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National and Sectoral Effects of a Decline in the Desirability of Investing in Australia

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Abstract

Australia has a long-standing dependence on foreign investment to make up the difference between domestic saving and investment opportunities. There is, nevertheless, an ongoing debate about the merits or otherwise of inward foreign investment. There has also been a recent tightening of criteria governing foreign investment. The OECD assesses Australia's foreign direct investment regime to be one of the most restrictive in the OECD area, while broader discussions have considered the potential for a decline in Australia's credit rating. This paper uses a dynamic global general equilibrium model—GDyn-FS—to report on the national and sectoral effects of a decline in the desirability of investing in Australia, relative to other countries.

JEL CLASSIFICATION

C68; E17; E21; F11; F21; F43

1. Introduction

Policy or economic changes that influence firms' capability and willingness to invest in new capital will affect both commodity supplies and demands, with those effects flowing through over time to national activity, income and consumption levels. These matters are of traditional importance in discussions of how countries and regions may reach their productive potential and are of contemporary importance in an era of global trade tensions, interruption of global economic activity with the COVID-19 pandemic, regulation of global capital flows through national foreign investment guidelines, and anti-dumping and countervailing duty actions.

These matters are of heightened importance to Australia, which is a relatively capital intensive economy on a per capita basis and historically dependent on foreign saving to make up the gap between domestic saving and investment opportunities.

In addition to providing a natural basis for the analysis of trade and industry policy and environmental concerns, dynamic regional computable general equilibrium (CGE) models provide a meaningful basis for analysing the potential impacts of regulatory and economic changes that impose barriers to efficient investment and that influence firms' capabilities and willingness to invest.

This paper seeks to make such analysis more accessible, using a new version of the GDyn model, which is an intertemporal variant of the widely used GTAP modelling

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framework (Hertel and Tsigas 1997; Ianchovichina and Walmsley 2012; Hertel 2013; Corong et al. 2017). The GTAP model is chosen because of its extensive coverage. It is based on a detailed input–output data base that is easily accessed and scaled to focus on any subset of countries, regions and sectors, and it provides an effective tool for the analysis of policy and economic changes affecting the real economy. The model is solved with GEMPACK 12 software, which through advances in matrix decomposition is suitable for solving large models (Horridge et al. 2019). Another important advantage of both the GTAP and the GDyn models for economic research and policy analysis is that they are fully documented, accessible and in the public domain.

The new version of the GDyn model—called GDyn-FS: (1) builds a capability to project a stable long-run baseline with non-convex adjustment costs; (2) introduces a rate-of-return rule for the allocation of saving between regions (capital-finance flows) and 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; (3) relaxes the assumption of fixed shares (the Cobb–Douglas assumption) in the consumption–saving decisions of national households; and (4) provides for the inclusion of exogenously determined changes in national consumption–saving choices. 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.

A full description of GDyn-FS is provided in the next section. The new GDyn-FS model is then used to simulate the national and sectoral impacts over time of a more restrictive and risky investment environment in Australia, a medium-sized OECD economy. This policy is modelled as an increase in the required rate of return on investment on account of increased barriers to investment and increased country risk. The policy scenario is set against a baseline extended to 2050 based on projections of value added, population and employment of skilled and unskilled workers. In addition to these growth determinants, the model is used to simulate the reversion to the mean in saving rate for China in the long-run from historically high of levels of around 50 per cent of GDP to levels comparable to other regions and the historical average for China.

The simulations use a database with 6 diverse regions—Australia, China, Japan, the United States, EU28 and the Rest-of-the-World—and 13 industry sectors—two agriculture, one mining, four manufacturing, five services, plus ownership of dwellings. Five primary factor inputs are modelled—land, natural resources, skilled labour, unskilled labour and (produced) physical capital. The database reference year is 2011. The illustrative application is reported to 2050.

A final section summarises the contribution and findings of the paper.

The Australian economy would be worse off with a decline in its desirability as a place to invest and work. A 10 basis point increase in the required rate of return on capital is estimated to lead to a 1.7 per cent reduction in capital and an associated drop in GDP of 0.65 per cent ($AU13 billion in current values). Workers would be worse off with real wages projected to fall by over 0.6 per cent and real national income falling in a similar proportion. Lower consumption would follow. There would be economic loss and disruption early on, particularly in the construction, manufacturing and service industries supplying investment goods and services. The disruptive short-run effects suggest that there could be benefits from measures that would ease adjustment pressures and help restore competitiveness including in ensuring labour market flexibility, education and training and measures to strengthen local research and development. Higher capital costs and associated economic disruption could also lead to calls for additional protection via industry subsidies, trade restrictions and government purchasing arrangements to protect incumbent firms and their workforces. There is a need to avoid

unduly restrictive policies that could build on one another to deepen the erosion of competitiveness, productivity and economic wellbeing.

2. Modelling Framework

2.1 Overview of Simulation Model

The GDyn is a multi-sector, multi-region recursive dynamic 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).

Producers in each region are divided into industries that are assumed to minimise costs subject to a constant returns to scale technology. Capital and labour are treated as being imperfectly mobile between industries while agricultural land and natural resources are 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 capital, land and natural resources. Income from product and factor taxes also accrues to the regional household. With this income, households maximise 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' that 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 transport services is attached to international trade flows with supply by region being pooled in constant proportions. Regional firms' source finance from the regional household and from global saving (via the 'global trust').

As a real-economy model, GDyn 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.

2.2 Simulation Environment and Model Innovations

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 are 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.

In the GDyn model, the transition dynamics to long-run equilibrium in the baseline or policy simulation depend on the assumption that the reference rate of interest for a region is given exogenously. This requires that rates of return on capital employed by region adjust adaptively to be equal to this reference rate (the model rate of interest) and constant over time.[1]

To satisfy this requirement and achieve longer-run stability, the GDyn-FS model builds on the basic version GDyn in three ways: (1) extends the investment rule to ensure that forward looking producers gradually adjust capital to eliminate any differences between regional firms' expected rate of return on capital and the reference (or target) rate; (2) incorporates non-convex adjustment costs to recognise the installation of capital is costly and new capital may not become immediately productive; and (3) modifies the treatment of international capital flows to include optimising behaviour by regional firms and households, respectively, in domestic–foreign real-asset investment choices. In addition to affording model stability, these elements support the modelling of the regulatory and economic changes that impose barriers to efficient investment and that influence firms' capabilities and willingness to invest—the specific interest of this paper.

In addition, and within the stable environment afforded by the elements of the first step, a further element is added to enable the Cobb–Douglas fixed expenditure shares assumption between consumption and saving choices to be relaxed while providing for the inclusion of exogenously determined changes in national consumption–saving mixes. This element supports, for example, the modelling in the baseline of reversion to the mean in the saving rate of China.

Each of the model innovations and parameter choices is detailed in Appendix 1.

2.3 Parameter Settings

The modelling adopts the standard trade and production technology parameters provided with the GDyn database with two modifications. First, the Leontief fixed real input assumption is relaxed to allow a degree of input substitution in response to relative price changes. This more flexible case is represented by a substitution elasticity value of 1.2 for each production sector. This value is in the neighbourhood of the capital-labour substitution elasticities included in the model database. Second, labour and capital services are treated as imperfectly mobile between sectors (that is sluggish) in place of the database assumption of perfect mobility within a CET nest. Transformation elasticity values of 20 for labour and 10 for capital are adopted to allow gradual mobility of factors between sectors over time. The modified approach and associated parameters provide for: (1) sluggishness in the short-run to recognise that installed and new capital cannot necessarily be relocated between activities to equalise returns at database rates and that labour may not be perfectly mobile between activities; and (2) flexibility in the longer run whereby capital is relocated/newly accumulated between activities to approximately equalise returns at benchmark rates and labour relocates according to employment opportunities to approximately equalise proportional changes in real wage rates across activities. This approach aligns the current implementation with the class of CGE model that assumes stickiness in the allocation of capital across sectors (Chateau et al. 2020, p. 116). Foreign–domestic investment parameters have been set to reflect a home-country bias effect associated with the Feldstein and Horioka (1980) hypothesis and consumption–saving elasticities relax the fixed shares assumption of the original model to allow a limited degree of substitution between consumption now and in the future (through saving). This reflects the literature, which suggests the responsiveness of real household consumption spending to real investment income is relatively low (see Appendix 2 for discussion).

3. Simulating a More Restrictive and Risky Investment Environment in Australia

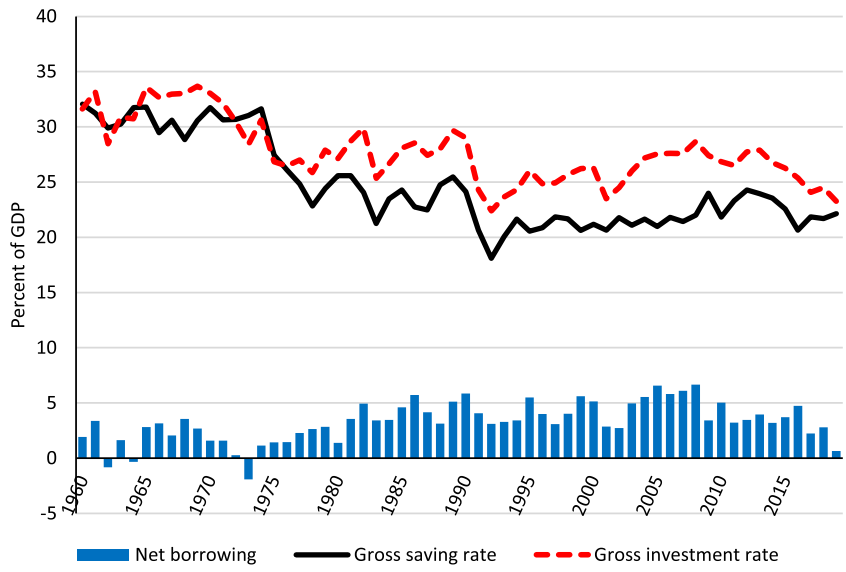
This section starts with a contextual discussion of Australia as a destination for investment funds sourced locally and from abroad, indicators of restrictions on capital and financial mobility and a brief survey of the literature followed by a description of the modelling baseline and simulation scenario depicting a more restrictive and risky investment environment in Australia. The next section reports the projected national and sectoral effects of this scenario.

