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Abstract

Australia's superannuation sector has become both a major institution in guiding the allocation of the nation's financial capital across asset classes, regions, and sectors, and a central intermediary in channelling the nation's annual savings into domestic capital formation and foreign financial asset accumulation. To put the industry's scale in context, in 2012 the sector had assets under management of approximately $1.4tn (Australia's GDP in the same year was approximately $1.5tn). Annual inflows to the system represent approximately one third of gross national savings. The sector's influence over the allocation of the nation's physical and financial assets continues to grow. We model this important institution within an economy-wide setting by embedding explicit modelling of the sector within a model of the financial sector which is in turn linked to a dynamic multi-sectoral CGE model of the real side of the economy. We develop the financial CGE model by building on a multi-sectoral dynamic model of the real side of the Australian economy. In particular, we introduce explicit treatment of: (i) financial intermediaries and the agents with which they transact; (ii) financial instruments describing assets and liabilities; (iii) the financial flows related to these instruments; (iv) rates of return on individual assets and liabilities; and (v) links between the real and monetary sides of the economy. We explore the effects of the superannuation sector by simulating a one percentage point increase in the ratio of superannuation contributions to the economy-wide nominal wage bill.

Key words: financial CGE model, superannuation.

JEL: C68, G11, G17, G21.

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1 Introduction

This paper develops a dynamic CGE model with financial sector detail, and uses it to explore the economic consequences of a policy-induced expansion in the size of the superannuation sector. We develop the financial CGE model by building on a multi-sectoral dynamic model of the real side of the Australian economy, VU-Nat (**V**ictoria **U**niversity **Nat**ional). VU-Nat has evolved from the MONASH model described in Dixon and Rimmer (2002), with new theory and data added to facilitate the modelling of the mining boom (Dixon et al. 2014). In moving from VU-Nat to the financial CGE model, we introduce explicit treatment of:

(i) Financial intermediaries and the agents with which they transact;
(ii) Financial assets and liabilities;
(iii) The financial flows related to these assets and liabilities;
(iv) The rates of return on individual assets and liabilities;
(v) Links between the real and monetary sides of the economy.

More formally, while still abstracting from much detail, we introduce the following variables to the real economy CGE model, along with a considerable number of supporting ancillary equations and variables:

AT(s,f,d) — The value of financial instrument *f*, issued as a liability by agent *s*, and held as an asset by agent *d*. For example A(Superannuation, Equity,Households) is the value of household assets under management by the superannuation sector in a particular year.

FLOW(s,f,d) — The flow of financial instrument *f*, issued as a liability by agent *s*, and held as an asset by agent *d*. For example F(Banks, Deposits and loans,Households) are new deposits made by Australian households with the domestic banking sector in a particular year.

VAL(s,f,d) — The change in the market value of financial instrument *f*, issued as a liability by agent *s*, and held as an asset by agent *d*. For example V(Industries, Equity, Superannuation) is the change, over a particular year, in the market value of the domestic equities held by the Australian superannuation sector.

ROI(s,f,d) — The rate of return of financial instrument *f*, issued as a liability by agent *s*, and held as an asset by agent *d*. For example, R(Government, Bonds, Superannuation) is the rate of return earned by the Australian superannuation sector on its holdings of government bonds in a particular year.

The above variables are defined over sets s ∈ LA, f ∈ FI and d ∈ AA, where the sets LA, FI and AA are defined as follows:

AA The set of "asset agents", comprising: Superannuation, Banks, the RBA, Foreigners, Government, Households, Industries, Non-bank financial intermediaries, Reproducible housing, Non-reproducible housing, and Life Insurance.

FI The set of "financial instruments", comprising: Cash, Deposits and loans, Bonds, Equity, and Gold and SDRs.

LA The set of "liability agents", comprising: Superannuation, Banks, the RBA, Foreigners, Government, Households, Industries, Non-bank financial intermediaries, Reproducible housing, Non-reproducible housing, and Life Insurance.

Each asset agent and each liability agent is modelled as a constrained optimiser. Asset agents are assumed to maximise benefits subject to a given availability of funds and given rates of return across assets. Liability agents are assumed to minimise financing costs subject to given rates of return across liability instruments and given funding requirements. The joint solution to these optimisation problems allows the endogenous determination of rates of return, equity valuations, and the nominal exchange rate.

Broadly, the system of equations describing the financial system is linked to the system of equations describing the real side of the economy as follows:

- Acquisitions of new liabilities by the government sector are linked to the government's borrowing requirement;
- Acquisitions of new liabilities by industry are linked to the investment expenditure requirements of domestic industries;
- Acquisitions of new liabilities by the superannuation sector are linked to movements in national labour income via a given superannuation contribution rate;
- The required rate of return on gross fixed capital formation is linked to the weighted average cost of capital to domestic industries;
- The acquisition of new financial assets by domestic households is linked to the savings of domestic households;
- Net acquisition of financial assets by foreigners is linked to the current account deficit.

The remainder of this paper is structured as follows. Section 2 is concerned with data, explaining the sources for the initial values for the model's key financial data arrays. Section 3 describes the theory of the financial side of the FCGE model. Section 5 describes a simulation in which we explore the effects on the economy of a rise in the mandated superannuation contribution rate.

2 Data

2.1 Introduction

As described in Section 1, there are four arrays that describe the core data requirements of the model's financial theory:

(i) Values for the stocks of financial assets and liabilities (AT(s,f,d));
(ii) Acquisitions of new assets and liabilities during each year (FLOW(s,f,d));
(iii) Values for indices measuring asset valuations (VAL(s,f,d));
(iv) Rates of return on financial assets (ROI(s,f,d)).

