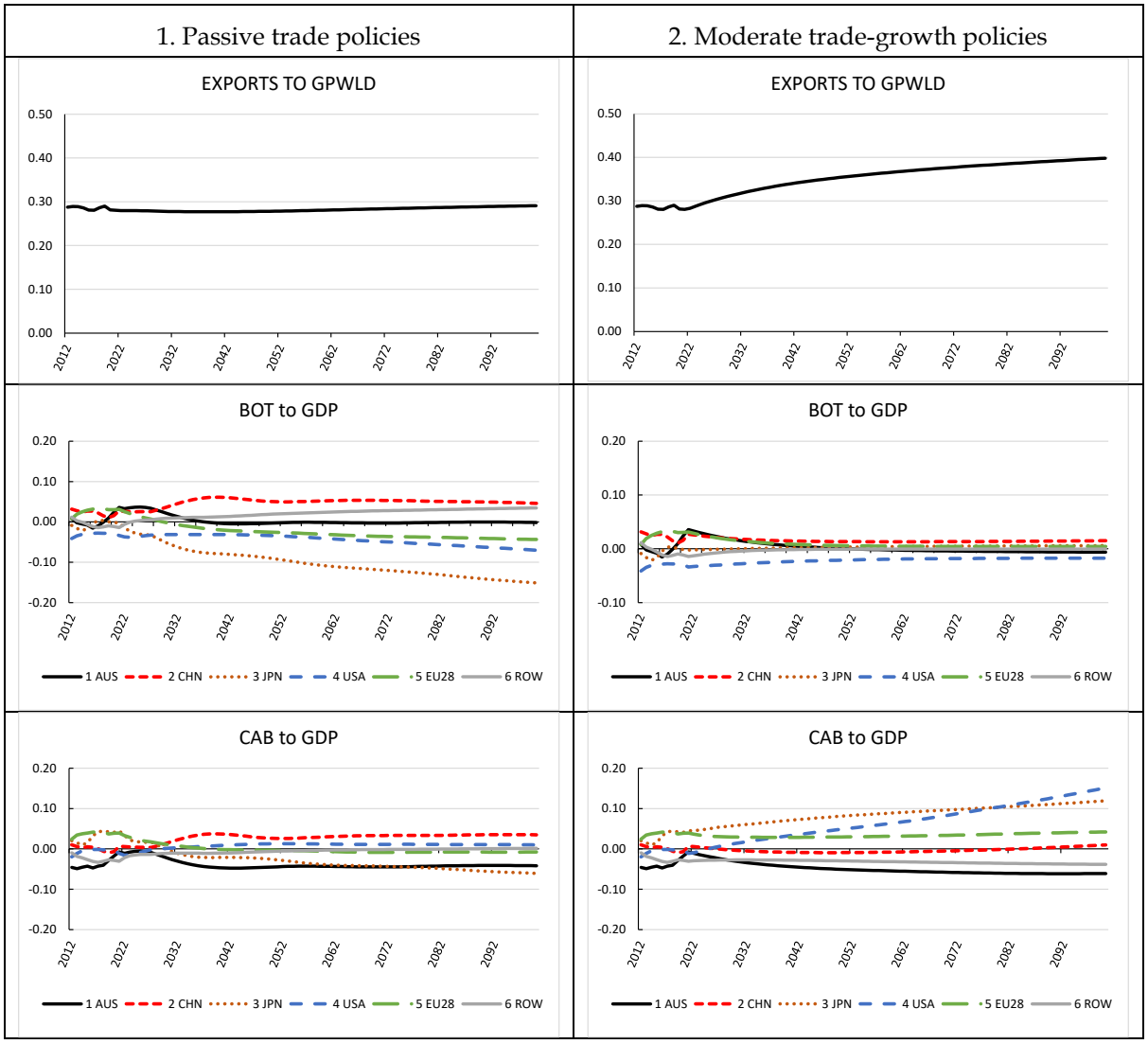


Figure 9: How might trade and the CAB/GDP evolve with passive policy towards the CAB? 2012-2100 (ratio, USD)

Source*: Author estimates based on the GDyn-FS model.*

Turning to the moderate trade growth policies scenario (right column figure 9), global exports are projected to rise from around 30 percent of global product to around 40 percent (figure 9, top right panel). By assumption, the BoT by region to regional product is projected to converge to the historical average (figure 9, centre right panel). Considerable variability, however, is evident in the projections for the CAB to GDP over the forward period. With the BoT to GDP ratio fixed by assumption, this variability comes from changing terms of trade flowing through to gross investment as a share of GDP, whereby: (i) a *positive* terms of trade effect raises income and the incentive to invest, lowering the CAB to GDP from what it would otherwise be for the given saving rate; while (ii) a *negative* terms of trade effect would lower income and the incentive to invest raising the CAB to GDP. This negative effect is strongest for the Japan and the USA, and persistent over the forward projection period. For Australia, China, EU28 and the ROW, the terms of trade effect is neutral or positive.

9.3 Evolving CAB to GDP with active CAB policies

The following simulations consider the case in which all regions (but one) adopt active policies to stabilize the CAB to GDP around historically-based conjectures through changes in the gross saving rate (scenario 3) or gross investment though changes in the required long-

run rates of return on capital (scenario 4). As noted, for illustration, the active policies are modelled as coming into force from 2051.

With the active CAB stabilization policies directed via the saving rate, global exports to global product is stabilized at levels approaching 40 percent, but below scenario 2 (figures 9 and 10). The CAB to GDP ratio is also projected to be stabilized across regions within the range of 5 percent of GDP (figure 10, bottom panel). However, the CAB stabilization effect is associated with a fanning out of the BoT to GDP ratio (figure 10, centre panel). With the saving rate variable, changes in the CAB are channelled through the consumption-saving mix, indirectly widening (or narrowing) the wedge between exports and imports. This effect is particularly evident for Japan and the USA in the policy period. There is also some opposing oscillations between China and Japan over the convergence period indicating a degree of interaction between the export sectors of the respective countries (appendix C, figure 2).