3.1 Background

In the context of growing economic tensions in global markets, tightening of regulatory restrictions on foreign investment, this section considers the economic impacts of a more restrictive and risky investment environment in Australia—a medium-sized OECD economy. This matter is of importance given its modern history of economic reform and market liberalisation (for example, see Gretton 2013), a tapering of economic growth merging with the first recession in 30 years with the COVID-19 event and its aftermath, its dependence on foreign debt and equity investment to make up the gap between domestic saving and investment opportunities (Figure 1), and the associated longstanding public policy debate concerning the impacts and benefits of foreign investment (Johnson 1972; Crawford et al. 1978; Hanratty 1996; Evans 1999; Australian Productivity Commission 2020).

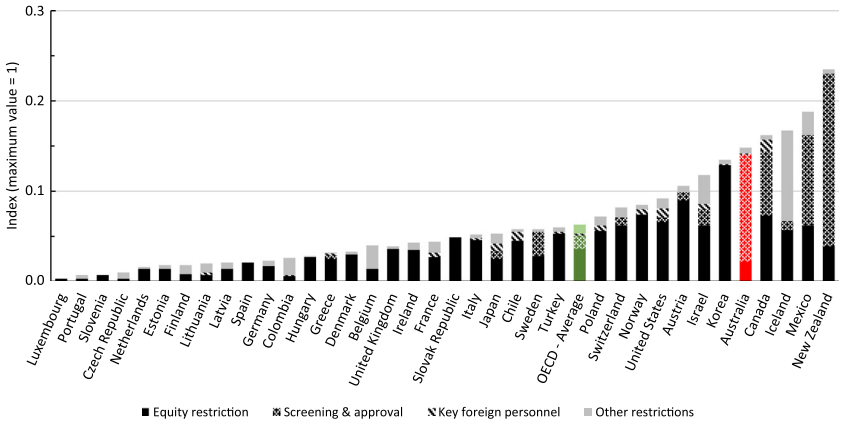
Australia's financial markets are relatively developed by global standards.[2] In common with other countries, nevertheless, inward foreign investment is subject to regulation. This regulation operates through a screening and approval regime under the Foreign Investment Review Board, restrictions on the ownership of equity in sensitive businesses and industries, and other regulations. The screening and approval regime applies to all inward foreign investment (direct, portfolio and other) above designated thresholds and applications to invest in designated activities, such as agriculture and residential real estate. According to the OECD foreign direct investment (FDI) regulatory restrictiveness index (Kalinova, Palerm and Thomsen 2010), Australia had the fifth most restrictive regime across the 37 OECD economies in 2018, below Canada, Israel, Mexico and New Zealand, but above the United States, the United Kingdom, France, Germany and Italy (Figure 2). While recognising that the index scoring mechanism is judgmental and does not capture influences such as system administration, subnational

Figure 1 The Saving-Investment Gap and Net Borrowing, 1960–2019[a,b]



Note: (a) Net borrowing equals (the negative) of the balance on current account plus net capital transfers; Gross Saving includes net capital transfers; (b) Gross investment is the sum of gross fixed capital formation and changes in inventories.
Source: Author estimates based on ABS, Australian System of National Accounts, Catalogue no. 5204.0, tables 2 Expenditure on GDP, 8 National Capital Account and 43 External Accounts, October 2019.

Figure 2 Restrictiveness of Foreign Investment Regimes Across OECD Members, 2018



Source: OECD FDI Regulatory Restrictiveness Index, OECD.Stat at https://stats.oecd.org/ (accessed 4 September 2020).

measures and national security, Mistura and Roulet (2019), in a gravity model analysis of bilateral FDI holdings, found that an increase in the index value was associated with a decline in the level of inward FDI holdings (Mistura and Roulet 2019, p. 37). FDI holdings were found to be more sensitive to restrictions on equity ownership than to screening mechanisms, the dominant mechanism for Australia.

MacDougall (1960), in a theoretical approach, analysed the national economic costs of lower capital inflows to depict that a reduction in the supply of foreign investment would increase its scarcity, raising its marginal product. Quantitatively, the Australian Productivity Commission used a longer-run comparative static global CGE model to estimate the longer-run economic benefits of a reduction in the risk premium on FDI between Australia and a large partner economy (the United States) (Productivity Commission 2010, pp. 55, 104). More recently, the Productivity Commission (2020) used a comparative static global general equilibrium model to estimate the economic costs of a decrease in Australia's inward FDI holdings. Gali and Taplin (2012) used a national general equilibrium dynamic modelling approach to estimate the economic costs after 10 years of a permanent drop of foreign debt and equity capital inflows.

The implications of changes in the availability and cost of capital have also been addressed in broader policy studies. For example, McKibbin (1999) used a dynamic intertemporal general equilibrium model to project the impact and benefits of partial removal of the wedge in bond rates between developing Asian economies and a reference economy (the United States) from reductions in government restrictions of financial markets. Gretton and Vines (2018) considered the possible economic costs of a decline in the willingness to invest in the United Kingdom following Brexit (conceived as increased country risk). Constantinescu et al. (2019) conjectured that contemporary trade tensions could erode firms' willingness to invest (conceived as an autonomous drop in the global investment to GDP ratio), lowering global output.

Empirical studies have found increased inward foreign investment to Australia preceded (Granger caused) GDP growth in the short run and, for direct investment, growth in the longer-run (Iyer, Rambaldi and Tang 2009), and that inward FDI had a positive effect on fixed capital expenditure, GDP and import growth but a negative effect on export growth of Australia (Faeth 2006). With a wider focus, Quinn, Schindler and Toyoda (2011) in a review of indexes of

financial openness, report that the positive relationship between capital market liberalisation and growth appears to have declined over time and that, on the country dimension, the effects are larger for emerging markets than advanced economies. Bumann, Hermes and Lensink (2013) provide a systematic meta-analysis of 60 empirical studies of the relationship between financial liberalisation and economic growth. They find a weak positive relationship between financial liberalisation and growth across countries, but that the impact of liberalising policies is somewhat sensitive to financial market development and market depth.

Contemporary events also have the potential to influence credit and investment worthiness at the national level. In the context of large-scale deficit spending associated with managing the economic fallout of the COVID-19 pandemic and mounting global strategic tensions particularly around China's regional intensions, reports have been made that Australia could lose its AAA credit rating (Read 2021; Joye 2021). It is reported that such an eventuality would potentially raise the cost of credit and make investing in Australia less attractive. Concerning the transition to lower carbon-emission energy generation, it has been found that policies in Australia lack clarity and that there is an increasing reliance on intermittent and variable renewable energy (Productivity Commission 2017, p. 57). It has also been reported that climate policy uncertainty is proving a significant barrier to long-term investment in Australia with investments incurring higher risk premia as firms hedge against policy risk (Jackson 2019, p. 2; Macdonald-Smith 2020).

3.2 Simulation Scenario

The simulation scenario in this paper focuses on the issue of what may be at stake for a small open capital importing OECD economy such as Australia, if policies or the broader economic environment are perceived to make investment more risky or institutions less favourable to investment activity, than otherwise. The scenario does not necessarily represent the effects of a single policy or economic event, but rather a broad change in the policy and economic environment affecting the pool of funding for investment in Australia, both foreign and domestically sourced.

The analysis adds to the existing literature in two ways: (1) it takes as its starting point a (permanent) change in the policy or business environment that leads to a permanent increase in country and commercial risk to which investors gradually adjust giving a dimension not available in projections based on a once off change in the level of capital or investment; and (2) it traces out the scale of adjustment over time providing a dimension not available in comparative-static approaches. It also traces out the economic mechanisms behind changes, a perspective not necessarily accessible in reduced form empirical studies.

The scenario is modelled as a permanent increase in the average rate of return required by all investors for investing in Australia of 10 basis points. This is equivalent to an 8 per cent increase in the difference between the US and Australian real commercial bond rate averaged over the period 2000–2019 (based on data from World Development Indicators 2020). For model simulation, this change is calibrated as an increase in the required returns from 8.1 per cent (the data base reference rate for Australia) to 8.2 per cent, that is, a ~1.2 per cent increase (via Equation A5).

The change is modelled to occur in one year while adjustment to the change is modelled as being gradual. Key adjustment assumptions to the transition process are: (1) the changes are not anticipated by investors so the actual and expected rates of return when the change occurs are formed by the business as usual case (the model baseline); (2) installed capital depreciates on average at a rate of 4 per cent per annum; (3) installed capital services are assumed to be imperfectly mobile between industries in the short run, and subject to the capability of industries to substitute between labour and installed capital services; (4) new investment, planned capital

growth and output can adjust in any one year to close one fifth of the gap between the model expected, actual and reference rates of return on capital, all else being equal; and (5) real wages adjust to maintain national employment at baseline levels.[3] Because the baseline embodies changes in the structure of the global economy, the projected impacts of a policy change affecting one region (in this case Australia) will also be influenced by those global changes, that is, the policy projections will be 'path dependent'.[4]

The baseline is projected using the longer-run projections of GDP, population and skilled and unskilled labour to 2050 (Foure et al. 2010).[5] The projections reflect an expectation that GDP growth in China and the regions covered by the Rest-of-the-World grouping will continue at rates above those for Australia, Japan, the United States and the Europe-28 economies, but that projected growth rates for China and Japan, in particular, will taper off. For China, the gross saving rate as a proportion of GDP is projected (via Equation A11) to decline from a peak of around 50 per cent of GDP to around 24 per cent of GDP—a level near the average for other regions. Investment by region is determined by the investment rule (Equation A3), subject to other growth assumptions.

In the baseline, it is recognised that differences in regional risk and institutions would remain over the projection period.

4. National and Sectoral Effects

4.1 Long-Run National Effects

A 10 basis point increase in the required rate of return on capital is projected to lead to a 1.7 per cent reduction in capital installed from baseline levels, after 30 years—the long-run time horizon adopted in this study (Table 1). With lower capital stocks, labour fixed at baseline levels and no increase in productivity to make up for the decline in capital, national output as measured by GDP is projected to fall by 0.65 per cent. With a reduction in output, real wages evaluated with respect to the local price of household consumption are projected to decline by 0.66 and 0.61 per cent for unskilled and skilled labour, respectively, to maintain employment at baseline levels. Real national income is projected to decline by 0.61 per cent in the long run.

Lower real income and a less capital-intensive economy are reflected in projected declines in real private and government consumption and investment of 0.6, 0.36 and 1.12 per cent, respectively. With lower domestic absorption, the volume of imports are projected to decline by 0.5 per cent while exports, now less competitive in global markets, are projected to decline by 0.39 per cent. The terms of trade is projected to increase by 0.05 percentage points as export prices rise relative to import prices while a slight increase in the balance of trade as a share of GDP is projected. In the less capital-intensive economy, foreign liabilities are projected to decline by 1.55 per cent. Income remittances abroad, however, are projected to rise with higher returns on lower inward investment. Lower investment abroad is projected to follow as local investors become more inward looking.

The central influences on these projected changes, in addition to the policy shock, are tied to the relative importance of labour and capital in value added and the extent to which labour and capital can be substituted in production. Focusing just on these elements, a first approximation of the long-run comparative static change in capital (k) (in percentage change terms) can be depicted as $k = -\frac{\sigma}{L} ror$ where σ is the CES elasticity of substitution between labour and capital in production (approximately 1.2 in the across activities in the database), L is the labour share in value added (about 0.6 for Australia) and ror is the exogenous percentage change in the rate of return on capital (estimated at 1.2 per cent) (see Appendix 2 for an outline of this stylised model). This first approximation yields a potential decline in capital of about 2 per cent in the long run. Similarly, the potential change in output (y) can be depicted in $y = -\sigma \frac{K}{L} ror$ where K is the capital share of output. With a database capital share of the

Table 1 Illustrative Projections of Economy-Wide Adjustments to a 10 Basis Point Increase in the Required Gross Rate of Return to Capital, Australia, Deviation From Base Line

			Year from policy change			
	Label		*1*	*5*	*10*	*30*
Summary indicators						
GDP	qgdp	%	–0.155	–0.541	–0.866	–0.652
Capital stock	qk	%	–0.168	–1.161	–2.083	–1.699
Gross rate of return—target	rorgt	%	1.200	1.200	1.200	1.200
Gross rate of return—expected	rorge	%	0.152	0.896	1.452	1.127
Gross rate of return—actual	rorga	%	0.067	0.747	1.403	1.158
Capital services rental price	rental	%	–0.677	0.004	0.931	1.170
Real wages—unskilled labour	pfactreal	%	–0.541	–0.932	–1.120	–0.658
Real wages—skilled labour	pfactreal	%	–0.314	–0.676	–0.921	–0.607
Real capital rentals	pfactreal	%	0.052	0.603	1.136	0.939
Real land rentals	pfactreal	%	2.292	1.695	0.301	–0.887
Real natural resource rentals	pfactreal	%	2.840	1.573	–0.618	–1.847
Real income	yreal	%	–0.221	–0.676	–0.921	–0.607
Terms of trade	tot	%	–0.421	–0.384	–0.201	0.047
Balance of trade to GDP	DTBALRG	% pts	0.923	0.956	0.637	0.039
Balance of Trade	DTBAL	US$m	14.3	15.8	11.3	0.2
Final demand quantum						
Private consumption	qpriv	%	–0.219	–0.575	–0.854	–0.603
Government consumption	qgov	%	–0.057	–0.272	–0.469	–0.364
Investment	qcgds	%	–4.484	–5.281	–4.187	–1.117
Exports (vol.)	qxwreg	%	2.307	2.040	0.964	–0.394
Imports (vol.)	qiwreg	%	–2.180	–2.464	–1.962	–0.498
Final demand prices						
Private consumption	ppriv	%	–0.729	–0.595	–0.203	0.229
Government consumption	pgov	%	–0.890	–0.897	–0.589	–0.011
Investment	pcgds	%	–0.743	–0.738	–0.465	0.012
Exports (fob)	psw	%	–0.415	–0.377	–0.193	0.052
Imports (cif)	pdw	%	0.006	0.008	0.009	0.006
GDP	pgdp	%	–0.812	–0.725	–0.354	0.146
Factor prices						
Unskilled labour	pm	%	–1.266	–1.522	–1.320	–0.431
Skilled labour	pm	%	–1.040	–1.267	–1.122	–0.380
Capital rentals	pm	%	–0.677	0.004	0.931	1.170
Land rentals	pm	%	1.546	1.089	0.098	–0.660
Natural resource rentals	pm	%	2.090	0.968	–0.819	–1.622
Value adding factors combined	pfact	%	–0.825	–0.736	–0.358	0.153
Income and outlay						
Income	y	%	–0.948	–1.168	–1.054	–0.373
Consumption	yc	%	–0.946	–1.167	–1.055	–0.375
Saving	ys	%	–0.965	–1.176	–1.048	–0.357
Consumption price	pc	%	–0.769	–0.671	–0.299	0.169
Saving price	ps (psave)	%	–0.579	–0.576	–0.371	–0.013
Local capital income and holdings						
Capital income of firms	yf	%	–0.777	–0.425	0.155	0.564
Capital income from abroad	yht	%	–0.015	–0.061	–0.101	–0.081
Capital income accruing abroad	ytf	%	–0.763	–0.315	0.335	0.704
Local firms' capital holdings	wf	%	–0.911	–1.890	–2.538	–1.687
Outward investment holdings	wht	%	–0.069	–0.129	–0.182	–0.143
Inward investment holdings	wtf	%	–0.897	–1.782	–2.363	–1.550
Local-foreign substitution	swtf	%	0.014	0.110	0.180	0.139

(Continues)

Table 1 (Continued)

	Label		Year from policy change 1	5	10	30
Global trust capital income and holdings						
Rate of return—actual	rorga_r	%	0.026	0.026	0.030	0.029
Price of holdings	ptrust	%	–0.019	–0.020	–0.013	–0.001
Capital income	yt	%	–0.012	–0.006	0.003	0.005
Holdings	wt	%	–0.066	–0.073	–0.078	–0.057

Source: Author estimates based on GDyn-FS model.

order of 0.4, this first approximation yields a potential output decline of 0.99 per cent in the long run. These simplified representations, while highlighting the importance of capital and labour intensity and substitution possibilities to final outcomes, also highlight the importance of wider factors such as trade and the flexibility of the use of intermediate and primary factor inputs across sectors included in the full model but not the stylised model to model projections.

The domestic cost of production, represented as the price of value added at factor cost is projected to increase by 0.15 per cent from baseline levels in the long run (Table 1).[6] This increase reflects the net effect of a projected increase in the rental price of capital services (1.17 per cent), a decrease in nominal wages (−0.43 and −0.38 for unskilled and skilled labour, respectively), and a decline in the rental prices of land and natural resources (−0.66 and −1.62, respectively).

With the rental price of capital projected to increase relative to the price of other value adding factors and a substitution parameter between labour and capital of greater than one, the share of capital in value added is estimated to decline relative to baseline levels by 0.017 percentage points in the long run (Table 2). There are commensurate increases in the labour shares of value added, but declines in the land and natural resource shares as the rental price of those factors (which are assumed fixed at baseline levels and complementary to labour and capital in the land and resource using sectors) decline relative to the price of other factors.

In a less capital intensive economy, the proportion of GDP (by value) absorbed by depreciation of capital would decline from baseline levels (Table 3) raising net income as a proportion of GDP.

After depreciation of capital, income available for consumption and saving will also be affected by capital income accruing abroad on foreign ownership of local capital (*ytf*) and receipts accruing on local ownership of foreign capital (*yht*)—projected to rise by 0.7 per cent and fall by 0.08 per cent, respectively (Table 1).[7] Each element therefore erodes local income while rising as a share of the projected lower GDP (Table 3). The change in the value of capital income accruing abroad reflects both a level effect and a sourcing effect defined by $ytf = yf + wtf - wf$ where yf is the percentage change in capital income (0.56 per cent) while $wtf - wf$ represents a net sourcing effect of 0.14 per cent where wtf is the percentage change in foreign investment in

Table 2 Percentage Point Change in Value Adding Factor Shares After 30 Years by Component, Australia, Deviation From Baseline

		Land	Unskilled labour	Skilled labour	Capital	Natural resources
Change	% points	−0.001	0.015	0.046	−0.017	−0.042

Source: Author estimates based on GDyn-FS model.

Table 3 Percentage Point Change of Source And Use of Income As a Share of GDP After 30 Years, Australia, Deviation From Baseline

	Depreciation of fixed capital	*Capital income received from abroad*	*Capital income remittances abroad*	*Income (net of depreciation)*	*Consumption*	*Saving (net)*
	Less[a]	*Plus*	*Less*[a]			
Change % points	−0.173	0.019	0.080	0.112	0.095	0.018

Note: [a]A negative change indicates a smaller deduction from GDP in the derivation of income, that is the item is proportionately smaller relative to GDP; a positive change indicates a larger deduction, that is, the item is proportionately larger relative to GDP.
Source: Author estimates based on GDyn-FS model.

local capital (−1.55) and *wf* is the percentage change in the value of local capital (−1.69). The positive sourcing effect reflects a decline in local firms' use of local relative to lower cost foreign finance (by Equation A9). The positive level and sourcing effects contribute to the higher projected share of offshore remittances of investment income in GDP.

The GDP share of capital income received from abroad is also projected to increase fractionally, but in this case, because the projected decline in foreign investment earnings is less than the decline in the value of local output. The change in the value of investment income accruing from offshore investments (*yht*) reflects a global income (level) effect and an investment effect defined by $yht = yt + wht - wt$ where *yt* is income on capital intermediated through the global trust (the global income effect) (0.005 per cent) while $wht - wt$ represents the investment effect of 0.09 per cent where *wht* is the percentage change in investment in capital abroad by locals (−0.143 per cent) and *wt* the percentage change in total capital holdings through the global trust (−0.057 per cent). The positive income effect arises because of a rebound effect by which some of the higher remittances by local firms abroad accrue indirectly to local investors. The negative investment effect reflects a decline in local investment in capital abroad relative to domestic capital (by Equation A7).