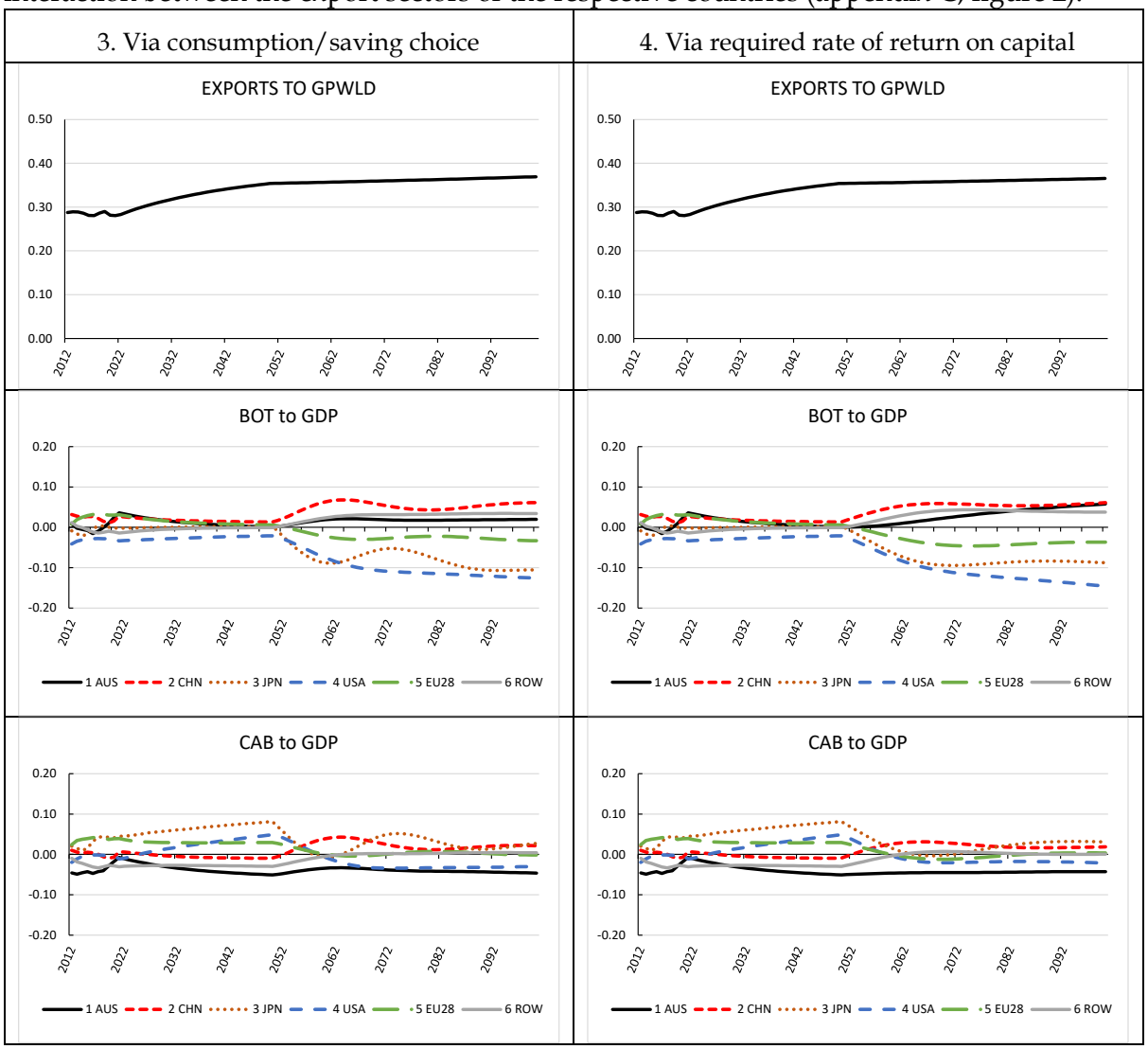


Figure 10: How might trade and the CAB/GDP evolve with moderate trade growth policies to 2050 and active policies towards the CAB from 2050? 2012-2100 (ratio, USD)

Source: *Author estimates based on the GDyn-FS model.*

With the active CAB stabilization policies directed via the rate of return, global exports to global product is again stabilized at levels approaching 40 percent, although at a slightly lower level than in scenarios 2 and 3 (figures 9 and 10). The CAB to GDP ratio is also projected to be stabilized across regions within the range of 5 percent of GDP (figure 10, bottom right panel) and in a slightly narrower band than the case of scenario 3. However, the CAB

stabilization effect is associated with a fanning out of the BoT to GDP ratio and slightly more so than scenario 3 (figure 10, centre panel). With the rate of return variable (and the USA treated as the numeraire economy with its rate of return fixed by assumption), changes in the CAB are channelled through investment, indirectly widening (or narrowing) the wedge between exports and imports, and thereby the BoT (appendix C, figure C1). For the CAB to GDP to close towards target values, investment to GDP must increase for Japan and the EU28 and indirectly for the USA. In each case, this is accompanied by an increase in imports and a lowering of exports as a share of GDP, as investment goods are acquired from off shore or supplies are channeled away from exports to the domestic market (appendix C, figure C2). This effect is again particularly evident for the Japan, the USA and less so for the EU28 region, in the post 2050 policy period. In the case of Australia and China, the projected lowing of investment is associated with higher exports as resources are channeled to offshore markets. For the ROW region, investment as a share of GDP is projected to decline with an associated lowering of exports and imports as a share of GDP with a net effect of raising the BoT as a share of GDP.

These two scenarios indicate that while the CAB to GDP can be drawn to within a target range consistent with policy conventions, the flow-on effects to the BoT to GDP and the wider economy can be quite specific to the choice of instrument.

9.4 Saving rate and capital return adjustments under policy scenarios

Active policies towards the longer-run targeting of the CAB to GDP were assumed to be implemented through actions affecting saving through the consumption-saving mix (scenario 3) or investment through the required rate of return on productive capital (scenario 4). With respect to scenario 3, the simulation results indicate that the largest adjustments from 2051 (the first year in the policy period) are simulated for the China, Japan and the USA (figure 11, centre left col.). The gross rate of return (and implicitly the country-specific risk premium) on capital is simulated to remain around initial levels (figure 11, centre right column).

This is not the case for the gross rate of return scenario (scenario 4). In this scenario, with the USA treated as the benchmark economy with its target rate of return fixed by assumption, all adjustment occurs through rises in the required rates of return on capital within other regions (figure 11, bottom right column). These projections would seem at odds with the concept of financial deepening in economic development which conjectures that effective financial market development would be associated with the gradual and conditional lowering of country investment risk towards a global benchmark (McKinnon (1973), Shaw (1973)). It is therefore suggested that the more fruitful course for the inclusion of CAB to GDP constrains in a baseline simulation would be via the consumption-saving mix. Moreover, in scenario 4, the rate of saving is indirectly affected by changes in the rate of return. This effect arises as the price of increasingly scarce capital rises, leading to a rise in the price of saving relative to consumption and a substitution in favour of consumption by regional households.

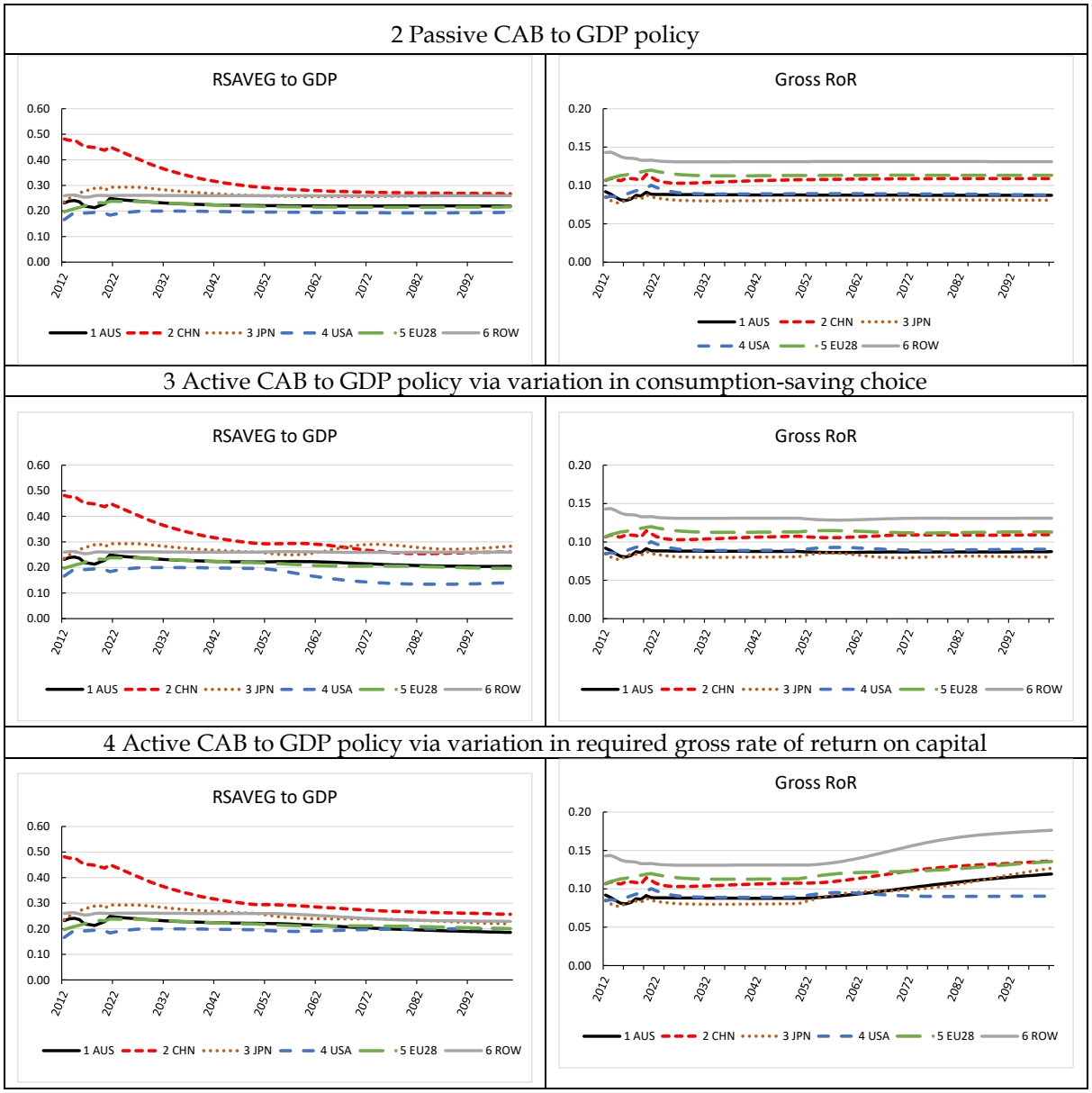


Figure 11: What are the projected adjustments in gross saving rates and capital returns under each scenario? 2012-2100 (ratio, USD)

Source: *Author estimates based on the GDyn-FS model.*

9.5 Further examination of conjectured and projected gross saving to GDP

Making longer term projections to as far distant points in time as 2100 is problematic. The introduction of constraints such as on the CAB to GDP ratio confounds the difficulty. Nevertheless, policy relevant baselines do extend this far into the future. Of importance in these simulations is the credibility of the projected saving to GDP ratios, the measure used to target the CAB as a share of GDP in scenario 3. Focusing on scenario 3, what stands out is the similarity of projections in 2100 with initial conjectures based on historical experience and theory (table 8, cols. 1 and 4) for all regions considered except the USA. For the USA, the simulated estimate lies between CEPII (2021) projections and hypothetical Ramsey model estimates based on model parameters and growth rates in 2100. Thus, while the projections for the USA are low by historical benchmarks, they are not misaligned with corroborating independently derived measures.

Maintaining the focus on scenario 3, there is material diversity between results for this scenario between the projections for China and the ROW. For China, the CEPII (2021) estimate places the projected rate at around the historical average. In the longer term projections of this study, this would imply either: (i) a very large and continuing CA surplus; (ii) continuing high investment as a share of GDP combined with higher growth; or (iii) a combination of both. On the other hand, the lower Ramsey model estimate reflects the low or negative projected population growth in China in 2100 occasioning low investment demand and required saving. The projections for the ROW reflect the treatment of the ROW with exogenous saving rate and endogenous CAB in the model closure. As such the projection aligns with the initial conjecture. It is notable that the CEPII (2021)-based and Ramsey model estimates for the ROW roughly align. This may suggest that there is scope to consider a lower target gross saving rate. Given the global demand for saving is determined by global economic activity, this would imply an increase in the saving rates for other countries, possibly including the USA, or a lower global level of saving (and investment) or a conjecture that the global saving rate should be lower than implied by the regional estimates.

Table 8: Conjectured and simulated gross saving as a share of GDP (percent)

	Conjecture 2050 (Gretton 2022) (S1 & S2)	CEPII (2021) at 2100	Simulated Ramsey- model based at 2100[a]	Simulated at 2100 (S3)	Simulated at 2100 (S4)
1 AUS	22	22	20	20	19
2 CHN	27	38	16	26	26
3 JPN	27	24	18	28	22
4 USA	20	11	14	14	20
5 EU28	22	20	13	20	20
6 ROW	26	16	18	26	23

a A steady state gross saving rate, s^* is calculated for the global economy for the Cobb-Douglas case according to $s^* = \alpha * (x + n + \delta)/(\delta + \rho + \theta x)$ where α is the capital input share of gross value added, $x + n$ are technological and population growth, respectively, δ is the depreciation rate, ρ is the rate of time preference and θ is the inverse of the intertemporal elasticity of substitution (Barro and Sala-i-Martin 1995, p.78). The estimates reported are generated in the baseline simulation of scenario 1 at 2100.