In the less capital-intensive economy, income (net of depreciation allowances) is then projected to rise as a share of GDP. Net income accruing to the regional household is allocated between consumption (private plus government) and saving (net of depreciation allowances) in the model's top-level CES indirect utility function (Equation A11). With the decline in net income, both consumption and saving are projected to fall in value terms (Table 1) but to increase (slightly) as a share of GDP (Table 3). The CES substitution effect between consumption and saving is tied to relative changes in the price of the consumption and saving bundles, respectively, and the extent to which consumption and saving can be substituted by the regional household. The substitution effect can be depicted as $yc - ys = -\varphi cs(pc - ps)$ where *yc* and *ys* are the percentage changes in the value of the consumption and saving bundles, respectively, φ is the elasticity of substitution between consumption and saving in the indirect utility function (with a value of 0.1, section A4.2, Appendix 1) and *pc* and *ps* are the percentage changes in the price of consumption and saving bundles, respectively. The price of consumption is projected to increase by 0.17 per cent broadly in line with the projected increase in general price level (Table 1). With domestic and foreign investment components, the price of saving is defined as $ps = \frac{WHFIRM}{WHHOLD} \times pcgds + \frac{WHTRUST}{WHHOLD} \times ptrust$ where $\frac{WHFIRM}{WHHOLD}$ is the share of local household real wealth held in local firms (about 70 per cent), *pcgds* is the percentage change in the price of the local investment-good bundle, $\frac{WHTRUST}{WHHOLD}$ is the share of local

Table 4 Percentage Point Changes in Final Demand Shares after 30 Years by Component, Australia, Deviation From Baseline

		Private consumption	*Gov't consumption*	*Investment*	*Exports (fob)*	*Imports (cife)*
Change	% points	0.071	0.024	−0.134	0.042	−0.003

Source: Author estimates based on GDyn-FS model.

household real wealth held in global investments (about 30 per cent) and *ptrust* is the percentage change in the price of the capital investment intermediated though the global trust. The local component (*pcgds*) is related to the rate of return on capital (the shock variable) through the condition $ror = rental - pcgds$ where *ror* is the exogenous percentage change in the rate of return (1.2 per cent, as above) and rental is the *rental* price of capital services. With *ror* being the shock variable, a first approximation of the long-run comparative static change in the rental price can be depicted as $ror = rental$ implying a change in the price of capital goods of zero.[8] The projected deviation (for *pcgds*), which takes into account general equilibrium effects, is 0.012 per cent (Table 1). With the global price of saving set as the model price numeraire, a first approximation of *ptrust* is also zero, which compares to the projected deviation of −0.001 per cent. Combining the deviation on the domestic price of capital goods with that of the global trust price gives a first approximation of *psave* of 0.007 per cent, which compares to the projected value of −0.013 per cent.[9] Substituting the projected values into the consumption–saving relation yields a substitution effect of around $-0.018 = -0.1(0.169 + 0.013)$ percentage points, indicating that a slightly higher proportion of lower income would be devoted to saving.

Lower domestic consumption is projected to flow though to lower private and government consumption. Under a constant value share assumption, the higher-priced private consumption bundle is projected to decline in real terms relative to the more labour-intensive government consumption bundle for which the fall in real wages provides a greater offset to the increased cost of capital (Table 1). The lower capital stock requires less investment relative to the baseline in the longer run.[10]

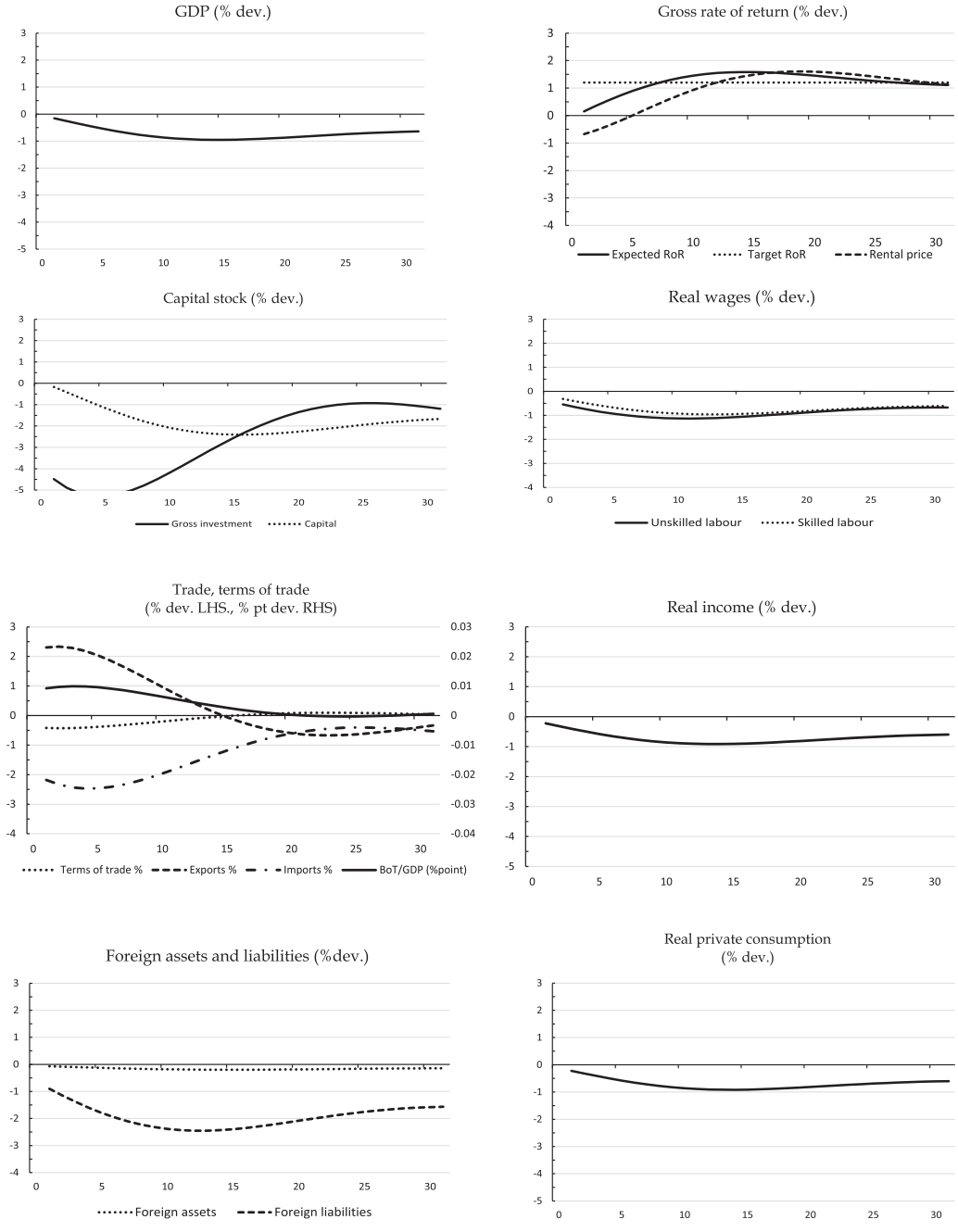
The decrease in overall domestic absorption means that the volume of imports is projected to decline. The projected decline of 0.5 per cent (Table 1), however, is less than the decline in GDP as local buyers of consumption, intermediate and investment goods substitute towards lower cost imports. Because export demand curves are downward sloping in GDyn, higher domestic costs are reflected in increased export prices (0.05 per cent) and an associated projected decline in export volumes (0.39 per cent). The real revaluation of the Australian economy would raise the cost of trade globally and flow through to slightly higher import prices (0.01 per cent). These changes flow through to slightly positive projected terms of trade (0.05 percentage points) and balance of trade as a share of GDP (0.04 percentage points) in the long run.

Overall, the value of domestic private and government consumption and exports are projected to increase as a share of GDP while the investment share is projected to decline as is the import share (Table 4).

4.2 Transition Paths

Over the transition period, a 10 basis point increase in required returns would initially increase that rate relative to the modelled expected rate, lowering the incentive to invest relative to the business as usual case (as shown Table 1; Figure 3, top right panel). This flows through (via Equation A3) to a reduction in investment spending in the first period of nearly 5 per cent (Table 1; Figure 3, second row left panel).

Figure 3 Illustrative Projections of Economy-Wide Adjustments to a 10 Basis Point Increase in the Required Gross Rate of Return to Capital, Australia, Deviation from Base Line



Source: Author estimates based on GDyn-FS model.

The projected decline in investment spending would flow through to reduced demand for domestically produced and imported capital goods contributing to lower national output and lower aggregate imports in the first year of 0.2 and 2.2 per cent, respectively (Table 1; Figure 3, top and third left panels respectively).[11] With the level of installed capital capacity now exceeding required levels, its rental price is projected to decline by 0.7 per cent in the first year.

Further reductions in investment spending relative to the baseline are projected to year five as firms gradually adjust capital stocks downward relative to baseline levels and expected returns are drawn towards the target rate. Capital stocks decline at a slower rate than investment so that the underlying investment to capital ratio declines relative to the baseline ratio. The rate of new investment is then drawn higher, raising the investment to capital ratio. Output is drawn down, but not by as much as the decline in capital so that its rental price is projected to gradually rise (Table 1; Figure 3, top right panel).

As capital stocks approach a new lower long-run level of around 1.7 per cent below baseline levels, investors' expected and firms' actual returns (*RORGEXP* and *RORGROSS*, respectively) are projected to gradually approach the target level (*RORGTARG*) to meet the long-run equilibrium condition $RORGEXP = RORGTARG = RORGROSS$ (Equation A1). As these rates converge, the percentage deviations from the baseline for the expected and actual rates approach the exogenous change in the target rate of 1.2 per cent (Table 1; Figure 3, top right panel). With the price of global saving defined as the model price numeraire and not shocked (discussed above), the percentage deviation in the rental price of capital services from the baseline value also converges towards the exogenous increase in the target rate of return.

With the gradual adjustment of available capital to a lower long-run level, GDP is projected to decline by about 0.5 per cent after 5 years and 0.9 per cent after 10 years, converging via a lagged adjustment process to about 0.6 per cent in the long run (Table 1; Figure 3, top left panel).