Source*: CEPII (2021), Gretton 2021b, Author estimates based on the GDyn-FS model.*

Focusing on scenario 4, the projections for the saving rate at 2100, as noted above, differ somewhat from the original conjectures applied to 2050, although the saving rate is not the instrument used to target the CAB as a share of GDP, as in scenario 3. This outcome is most evident Japan for which the saving rate is projected to decline to 22 percent in contrast to the longer run target value of 27 percent (table 8, cols. 1 and 5), although it applies to all regions depending on regional circumstances. For a region (such as Japan) with an opening current account surplus above the target level (such as Japan) those differences arise from: (i) upward pressure on the rate of return on capital (figure11) leading to upward pressure on capital rental and downward pressure on the price of now less competitive capital, and through this the price of saving (appendix figure C4); (ii) a reallocation of capital between regions towards regions affording the highest returns (relative to the US) according to the capital-finance theory of the model; (iii) a shift in domestic demand for the consumption-saving bundle and changes in real wages to maintain employment at baseline levels; and (iii) a substitution from consumption to saving according to the CES household utility theory of the model (appendix figure C5).

10. Some concluding comments and policy implications

It is possible to meaningfully simulate the path for the CAB/GDP in an historical simulation. It is also possible to establish a long-run base line out to the boundary of long-term growth projections with projected CAB to GDP falling within plausible ranges. The projections indicate adjustment path may not be even. They also indicate that active policies towards rates of return on capital may imply adjustments outside of conventional ranges or rates consistent with financial market develop and economic deepening. On the other hand, active policies towards consumption-saving choices would appear to imply adjustment within the bounds suggested by theory and historical experience and are likely to be the most fruitful. Adjustments towards CABs as a proportion of GDP to within accepted ranges are likely to: (i) draw countries and regions with differing differing social, legal and commercial traditions closer together; and (ii) have implications for the evolution of international commercial relations and institutions.

Some avenues for further investigation include: (i) further analysis of baseline assumptions particularly as they relate to the interaction of the BoT and CAB to GDP, given plausible baseline scenario assumptions; (ii) improvement in the targeting of CAB to GDP using the saving rate as the instrument, particularly as it relates to the residual sector (ROW in this study); (iii) application of the method to a highly disaggregated database (for example, 32 regions by 57 sectors); (iv) consideration of broader policy implications of the analysis, including regulatory or environment factors that may facilitate or impede satisfaction of longer-run policy guidelines with respect to key balances; and (v) better understand the relationship between WDI benchmark indicators and database projections.

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Appendix A Data

Appendix table A1: Components of the Current Account, 2011 (current USD)

CURRENTACCT	1 EXP	2 IMP	3 YQHT	4 YQTF	5 YQFR	6 YQFP	Regional total
1 AUS	280864	-257818	45482	-95711	414	-17338	-44107
2 CHN	1951878	-1651997	129083	-210683	5036	-91523	131794
3 JPN	943337	-956998	235894	-49783	24208	-73820	122837
4 USA	1880767	-2676776	761793	-518958	293759	-194172	-453587
5 EU28	6950305	-7112555	1418085	-1350434	396691	-220828	81265
6 ROW	8146784	-7497791	632877	-997645	173355	-295782	161798
Global total	20153934	-20153933	3223215	-3223215	893464	-893464	**0**

Sources: GDyn database R9.0_2011 May 2015; Author calculations based on WDI data.

Appendix table A2: Reconciliation of initial and revised Current Account balance, 2011 (current USD)

	Original database	Net current transfers	Revised database
1 AUS	136953	-16923	120030
2 CHN	2552913	-86488	2466425
3 JPN	349502	-49612	299890
4 USA	398704	99587	498289
5 EU28	895424	175863	1071287
6 ROW	3022315	-122427	2899889
Global total	7355811	-1	7355809

Sources: GDyn database R9.0_2011 May 2015; Author calculations based on WDI data.

Appendix B Model homogeneity and Walras Law

GDyn-FS conforms to the following model homogeneity and market clearing conventions.

Homogeneous of degree one in prices

Tested by implementing the policy shock in simulation year 1 (ie 2012) on model numeraire price psavewld via aShock psavewld = 1.

Walras Law

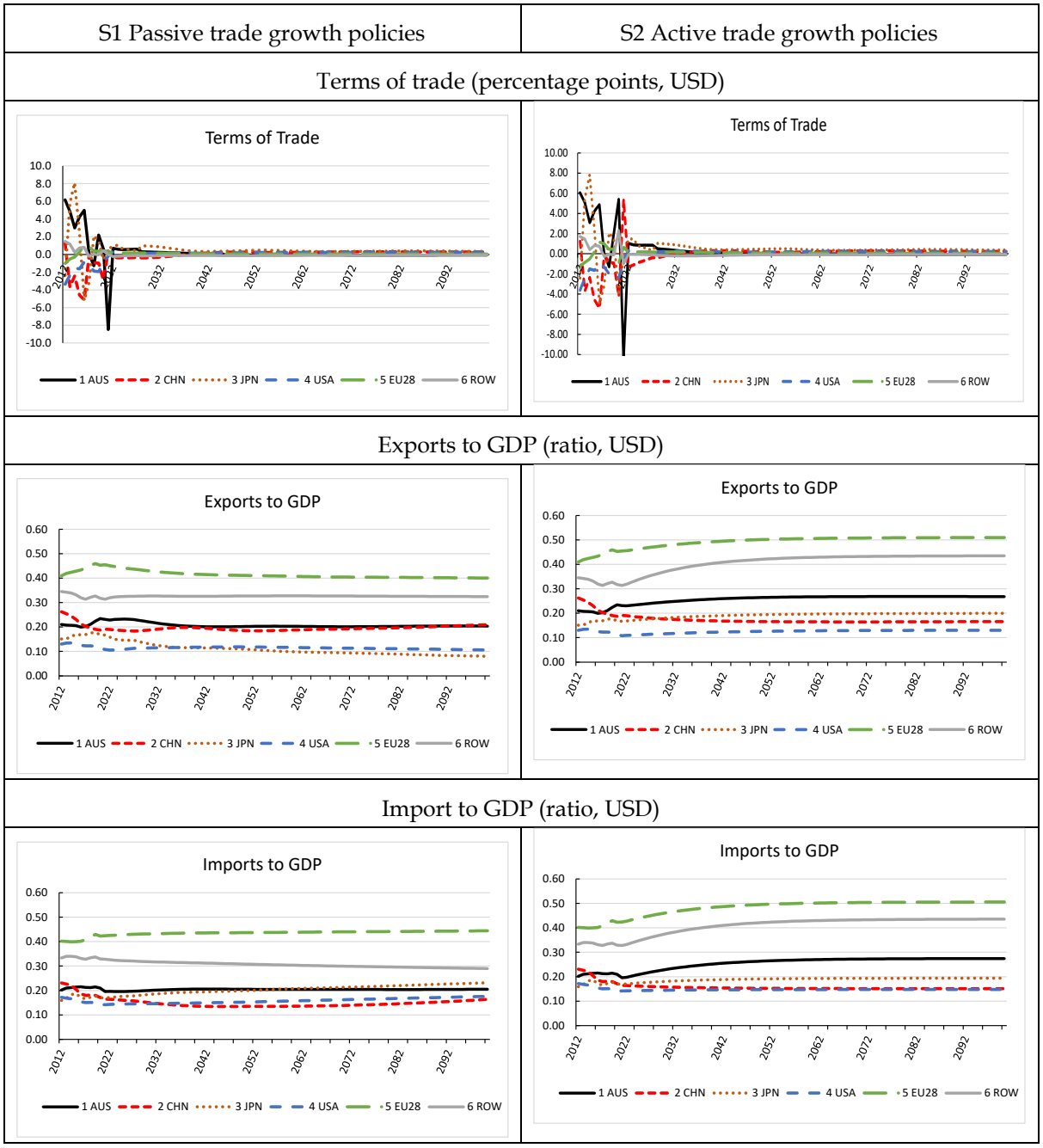
Walras Law requires that global supply and demand are equal in global markets. It is verified with tests on borrowing and lending via the global trust, global saving and investment, and the global current account balances and net lending.