Aggregate employment is maintained through lower real wages (Table 1; Figure 3, second right panel). In the early periods of adjustment, wages of unskilled workers, which include construction workers and process workers in trade exposed sectors, are projected to decline by more than workers in the skilled category.[12] Lower real wages improves the competitiveness of the trade exposed sectors so that exports are projected to increase and imports decrease in the early years of adjustment. For example, in the first year, the volume of exports is projected to rise by 2.3 per cent, while the volume of imports is projected to decline by 2.2 per cent (Table 1; Figure 3, third left panel). After accounting for a projected decline in the terms of trade (of −0.4 per cent in the first year), the balance of trade by value and as a share of GDP is projected to rise in the short-run. After a period of transition involving the gradual relocation of local factors between activities on a lower capital base but with an increase in local costs (with the permanently higher cost of capital), the volume of imports and exports are projected to converge close to but below baseline levels in the long run. Simultaneously, the terms of trade, the balance of trade by value and as a share of GDP, are projected to gradually return close to initial values. Real wage rates across the skill groups are also drawn together at lower long-run rates as labour moves between activities.

Real net income (measured as nominal income adjusted for private consumption prices) is projected to decline from baseline levels mainly as a consequence of lower domestic production. In the first year, the capital base is mostly fixed at baseline levels (less depreciation) and with this real income is projected to decline by 0.22 per cent from baseline levels, which relates closely to the projected decline in GDP of 0.16 per cent (Table 1). In the long run, the real income is projected to decline by 0.61 per cent but, with the increase in the share of GDP accruing as income, slightly less than the decline in GDP (of −0.65 per cent). With the decline in real income, real private and government

consumption are also projected to decline over time to new lower levels relative to the baseline (Table 1; Figure 3, third and bottom right panels).

Foreign liabilities of Australian firms are projected to decline in nominal US dollar terms (via Equations A9 and A10) (Table 1; Figure 3, bottom left panel). This reflects three effects: (1) a negative shift effect associated with the decline in the value of domestic real capital stocks; (2) an initial negative valuation effect associated with a projected decline in local capital goods-prices with the decline in demand; and (3) a small (positive) substitution effect associated with the expected cost of local capital rising (with required rates of return) relative to finance from abroad. Because of the home-bias assumption adopted in parameter settings, the substitution effect is small absolutely and relative to the other effects. While in the simulation the valuation effect is temporary,[13] the shift and substitution effects are permanent. From A10 of Appendix 1, the percentage change in foreign liabilities in Australia (*wtf*) is defined as $wtf = wf + swtf$ where the change in the value of local capital is given by $wf = qk + pcgds$ and *swtf* represents a substitution (or sourcing) effect towards trust investment in local firms from firm financing decisions between local and foreign capital. In the first year, the percentage deviation from the baseline is estimated as $-0.897 = -0.168 - 0.743 + 0.014$ giving emphasis to the capital base and capital-goods price index effects (Table 1). In the longer run, the projected decline in the level of foreign investment in local firms relative to the baseline of 1.55 per cent, closely aligns with, but on account of the positve substitution effect (of 0.139), is less than, the decline in the level of real assets of local firms of 1.687 per cent. Over time, local firms are projected to source slightly more of their lower level of financial requirements from offshore (Table 5).

The level of foreign assets held by Australian households is initially projected to decline with the value of the global trust (via Equations A7 and A8). This decline is mainly associated with the decline in nominal asset values in Australia in which the trust invests. From A7, the percentage change in outward foreign investment (*wht*) can be defined in simplified form as $wht = wt + \tau cf.\ S_1(rorga\_r - rorga)$ where *wt* is the percentage change in the value of real capital held by the global trust across regions, τcf is the indirect revenue function elasticity of transformation between domestic and foreign wealth holdings (0.05), S_1 is the share of region household wealth held in the global trust (about 25 per cent), while *rorga_r* and *rorga* are the percentage changes in the global average actual rate of return accruing via the global trust and the actual rate of return on holdings in local firms, respectively. In the first year, the value of outward investment in real assets abroad is projected to decline (by value) by 0.069 per cent (Table 1; Figure 3 bottom left panel) from a negative level effect of −0.066 (Table 1) and a slight transformation effect of −0.003. Over time, local households are projected to transform financial asset holdings away from investment via the global trust in favour of investment in local firms that are now yielding relatively higher returns. For year 30, investment abroad is projected to decline by 0.143 per cent from a negative level effect of −0.057 per cent and a negative transformation effect of −0.086 per cent.[14] Because the domestic capital base declines more than the global capital base, the share of local wealth held abroad rises (Table 6).

Table 5 Percentage Point Changes Share of Firm Capital-Finance Sourced from Abroad, Australia, Deviation From Baseline

		Year from policy change			
		1	*5*	*10*	*30*
Change	% points	0.006	0.049	0.079	0.061

Source: Author estimates based on GDyn-FS model.

4.3 Sectoral Effects

With a projected decline in investment, the activities most dependent on supplying investment goods and services, particularly

Table 6 Percentage Point Changes Share of Local Wealth Held Abroad, Australia, Deviation from Baseline

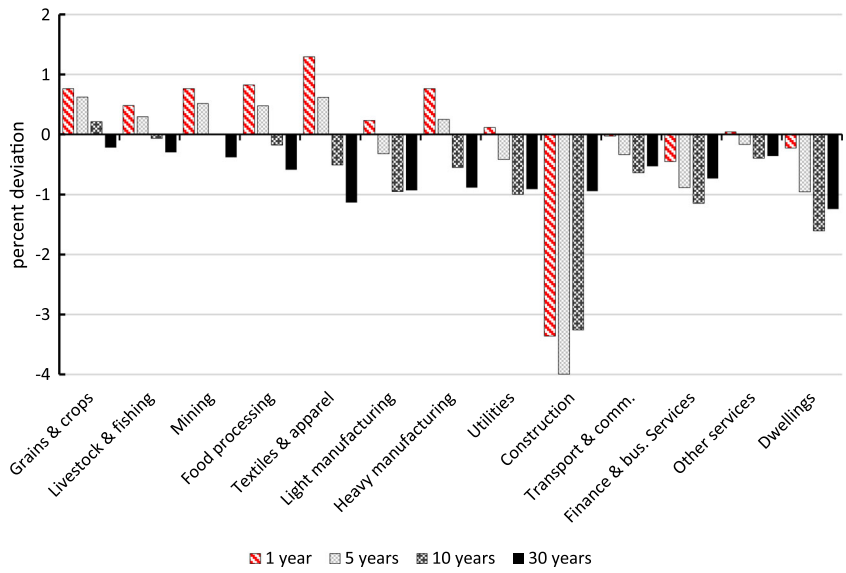
		Year from policy change			
		1	*5*	*10*	*30*
Change	% points	0.151	0.336	0.466	0.325

Source: Author estimates based on GDyn-FS model.

construction, are hardest hit in the short run (Figure 4). The projected decline in output is not strictly proportional to the decline in investment, however, because of ongoing repair, maintenance and service provision, which would be leveraged to the overall level of activity. Other sectors projected to be negatively affected in the short run are those supplying services to investment activity, particularly finance and business services. Under the assumption that labour markets are sufficiently flexible to maintain employment at baseline levels and real wages decline to clear the labour market (Figure 3), the more trade exposed agriculture, mining and manufacturing sectors are projected to expand in the short run through an increase in exports or via import replacement (Figure 4).

With the progression of time and realisation of the effects of erosion of the investment environment through lower income, the impacts of higher capital costs are projected to gradually transition, with some variation, to lower activity levels than otherwise across all sectors in the longer-run (Figure 4). Over this horizon, the projected decline in output for the extractive industries and the downstream food processing industry is less than the average because of the importance of the fixed factors land and natural resources as inputs (about one quarter for rural activities and one third for mining activities in the data base). To maintain resources at baseline levels, the rental price of land and natural resources is projected to decline by 0.7 and 1.6 per cent (Table 1), respectively, raising competitiveness relative to other trade exposed sectors. The projected decline across transport, business and other services is also less than average because of the relative importance of lower priced labour and lower trade exposure.

Figure 4 Illustrative Projections of Sectoral Effects to a 10 Basis Point Increase in Required Returns to Capital, Australia, Percentage Deviation From Base Line



Source: Author estimates based on GDyn-FS model.

The dwelling sector stands out as being potentially hardest hit in the long run. This sector sells nearly all of its output to private final consumption. The projected decline in sector output relative to the baseline reflects the predominance of capital services in the input structure of the dwellings industry (about 75 per cent of total inputs and the only value adding factor). For year 30, the price of dwelling services is projected to rise relative to the baseline by 0.883 per cent, most of which is accounted for by an increase in the sector-specific capital services price ($0.889 = 1.185 \times 0.75$).[15] With output projected to decline in volume terms by 1.243 per cent, the value of output of dwelling services would decline by 0.36 per cent (that is, approximately 0.889–1.243) from baseline levels. Reflecting the assumption in GDyn of stickiness in dwelling demand in response to relative price changes, that decline is less than the projected decline in nominal private consumption spending of 0.39 per cent indicating a slight increase in the share of dwelling services from baseline levels in a smaller private consumption bundle.

5. Conclusion

This paper examines the economic implications of a more restrictive and risky investment environment in Australia, a medium sized OECD economy, modelled as a 10 basis point increase in the required rate of return on capital. The simulations show that Australia would experience substantive economic disruption in the first 10 years with disruptions gradually giving way to permanently lower activity, income and wealth levels. The results highlight the economic loss and disruption in the short to medium runs, particularly through lower output in industries supplying investment goods and services and lower real wages for workers. Such results cannot be depicted in standard comparative-static CGE analysis or models that do not afford convergence to saddle-path stability over the longer-run.

With potential economic costs in mind, a key policy focus of governments confronting decisions that could restrict the supply of capital or situations that may erode firms' willingness to invest should include careful evaluation of potential direct and indirect economic costs in an economy-wide framework, in the short and longer terms. The industry results also suggest a number of broad policy imperatives to ease the cost of adjustment to more economically restrictive investment regimes. Labour markets should be sufficiently flexible to support the movement of people between activities to avoid unemployment and to ensure people transition to areas of greatest value. Training and retraining of the workforce should be configured to best fit people for new roles, potentially outside of industries and activities of former employment. Domestic research and development capabilities should be strengthened to make up for new technologies and ways of working foregone with a lowering of the capital base and lower foreign capital inflow. Trade restrictions that divert demand from least cost/highest quality suppliers in the global market place and raise costs to local firms should also be avoided.