First, in any simulation, borrowing by the global trust should be equal to lending by the trust that is $WQTRUST * wqt = WQ\_TRUST * (wq\_t + wtrustslack)$ where $WQTRUST$ is the value of the global trust and WQ_TRUST is the implicit value of household investment in the global trust while wqt and wq_t are the percentage changes in the respective totals. The value of $walraslack$ should be zero in any GE simulation.

Second, in a simulation, global saving should be equal to global investment that is, $GLOBINV * walras\_sup = GLOBDEM * (walras\_dem + walraslack)$ where $GLOBINV$ is global investment and $GLOBDEM$ is global saving while $walras\_sup$ and $walras\_dem$ are percentage changes in the respective totals. The value of $walraslack$ should be zero in any CGE simulation.

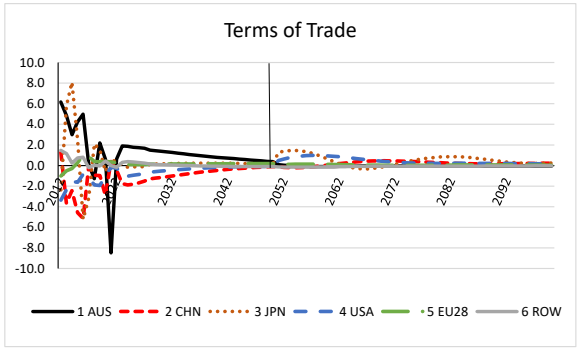
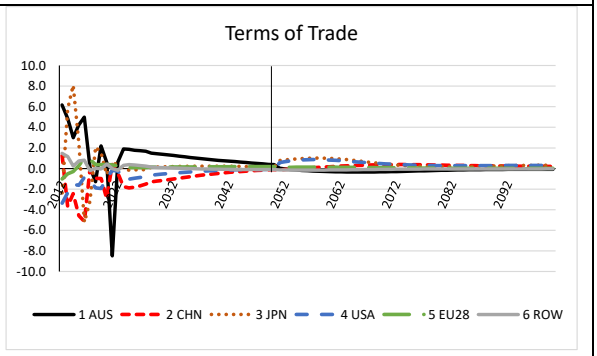
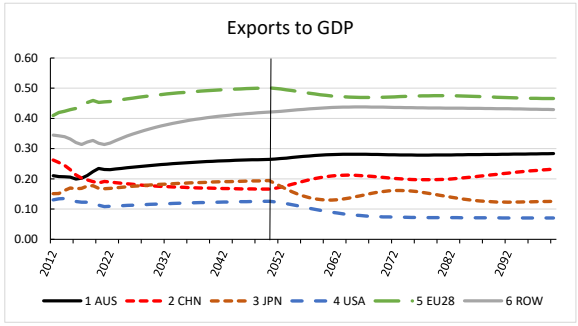
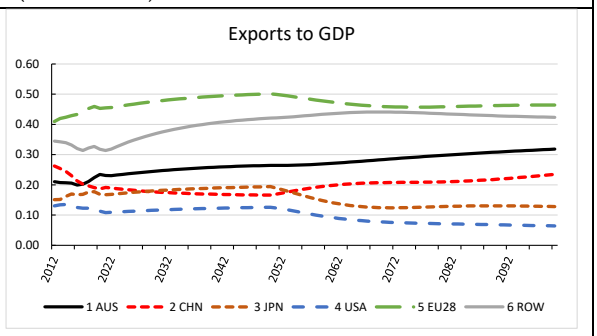
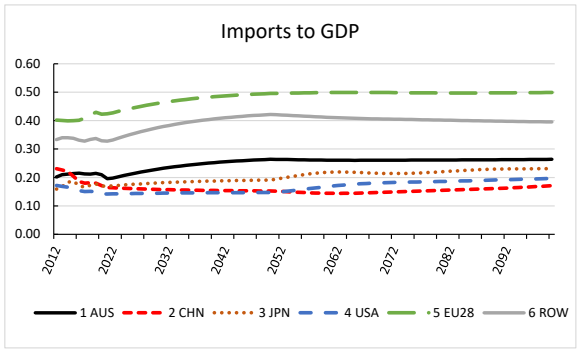
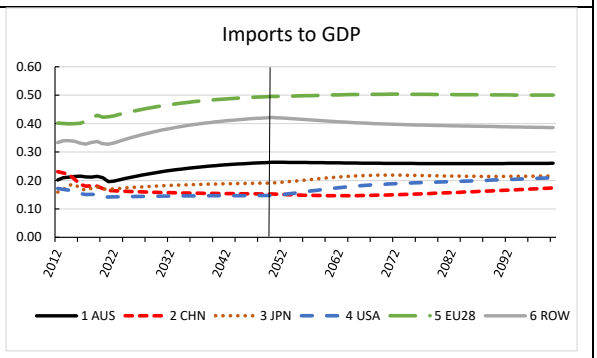
Third, in any simulation, the value of current account balances across regions should be zero and equal to net lending across regions that is $WALRAS\_CAB = WALRAS\_NL + WALRASXASLACK$ where $WALRAS\_CAB$ is the sum of current account balances across regions (in USD), $WALRAS\_NL$ is the sum of net lending across regions (in USD). The variable $WALRASXASLACK$ is exogenous and zero in any CGE simulation.

Appendix C Additional results from simulations



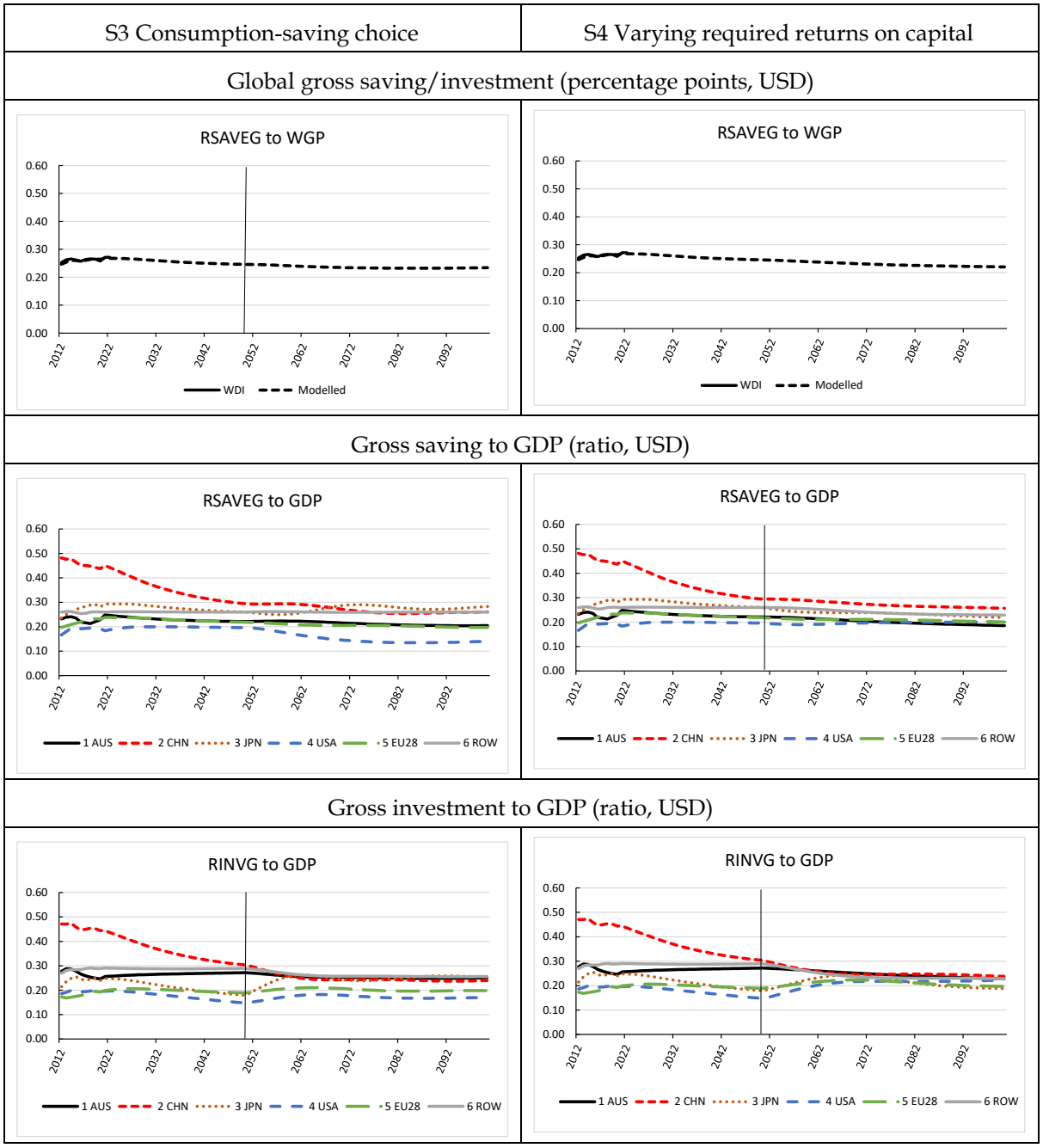
Appendix figure C1: What are the projected adjustments in the terms of trade and exports and imports to GDP under scenarios 1 and 2? 2012-2100

Source: *Author estimates based on the GDyn-FS model.*

S3 Consumption-saving choice	S4 Varying required returns on capital
Terms of trade (percentage points, USD)	
	
Exports to GDP (ratio, USD)	
	
Import to GDP (ratio, USD)	
	

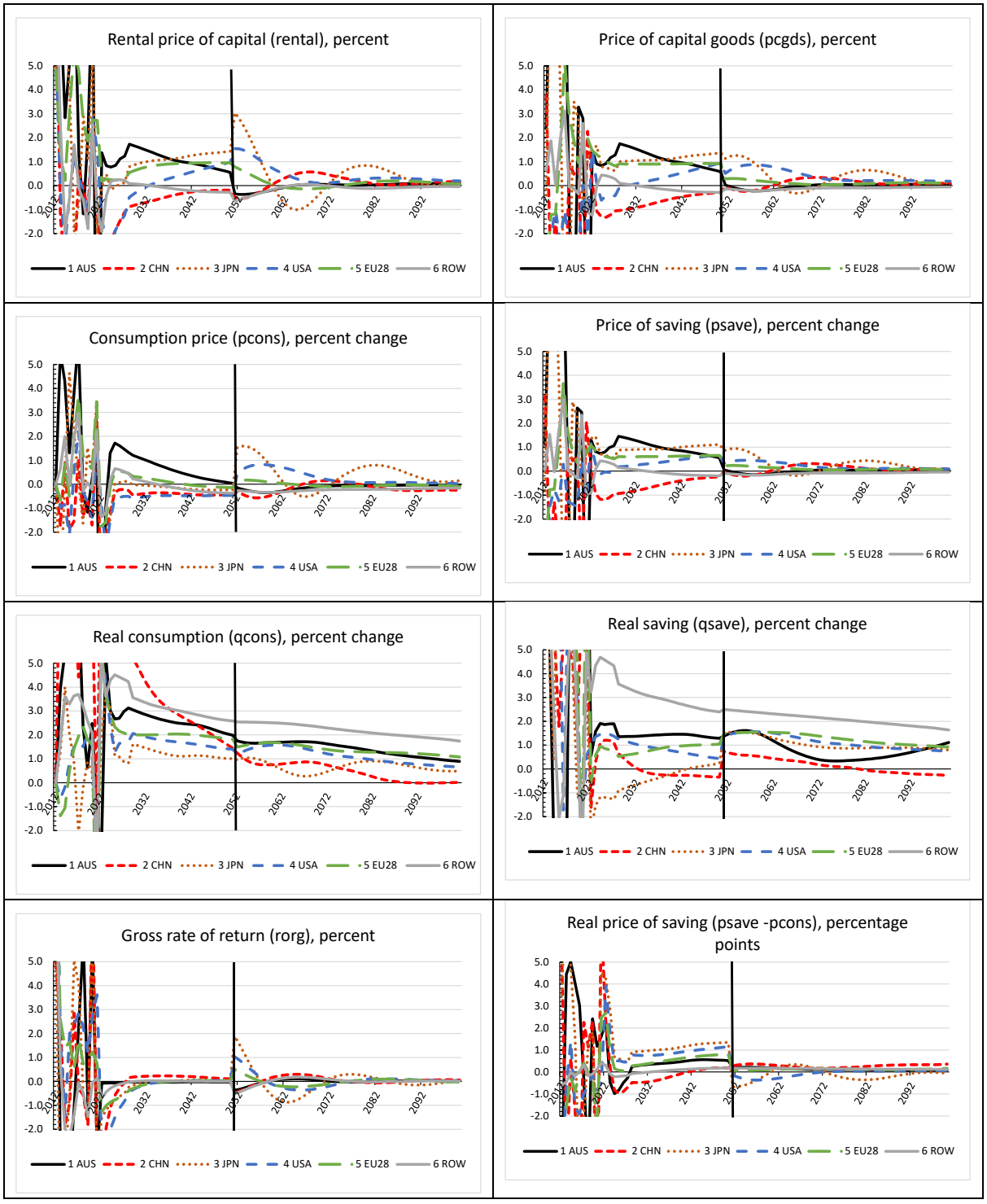
Appendix figure C2: What are the projected adjustments in the terms of trade and exports and imports to GDP under scenarios 3 and 4? 2012-2100