Higher costs of capital and the associated economic disruption could also lead to calls for additional protection including via industry subsidies, anti-dumping actions and government purchasing arrangements to protect incumbent firms and their workforces. There is also a need to guard against the real risk of such policy direction and avoid restrictive policies that could build on one another, deepening the erosion of competitiveness, productivity and economic wellbeing.

The innovations introduced in this paper through the GDyn-FS model should help facilitate the wider use of applied recursive dynamic CGE modelling in a global framework. Suggestions for further research in this regard, would be to use the model to consider the national and sectoral effects of major economic change, such as Brexit or of COVID-19 and its aftermath, that will have lasting and substantive effects over time on firms' willingness to invest at the national and sectoral levels, and flow on effects across national borders including Australia. The approach also could be used to analyse

changing economic and trading relations over time between regions, such as between Australia and the EU, OECD partners outside of the EU, Asia and other regions.

Further theoretic and applied developments would enhance this model's usefulness. Such developments could be pursued though, for example, incorporation of theory-based national saving rates by region to explicitly reflect time preference and longer run growth, and the modelling of national labour markets to allow for short-run unemployment.

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Endnotes

1. In the model's original implementation, however, this equilibrium condition is not satisfied with the rates of return on capital falling across regions without bounds (Ianchovichina and McDougall 2012; Golub and McDougall (2012); Gretton 2018).

2. As indicated by the IMF Financial Market Development Index for 2018 which scores Australia as sixth out of the 37 OECD countries, just behind Japan, the United States, Canada, the United Kingdom and Switzerland but ahead of the G20 economies France, Germany and Italy (IMF 2020).

3. The treatment accords with the comparative-static origins of the model in which employment is typically assumed fixed in policy simulations with labour market deviations evaluated in terms of changes in real wages leading to changes in real national income. Relaxation of the assumption would allow short-run unemployment/overemployment to be projected in a policy simulation. Changes in employment would flow though to national output and real incomes, and could have distributional consequences (for example, between employed and unemployed workers).

4. Sensitivity tests using alternative baseline assumptions such as a hypothetical saddle path equilibrium (Ha et al. 2017) or shared socio-economic pathway projections (Dellink et al. 2015) indicate that, in this case, the projected impacts of the policy scenario are broadly aligned across alternatives.

5. CEPII estimates provided with GDyn_V36, file: Projectionsforthe112_v3.zip downloaded from GTAP webpage 26 June 2016 (GTAP 2016).

6. Domestic costs are evaluated with respect to the global price of saving, the model numeraire price.

7. Investment income includes interest and dividends that pass through the banking system and reinvested earnings, which do not.

8. This conclusion is specific to this simulation. If, for example, an element of *pcgds* was the shock variable, as a first approximation, *psave* would vary in proportion to the share weighted value of *pcgds*. With no change in *ror*, *rental* = *pcgd* in the long run.

9. The difference between the implicit value and the projected value occurs because the linearised equations of the model are not satisfied exactly (Pearson et al. 2010, p. 15). In this case, the first approximation and the projected value are centred around zero, the value of the model numeraire and appropriate comparator.

10. The projected deviation of investment from baseline levels of 1.12 per cent differs from the projected deviation in real capital (of 1.7 per cent). This difference and the difference between the actual and the target rate of return (1.16 and 1.2 per cent, respectively) indicates that full convergence to a long-run equilibrium lies outside the projection period. As can be seen in Figure 3, the adjustment tapers towards a long-run equilibrium.

11. The model market clearing and balance sheet conditions ensure that global investment (the sum of investment across regions) is equal to global saving and that total wealth holdings by regional households is equal to the sum of real asset holdings of firms across regions.

12. As noted, labour market adjustment is modelled through factor price changes and imperfect mobility of labour between sectors in the short to medium runs. Relaxation of this assumption with an assumption of sticky wages at the national or sectoral levels would generate a degree of unemployment and a commensurate loss in real output. The upward effect on income from sticky wages would be countered by lower national

output. Unemployment would likely be concentrated in occupational groups hardest hit by the projected reductions in real wages.

13. This is ensured by setting the model price of global saving as the numeraire price and allowing mobility of saving and investment between regions.

14. A direct calculation of the transformation effect based on Equation A7 yields $-0.015 = 0.05 \times 0.264 \times (0.029-1.158)$. The difference between the implicit estimate and the direct calculation indicates a degree of linearisation error (see above). The negative transformation effect of the two estimates centres around −0.05 per cent.

15. The percentage deviation from the baseline of sector-specific rental prices converge towards the projected economy-wide change. Over the 30 year time horizon of this study, the national rental price on capital is projected to deviate from the baseline by 1.170 per cent (Table 1).

16. See chapter 3 of Dixon et al. (1992) for a description of the Johansen method and its application in CGE models.

17. As the setting is within-period, no adjustment is made to the value of the parameter LAMBRORGE between periods.

18. The implementation is simplified by the omission of the depreciation term, an element not subject to the current study.

19. While the rigidity parameters can be recalibrated to dampen variation and extend the time horizon of a simulation, such an approach is ad hoc and not robust.

20. This is similar to the approach adopted in Productivity Commission (2010), in which a CET|CES formulation was introduced to the GTAP model to examine the impact of polices affecting the relative cost of bilateral investments. That implementation differs from the GDyn application in this paper in that: substitution/transformation possibilities were mediated by real capital-good prices not rates of return; it was applied in a comparative static and not dynamic framework; and it implemented a disaggregation of the global trust into a 25 region by 25 region flow of funds account.

21. An elasticity value of zero in the indirect revenue function represents the Cobb–Douglas case. More fully, the transformation parameters are recorded for entry into (A7) according to the rule: $\tau cf > 0$ for $\theta cf < -1$, $\tau cf = 0$ for $\theta cf = -1$, and $\tau cf < 0$ for $-1 < \theta cf < 0$, where $\theta cf = 1/(1+\rho)$, $\rho < -1$, is the transformation elasticity in the direct revenue function (Dixon et al. 1992, p. 133).

22. Noting the sign of ϑ entered in (A9), the parameters are assigned values as follows: $\vartheta cf > 0$ for $\sigma cf > 1$, $\vartheta cf = 0$ for $\sigma cf = 1$, and $\vartheta cf < 0$ for $\sigma cf < 1$ where σcf is the substitution elasticity in the direct cost function.

23. If the utility function were expressed in the direct form the elasticity of substitution $\sigma = 1/(1-\rho)$ so that $\varphi s = 1 - \sigma$ (Silberberg 1990, p. 407).

24. The author is grateful to an anonymous referee for suggesting this model and its use in understanding long-run results.

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Appendix 1: Notes on Methods

A.1 Extending the Investment Rule

Regional investors are modelled as reacting adaptively to the difference between the *ex ante* gross rate of return expected by agents on installed capital ($RORGEXP_r$) and the required, or reference rate (termed $RORGTARG_r$). This process is central to a convex adjustment mechanism that gradually draws the expected towards the actual (*ex post*) rate ($RORGROSS_r$) and the reference rate so that in a long-run equilibrium, the *ex ante*, *ex post* and reference rates are equal for each region and constant over time, that is,

$$RORGEXP_r = RORGTARG_r = RORGROSS_r$$

and

$$rorge_r = rorgt_r = rorga_r = 0 \qquad \text{(A1)}$$

where $rorga_r$, $rorgt_r$ and $rorge_r$ are percentage changes in the respective measures of return.

The required rate of growth in expected returns by region is defined by a lagged adjustment process, replacing the left-side of the equality with:

$$ER\_RORGE_r = \left(\frac{RORGTARG_r}{RORGEXP_r}\right)^{LAMBRORGE_r} \qquad \text{(A2)}$$

where ER_RORGE_r denotes the partial adjustment factor with respect to the expected gross return in each region to align it adaptively with the target rate and $LAMBRORGE_r$ denotes a coefficient of partial adjustment. Because GDyn follows the Johansen (1960) computational approach,[16] this relation is linearised to give:

$$erg\_rorg_r = LAMBRORGE_r \times (rorgt_r - rorge_r) + 100 \times dLAMBRORGE_r \times log\left(\frac{RORGTARG_r}{RORGEXP_r}\right) \quad \text{(A3)}$$

where erg_rorg_r now denotes the percentage points change in the rate of growth in the expected rate of return, $rorgt_r$ denotes the percentage change in the target rate of return, $rorge_r$ denotes the percentage change in the expected rate of return, and $dLAMBRORGE_r$ denotes a within-period parameter adjustment. This expression provides a rule for investment in percentage changes that brings about a compression of both the difference in the rate of change of the expected relative to the target rates of return and the levels of the respective return measures. It allows the target rate to be conceived as being determined by factors outside of the model and set exogenously. In this application, the within period parameter is set at the square of the underlying parameter value, that is: $dLAMBRORGE_r = LAMBRORGE_r^2$.[17]

This implementation extends the original by including the ratio of the levels excluded from the original implementation. Under this approach, the expected rate of return draws to a designated reference rate, in levels as required. Omission of the ratio from the original provides an underlying source of model instability (Gretton 2018).

To complete the specification, the steady state value of the gross rate of return for a region, $RORGROSS_r^*$ would reflect a common risk neutral entrepreneurial income component ($RNETCOMM$), a regional institutions and risk component ($RRISK_r$) and a depreciation on region capital component ($RDEPN_r$), that can be depicted as:

$$RORGROSS_r^* = RNETCOMM + RRISK_r + RDEPN_r \quad \text{(A4)}$$

This steady state rate is represented by the models target rate of return ($RORGTARG_r$). In ordinary change form, the percentage change in a regional target rate ($rorgt_r$) can be expressed as:

$$rorgt_r = srorc_r + srorc\_r + srdepn_r \quad \text{(A5)}$$

where $srorc_r$, $srorc\_r$ and $srdepn_r$ are the respective percentage point contributions to changes in market rates of return.[18]

A.2 Recognising Non-Convex Adjustment Costs and Model Closure

Earlier consideration of adjustment costs in the capital accumulation process concluded that: the nature of a long-run equilibrium can depend on the costs of approaching and maintaining it, including adjustments of work routines and tasks (Lucas 1967; Hamermesh and Pfann 1996); the nature of adjustment can also be influenced by managerial and administrative abilities of firms as well as physical capital (Usawa 1969); and that adjustment can include internal costs where some output is expended in the process of expanding scale of firms productive processes (Treadaway 1969). In addition, period-to-period variations in capital spending and output can be influenced by the cross sectional distribution of firm responses to economic change as well as cyclical factors (for example, Caballero 1996). In later assessments, it is also recognised that the presence of non-convex adjustment costs mean that some capital is expended in the process of maintaining or expanding the scale of firms' productive capabilities (for example, see reviews by Cabarello 1992, 1999; Khan and Thomas 2008 and empirical studies by Cooper and Haltiwanger 2006; Wang and Wen 2012). Capital adjustment costs also represent an 'implicit cost of forgone output' (Khan and Thomas 2008) and are likely to

vary with the scale of new investment (McKibbin and Vines 2000). Also, new capital may not become instantaneously productive with varying lags.