Source: *Author estimates based on the GDyn-FS model.*

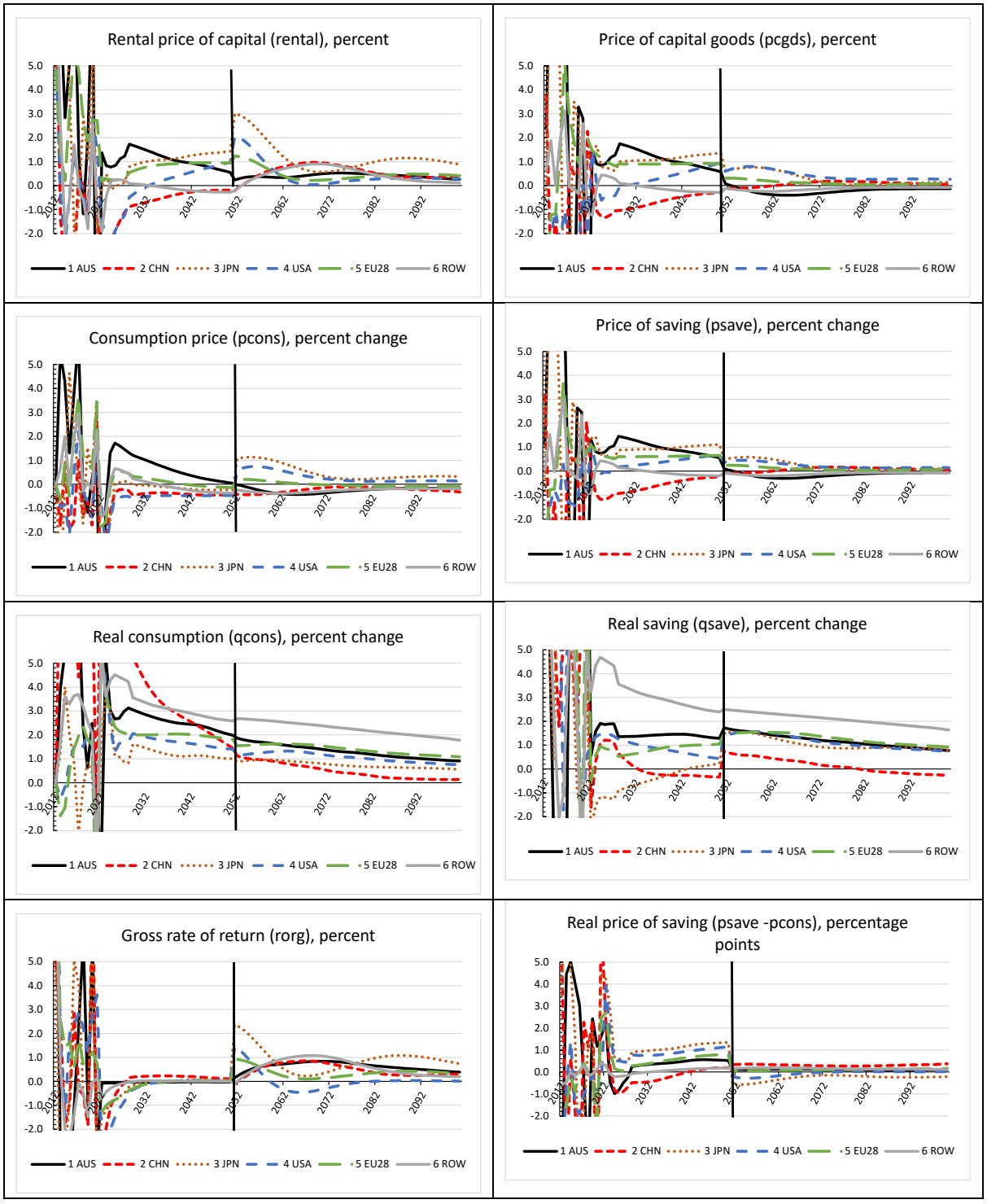


Appendix figure C3: What are the projected adjustments in saving and investment to GDP under each scenario? 2012-2100

Source: *Author estimates based on the GDyn-FS model.*



Appendix figure C4: What are the projected adjustments in capital, saving and consumption prices under scenario 3 targeting CAB to GDP via saving rate ? 2022-2100



Appendix figure C5: What are the projected adjustments in capital, saving and consumption prices and quantities under scenario 4 targeting CAB to GDP via investment rate? 2022-2100