Cooper and Haltiwanger (2006), in a balanced-panel analysis of 7000 large US manufacturing plants in operation over the period 1972–1988, estimated the fixed cost of adjustment to be almost 4 per cent of the value of plant level capital. McKibbin and Wilcoxen (1999) in the multi-country, multi-sector intertemporal CGE model (G-Cubed) assume that in the installation of a unit of effective capital firms must buy a larger quantity of the investment good. Capros et al. (2013), in a recursive dynamic global CGE model focused on the EU (GEM-E3), included as an adjustment installation investment costs in their depiction of capital formation. Following Ca'Zorzi and Rubaszek (2012), Ha et al. (2017) in their intertemporal GTAP model assumed that more than one unit of investment is needed to achieve a unit increase in capital and calibrated their capital adjustment costs parameter so that the average life of capital stock adjustment across countries is roughly 15 years.

With the investment defined by the investment rule in GDyn-FS (via Equation A3) and the steady-state rate of return determined (via Equation A4), a slack variable approach is adopted to project adjustment costs in this study. This is implemented via the capital accumulation process whereby, in each region, effective real capital stocks is modelled to change with the rate of fixed capital accumulation net of non-convex adjustment costs.

$$VK_r \times qk_r = 100 \times NETINV_r \times time + VK_r \times [sqk_r + sqkworld]$$

with

$$NETINV_r = GROSSINV_r - VDEP_r \quad \text{(A6)}$$

where VK_r is the value of regional real capital in region r at the beginning of the period t, qk_r is the estimated growth of regional real capital stocks ascribed to period t, $NETINV_r$ is net investment, $GROSSINV_r$ is the value of gross investment in period $t-1$, $VDEP_r$ is the value of depreciation of capital stocks at the beginning of period t. Non-convex adjustment costs (and other changes in capital available to productive activities) are represented by sqk_r and *sqkworld*, region-specific and region-generic adjustment terms, respectively. In this implementation, *sqkworld* is treated as the model slack variable on capital (with the shift term on the target rate of return—*srorc_r*—fixed, this treatment closes the model).

The slack variable approach also recognises the very real potential for there to be asset retirement (Gretton and Fisher 1997; Leamer 1988; Cooper and Haltiwinger 2006) and data inconsistencies and uncertainties. From this perspective the slack variable can also be viewed as a measure of ignorance.

A.3 Introducing a Theory-Based Modelling of International Capital Flows

Current account imbalances are financed by financial flows between countries with net lending matching net borrowing across regions. Within the real economy, the ownership of reproducible fixed capital in a region consists of two components: that owned by domestic residents and that owned by foreign residents while regional-household real-capital wealth can be held in local firms or foreign firms.

One approach to modelling capital-finance flows is to assume savings accumulates globally and this saving is allocated to regional investment on the basis of relative returns. The current account balance for each region, its net lending/borrowing, would represent the gap between a regions saving and investment as represented by the national accounting identity $S - I = BoT + R$ where S is regional saving, I regional investment, BoT the balance of trade and R *net* income transfers and other foreign remittances. Such an approach is adopted in the comparative static GTAP model (Hertel and Tsigas 1997, p. 54) with similar approaches adopted in the GCubed model, which assumes free mobility

of financial capital across regions (McKibbin and Wilcoxen 1999, p. 134) and in the MIRAGE model (Decreux and Valin 2007; Fontagne et al. 2013).

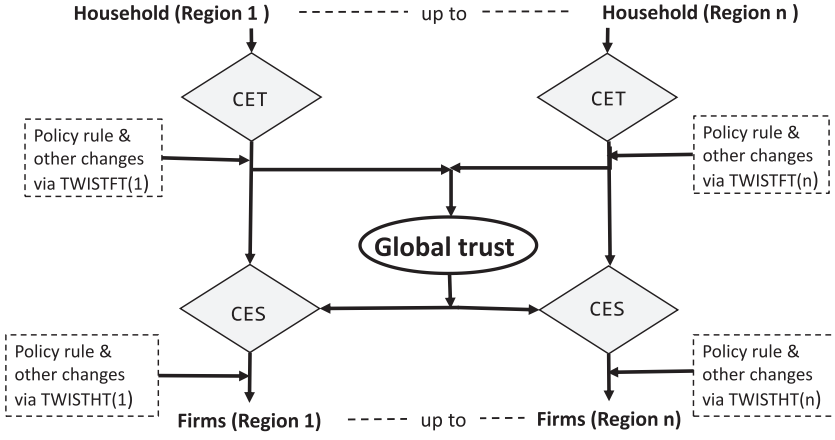
Another approach and that introduced in GDyn, is to divide the net lending/borrowing of a region into strictly positive capital inflow and outflow components and to allow for the gradual mobility of financial capital between regions (Ianchovichina and McDougall 2012). Under this approach, regional household real-capital wealth is held in a two asset portfolio composed of holdings in local firms and the global trust—the model's notional clearing house for cross border financial transactions. Firms then source finance for real capital accumulation directly from the regional household or from global savings via the global trust. Under market clearing conditions, firms' drawings on global capital (whether domestic or foreign sourced) is equal to households' holdings. Entrepreneurial income is distributed to regional households directly from firms' earnings or indirectly via the global trust, in proportion to their wealth holdings. The approach has the desirable feature of allowing for heterogeneity between regions in foreign investment balances.

The approach was implemented in GDyn using two atheoretic rigidity parameters that mediated changes in regional wealth into positive inflow and outflow components calibrated to stay as close as possible to the initial capital ownership shares (Golub and McDougall 2012, pp. 100–01). It has been found, however, that with the use of the rigidity-parameter method, long-run model stability is compromised (Gretton 2018).[19]

To further develop the approach and contribute to model stability, this paper introduces a theory-based method to mediate changes in the distribution of regional wealth. Importantly, it maintains the separate recording of capital inflows and outflows. Under this method, regional households allocate real wealth on the basis of relative returns according to a constant elasticity of transformation (CET) function, while domestic firms source finance on the basis of the relative expected cost of finance according to a constant elasticity of substitution (CES) process (Figure A1).[20]

Rebalancing of portfolios across regions arising from institutional or regulatory changes, changes in taste between domestic and foreign investment, or changes in public policy and economic conditions are modelled in this method via a 'twist' technology (Dixon and Rimmer 2015). Twist components are added to model the effects of exogenous

Figure A1 Regional Household And Firm Optimising Behaviour With a CET|CES Approach to Modelling Capital-Finance



Source: Author's representation.

changes in the mix of household wealth holdings between domestic firms and the global trust (via *twistft*), and for the mix of firms funding decisions between regional households and the global trust (via *twistht*).

It should be noted that the capital-finance flows so modelled combine direct, portfolio and other investment flows, which in GDyn are assumed to be fungible and to adjust as a composite across regions. As a real economy model, financial balances are equated to real capital holdings. Financial derivatives and monetary assets are omitted.

The separation of inward and outward flows, as in GDyn, affords the possibility of explicitly delineating home-country biases in capital-finance inflow and outflow decisions of regional households and industries. Combined with the exogenous setting of the required return above, it also affords possibilities for a more direct modelling of the potential impacts of changes in regional institutions, inflows and outflows on the availability of finance, linkages between country/regional financial markets, economic growth, and country convergence in returns on capital over time.

Sensitivity testing using the six-region, 13-sector database of this study, indicates that the method affords a level of model stability not available with the atheoretic approach (Gretton 2018).

A.3.1 Regional Households' Investment Decisions

Regional households' CET decisions for allocating regional wealth to international investment (via the global trust) are characterised for each region as an income maximisation problem through the indirect revenue function. In percentage changes, regional wealth holdings of foreign capital (wht_r) are depicted as:

$$wht_r = wt + \tau cf_r \left(rt_r - \sum_i S_{r,i} r_{r,i} \right) - (S_{r,1} \times twistft_r) + swht_r \qquad \text{(A7)}$$

where wt is the percentage change in the value of real capital held by the global trust across regions; τcf_r represents the constant elasticity of transformation between ownership of local and foreign capital by regional households;[21] rt_r, is the share weighted sum of returns on capital from the global trust, such that $rt_r = \sum_r ST_r r_r$ where ST_r is the value share of global trust wealth holdings in firms across all regions; and $S_{r,i}$ is the share of region r's households capital in domestic firms ($i = 1$) and the global trust ($i = 2$), respectively. Exogenous shifts in wealth shares are provided for via the region-specific variables, $twistft_r$, and exogenous region-specific shifts in holdings of foreign capital via the variable $swht_r$.

Subject to firm's sourcing of capital from domestic households (see below), holdings of regional households in domestic firms are then determined by the market clearing equation:

$$WQH_r \times wqh_r = WHF_r \times whf_r + WHT_r \times wht_r \qquad \text{(A8)}$$

A negative entry on the twist variable in this case would indicate a shift towards investment globally.

A.3.2 Regional Firms Funding Decisions

Regional firms' CES decisions for sourcing finance from regional and foreign sources are characterised as a cost minimisation problem through the indirect cost function. In percentage changes, the change in domestic ownership of firms' capital (whf_r) is given by:

$$whf_r = wf_r - \vartheta cf_r \left(rh_r - \sum_i S_{r,i} r_{r,i} \right) - (S_{r,tf} \times twistht_r) + swhf_r \qquad \text{(A9)}$$

where wf_r is the change the value of real capital of firms in region r, ϑcf_r represents the constant elasticity of substitution between funding sourced to local and foreign capital by regional firms in the indirect cost function,[22] rh_r is the percentage change in the expected cost of capital in region r, $\sum_i S_{r,i} r_{r,i}$ is the expected cost of capital from the global trust measured as the share weighted expected

costs across regions, $S_{r,tf}$ is the share of firms capital finance in region r sourced from the global trust, $twistht_r$ is the home-foreign finance twist term while $swhf_r$ is a shift term normally exogenous in simulations. The negatively signed twist represents a shift towards offshore finance.

In this closed system, with regional households' holdings of real capital wealth in the global trust (wht_r) and in domestic firms (whf_r), determined by Equations A7–A9, firms sourcing of funds from the global trust (wtf_r) is then given by:

$$wtf_r = wf_r + swtf_r \tag{A10}$$

where $swtf_r$ is a slack variable.

Investment income is allocated across regional households in proportion to wealth holdings. Model income accounting and market clearing conditions ensure global total remittances equal total global receipts in each period.

A.3.3 Capital-Finance Parameter Choices

Consistent with the home-country bias effect identified in the literature (Feldstein and Horioka 1980; Tesar and Werner 1995; Gordon, Bovenberg 1996; Lewis 1999; Kraay et al. 2005; Coeurdacier and Rey 2012) and underpinning the setting of the atheoretic parameters in GDyn (Golub and McDougall 2012, p. 100–01), ϑcf and τcf have been set relatively close to the Cobb–Douglas case at 0.1 and 0.05, respectively. Also consistent with the relativities adopted by Golub and McDougall (2012, pp. 126, 7), the CET parameter is set at half the value of the CES parameter. This reflects the notion that regional households have a greater bias towards investing at home than regional firms have in sourcing funding for new investment from local sources.

A.4 Relaxing the Fixed Consumption–Saving Share Assumption

Saving and investment across regions in a base year database would only coincidentally be optimal and consistent with a long-run steady state growth path. For example, in the 2011 database adopted in this study, the gross saving rate for China is estimated to be around 50 per cent, materially higher than historic savings rates for that economy, higher than comparator economies and higher than projections. The consumption–saving mix can also be influenced exogenously by, for example, changes in household preferences and institutional conditions, both domestically and internationally.

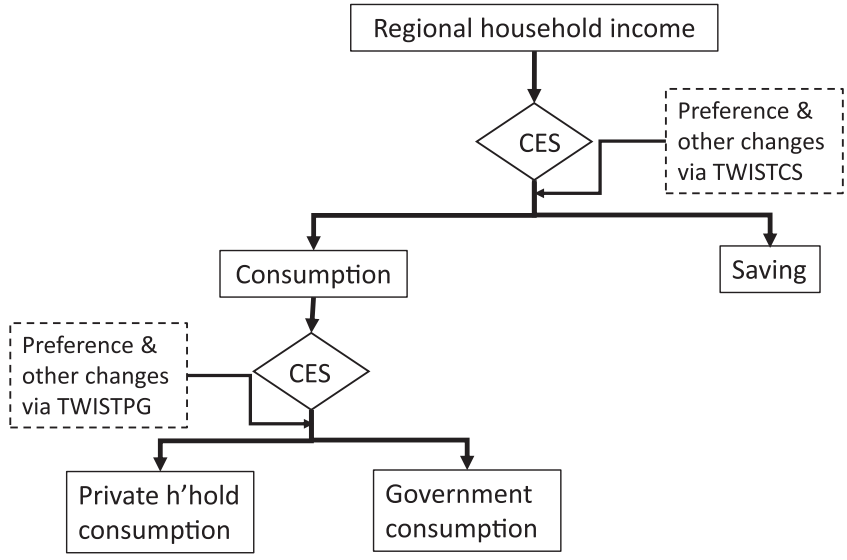
Using an indirect utility function approach, this paper: (1) relaxes the assumption of fixed shares in consumption and saving decisions of national households (Hertel and Tsigas 1997, p. 47; Corong et al. 2017, p. 22) to enable households to substitute between consumption and saving adaptively on the basis of the relative price of present versus future consumption as measured in the current period (Weitzman 1976); and (2) incorporates a 'twist' method (Dixon and Rimmer 2015) to make provision for the inclusion of exogenously determined changes in the consumption–saving share over time by region that may reflect changes in preferences/tastes, institutional change or disequilibria in a reference database or in baseline projections (Figure A2).

At the top of the (inverted) tree is household income equal to total regional household expenditure. This is used for consumption and saving and total consumption is divided between private household consumption and government consumption. A constant elasticity of substitution is used to mediate the consumption–saving choice and a constant elasticity of substitution is used to mediate the private household–government mix. As noted, twist terms permit exogenous shifts in spending shares between categories.

A.4.1 Model Implementation

The above approach, following Varian (1992), is implemented for the consumption–saving choices of regional households through the

Figure A2 Regional Household Top Level Utility Nest



Source: Author's representation.

indirect utility function. This approach allows the model to be interpreted directly against aggregate data on consumption and saving shares in regional income or regional GDP.

In percentage changes, the value of income directed to consumption spending (yc_r) and saving (ys_r), respectively, is:

$$\begin{aligned} yc_r &= y_r - \varphi cs_r \left(pc_r - \sum_i S_{i,r} p_{i,r} \right) \\ &\quad + \left(SS_r \times twistcs_r \right) + scon_r \\ &\quad + scon\_r \\ ys_r &= y_r - \varphi cs_r \left(ps_r - \sum_i S_{i,r} p_{i,r} \right) \\ &\quad - \left(SC_r \times twistcs_r \right) \\ &\quad + ssave_r + ssave\_r \end{aligned} \tag{A11}$$

where y_r is the change in nominal income of the regional household, φcs_r is a region-specific parameter representing the constant elasticity of substitution between consumption and saving in the indirect utility function (Varian 1992, p. 112),[23] pc_r and ps_r are the percentage changes in the prices of regional households consumption and saving bundles, $S_i \quad c, s \in i$, is the share of consumption and saving, respectively, in total expenditure such that $\sum_i S_i = 1$, $twistcs_r$ is the consumption–saving twist term while SS_r and SC_r are the regional saving and consumption shares in income, respectively. The positively signed twist term in the consumption equation (and negatively signed term in the saving equation) represents the case of a twist in favour of consumption over saving. The shift terms $scon_r$, $scon\_r$, $ssave_r$ and $ssave\_r$ represent region-specific changes and region-generic changes on consumption and saving, respectively, and are normally exogenous.

Private and government in the consumption–saving tree is modelled using the same approach.

A.4.2 Consumption–Saving Parameter Choices

The revised theory requires two additional parameters — φcs for the consumption–saving choice and ω for the private–government choice. With respect to the consumption–saving choice, the long-standing literature on an elasticity of intertemporal substitution to measure the responsiveness of real household consumption spending to a change in real interest rates (making saving more or less attractive to regional households) (Hall 1988; Havranek 2014; Best et al. 2017) suggests that this elasticity is low. Drawing a parallel between the rate of return on saving and the price of saving, a (indirect utility function) parameter value of 0.1 is adopted. This value is equivalent to a value of about 1.13 when evaluated in respect of the direct utility function.

Changes in the consumption–saving mix beyond those suggested by model parameterisation and projected real price changes, such as short to medium run deviations from long-term averages (for example, on account of variations in the current account balances), and long-term factors such as changes in household consumption–saving choices given time preferences and changes in the demographic structure, would be introduced through the twist method in GDyn-FS.

Approaches to the modelling of private-government mix vary. McKibbin and Wilcoxen (1999), in GCubed, model government spending as exogenous with a complementary government finance account. Fontagne and Foure (2018), in the MIRAGE model, treat private and government consumption expenditure as a composite final consumption expenditure category. Dixon and Rimmer (2015) and Adams et al. (2015) constrain government consumption to preserve a constant real ratio with private consumption. This paper adopts the constant expenditure share (Cobb–Douglas) assumption while allowing through twist and shift terms for the inclusion of exogenously determined changes and further theoretical developments.

Appendix 2: First Approximation Model[24]

To help verify key long-run results for GDP, capital and real wages, and aid understanding of key parameters driving them, a simple first approximation (or back-of-the envelope) model is used. In this model, for the region of interest (Australia):

$$l - k = -\sigma(w - q) \tag{B1}$$

$$p = Lw + Kq \tag{B2}$$

$$y = Ll + Kk \tag{B3}$$

$$ror = q - p \tag{B4}$$

$$rw = w - p \tag{B5}$$

where l, k and y represent the percentage deviations from the baseline in labour, capital and GDP respectively, w, q and p represent the percentage changes in the prices of labour, capital and GDP respectively, L and K represent the shares of labour and capital in GDP, and ror and rw represent the percentage changes in the rate of return and the real wage, respectively.

This representation is a very simplified depiction of a long-run comparative static CGE model, omitting intermediate inputs, factors of production other than labour and capital, international trade and agent-specific price levels. The GDP price level is the model numeraire and assumed to be fixed, meaning that Australia is a price-taker on world markets. All industry detail is omitted, reflecting the long-run assumption that sufficient time elapses for the full transformation of capital stocks between activities to take place.

As a long run model, labour (l) is assumed to be fixed while the rate of return on capital (ror) is exogenous and the shock variable.

Rearranging B1 in terms of q and substituting into B2 then substituting B1 and B2 into B4 and simplifying shows that:

$$k = -\frac{\sigma}{L} ror \tag{B6}$$

That is, the percentage change in capital depends on the shock, the share of labour in value added and σ the CES substitution elasticity in the production function. This depiction emphasises that the responsiveness of k to a change in capital returns is increasing in σ and decreasing in the labour share of value added. It also shows capital is negatively related to required returns.

Substituting the expression for k in B6 into B3 and simplifying then gives:

$$y = -\sigma \frac{K}{L} ror \tag{B7}$$

Noting that the price level is assumed fixed in this simplified depiction, substituting B4 into B2 and rearranging yields:

$$w = -\frac{K}{L} ror \tag{B8}$$

This depiction emphasises that the capital intensity of the economy would be important to real wage outcomes from a change in capital returns.