Appendix D Model closure

Table D1: Summary of model closure rules

Closure change and rationale	*Historical projection and transition periods 2012 to 2021*	*Forward projection periods*		
		2022 to 2027	*2028 to 2050*	*2051 to 2100*
	Targeting growth variables, gross saving share, export and import shares with the BoT share and CAB as residuals	*Targeting gross saving share, import and BoT shares with the export share and CAB as residuals*	*Targeting gross saving share, import and BoT shares with the export share and CAB as residuals*	*Targeting CAB to GDP with saving/returns on capital, trade shares as slack/residual*
Economic growth	**Scenarios 1,2,3,4**	**Scenarios 1,2,3,4**	**Scenarios 1,2,3,4**	**Scenarios 1,2,3,4**
Target population growth	Exogenous: population growth (pop)	As for historical simulation	As for historic simulation	As for historic simulation
Target employment growth by skill group	Exogenous: employment growth (qfactsup by sklab and unsklab)	As for historical simulation	As for historic simulation	As for historic simulation
Target gross domestic product (GDP) by swapping naturally endogenous change in GDP by allowing technological change to vary.	Endogenous: Multi primary factor technological change (avareg) Exogenous: GDP growth (qgdp)	As for historical simulation	Endogenous: Multi non-accumulating primary factor technological change (afenareg) Exogenous: GDP growth (qgdp)	As for 2028 to 2050
Target domestic investment (qcgds) by swapping naturally endogenous change in investment by allowing the long run *reference* gross rate of return on capital to vary from 2012 to 2019, or the *expected* gross rate of return on capital to vary to recognise the temporary effects of COVID-19.	Endogenous: (i) long-run (target) gross rate of return (srorc) to 2019 (ii) expected gross rate of return (srorge) in 2020,1 Exogenous: investment growth (qcgds)	Investment endogenous	As for 2022 to 2027	As for 2022 to 2027
Consumption-Saving choice	**Scenarios 1,2,3,4**	**Scenario 2,3,4**	**Scenario 2,3,4**	**Scenario 2**
Target domestic saving as a share	Endogenous: Consumption-saving	As for historical simulation	As for historical simulation	Incorporated in theory to target

Closure change and rationale	*Historical projection and transition periods 2012 to 2021*	*Forward projection periods*		
		2022 to 2027	*2028 to 2050*	*2051 to 2100*
	Targeting growth variables, gross saving share, export and import shares with the BoT share and CAB as residuals	*Targeting gross saving share, import and BoT shares with the export share and CAB as residuals*	*Targeting gross saving share, import and BoT shares with the export share and CAB as residuals*	*Targeting CAB to GDP with saving/returns on capital, trade shares as slack/residual*
of GDP (RSAVEG) by swapping the naturally endogenous shift term in the consumption-saving function with the consumption-saving twist and set the target rate of saving (RAVETARG) to the conjectured level.	twist (twistcs) Exogenous: shift term in partial adjustment consumption-saving theory (stwistcs) Partial adjustment flag (sflag_del_unity) = 0	Partial adjustment flag (sflag_del_unity) = 1	Partial adjustment flag (sflag_del_unity) = 1	CAB to GDP (see below) Partial adjustment flag (sflag_del_unity) = 1
Trade shares and trade balance	**Scenarios 1,2,3,4**	**Scenario 2,3,4**	**Scenario 2,3,4**	**Scenario 2**
Target the export share in GDP by linking the required change in the export share to the value of exports, allowing output augmenting technical change to vary.[a]	Endogenous: Output augmenting technical change ($aoreg$) Exogenous: Exports to GDP specific shift ($stwistxg$) For n-1 regions[b] Partial adjustment flag (eflag_del_unity) = 0			
Target the import share in GDP by linking the required change in the import share to the value of imports, enabled by region-specific import augmenting technical change	Endogenous: Regional generic import augmenting technical change by destination ($amsdest$) Exogenous: Imports to GDP specific shift ($stwistmg$) Partial adjustment flag (mflag_del_unity) = 0	As for historical simulation	As for historic simulation	As for historic simulation
Target the BoT share in GDP by linking the required change in the		Endogenous: Total factor output augmenting technical	As for 2022 to 2027	

Closure change and rationale	*Historical projection and transition periods 2012 to 2021*	*Forward projection periods*		
		2022 to 2027	*2028 to 2050*	*2051 to 2100*
	Targeting growth variables, gross saving share, export and import shares with the BoT share and CAB as residuals	*Targeting gross saving share, import and BoT shares with the export share and CAB as residuals*	*Targeting gross saving share, import and BoT shares with the export share and CAB as residuals*	*Targeting CAB to GDP with saving/returns on capital, trade shares as slack/residual*
BoT share to the value of the BoT, allowing output augmenting technical change to vary.[a]		change ($aoreg$) Exogenous: BoT to GDP specific shift ($stwisttg$) For n-1 regions[b] Partial adjustment flag (tflag_del_unity) = 1		
Current account balance	-	-	-	**Scenarios 3,4**
Target CAB as a share of GDP by linking the required change CAB share to the value of the CAB by:				Partial adjustment flag (cflag_del_unity) = 0
(i) allowing the saving rate to vary For n-1 regions (saving rate exogenous for the ROW region)				Endogenous: twist on CAB share in GDP (twistcg) Exogenous: shift on twist on CAB share in GDP (stwistcg) Allowing saving rate to vary Endogenous: consumption-saving twist (twistcs) Exogenous: shift on consumption saving twist (stwistcs) Partial adjustment flag (aflag_del_unity) = 1

Closure change and rationale	*Historical projection and transition periods 2012 to 2021*	*Forward projection periods*		
		2022 to 2027	*2028 to 2050*	*2051 to 2100*
	Targeting growth variables, gross saving share, export and import shares with the BoT share and CAB as residuals	*Targeting gross saving share, import and BoT shares with the export share and CAB as residuals*	*Targeting gross saving share, import and BoT shares with the export share and CAB as residuals*	*Targeting CAB to GDP with saving/returns on capital, trade shares as slack/residual*
(ii) allowing the rate of investment to vary. For n-1 regions (target ror exogenous for the USA which is treated as the reference economy)				Allowing gross investment to vary Endogenous: shift on long-run (target) gross rate of return (srorc) Exogenous: slack variable on required twist in gross investment to GDP (stwistiy) Partial adjustment flag (aflag_del_unity) = 2
Capital-finance	Scenarios 1,2,3,4			Scenarios 3,4
Allow for twists in firms sourcing of finance as between domestic households and the global trust. For n-1 regions	Endogenous: regional firms household-trust twist (twistht) Exogenous: shift on holdings of the global trust in regional firms (swqtsf) For n-1 regions			As for historic simulation

a The closure adopted in this implementation assumes all accommodating adjustments occur in the 'real' economy. **b** Rest of World region endogenous.
c Regional generic import augmenting technical change ($amsdest$) enters as a price effect through equations E_AMS, E_DPRICEIMP and IMPORTDEMAND.

Source: Author specification.