As described below, values for AT and FLOW are obtained from ((ABS), 2014). We set initial values for all elements of VAL at 1. Initial values for ROI are assembled from a variety of sources.

2.2 Values for financial stocks and flows (AT(s,f,d) and FLOW(s,f,d))

We calculate AT(s,f,d) and FLOW(s,f,d) using data from ((ABS), 2014). Note that the AT and FLOW matrices contain data with three dimensions (s,f,d) for each point in time. However ABS (2014) reports two dimensioned data for each point in time, in the following form:

AS(k,aa,t) Cross-classified asset type *aa* on agent *k*'s balance sheet at time *t*;

LI(k,l,t) Liability type *l* on agent *k*'s balance sheet at time *t*;

FFA(k,aa,t) Flow of funds relating to net transactions of asset type *aa* on agent *k*'s balance sheet during period *t*;

FFL(k,l,t) Flow of funds relating to net transactions of liability type *l* on agent *k*'s balance sheet during period *t*.

where aa $\in$ CCASSETS, *l* $\in$ FININST, k $\in$ FAGENTS and t $\in$ QTIME, are sets describing cross-classified assets (CCASSETS), financial instruments (FININST), financial agents (FAGENTS), and time distinguished by quarter (QTIME).

The elements of FININST are:

ABEX: Acceptance of bills of exchange drawn by other agents

BEX: Holdings of bills of exchange drawn by other agents

Bonds: Debt securities with maturity dates of greater than one year

Cur: Currency

Dep: Deposits

Ders: Derivatives

Equity: Shares and other equity

GldSDR:	Monetary gold and Special Drawing Rights
LAPs:	Loans and other placements
NELOR:	Net equity of pension funds in life office reserves
NEqRs:	Net equity in reserves
OARec:	Other accounts receivable
OneNP:	One name paper
Preps:	Prepayments of premiums and reserves against outstanding claims
UFSup:	Unfunded superannuation claims

The elements of FAGENTS are:

PNFIF:	Private non-financial investment funds
OPNFC:	Other Private Non-Financial Corporations
PNFC:	National Public Non-Financial Corporations
SLPNFC:	State and Local Public Non-Financial Corporations
CBank:	Central Bank
Banks:	Banks
ODepCo:	Other Depository Corporations
PFnds:	Pension Funds
LIC:	Life Insurance Corporations
NLICs:	Non-Life Insurance Corporations
MMFIF:	Money Market Financial Investment Funds
NMMFIF:	Non-Money Market Financial Investment Funds
CBAs:	Central Borrowing Authorities
Secs:	Securitisers
OFCos:	Other Financial Corporations
NGenGov:	National General Government
SLGG:	State and Local General Government
Hou:	Households
RoW:	Rest of the world

The elements of CCASSETS comprise the set product FININST x FAGENTS. Selected examples are:

DepBanks: Deposits with banks

CurCbank: Currency issued by the central bank

EquityPFnds: Equity issued by pension funds

BondsPNFC: Bonds issued by private non-financial corporations

The individual elements of CCASSETS thus describe both financial instruments, and the agents that have issued those instruments as liabilities. Hence the ABS matrices AS(k,aa,t) and FFA(k,aa,t) contain sufficient information to fully evaluate:

AA(k,l,j,t) Asset holding by agent *j* in year *t* of financial instrument *l* issued by agent *k* as a liability;

FF(k,l,j,t) Net transactions relating to new holdings by agent *j* in year *t* of financial instrument *l* issued by agent *k* as a liability.

For example:

AA(Banks,Dep,j,t) = AS(j,DepBanks,t)

AA(CBank,Cur,j,t) = AS(j,CurCBank,t)

FF(PFnds,Equity,j,t) = FFA(j,EquityPFnds,t)

FF(PNFC,Bonds,j,t) = FFA(j,BondsPNFC,t)

After evaluating AA and FF in this way, we cross-check against the published ABS liability-side of each agent's balance sheet by checking that the following conditions hold on the newly-created AA and FF matrices:

$$\sum_j AA(k,l,j,t) = LI(k,l,t)$$

$$\sum_j FF(k,l,j,t) = FFL(k,l,t)$$

Next, in moving from AA and FF to the AT and FLOW matrices, we aggregate the data in the agent and financial instrument dimensions. The sets FININST and FAGENTS contain 15 and 19 elements respectively. The AT and FLOW matrices are defined over 5 instruments and 11 agents, namely:

INST = {Bonds, Cash, DeposLoans, Equity, GldSDR}

AGENT = {Banks, CB, Foreigners, Govt, Hlds, Inds, NonBankFinIn, Super, LifeIns, NRH, RH}

Table 1 and provide the mappings between FININST and INST and FAGENTS and AGENT.

Table 1: Set mapping - FININST to INST

FININST	Description	INST
ABEX:	Acceptance of bills of exchange drawn by other agents	DeposLoans
BEX:	Holdings of bills of exchange drawn by other agents	DeposLoans
Bonds:	Debt securities with maturity dates of greater than one year	Bonds
Cur:	Currency	Cash
Dep:	Deposits	DeposLoans
Ders:	Derivatives	DeposLoans
Equity:	Shares and other equity	Equity
GldSDR:	Monetary gold and Special Drawing Rights	GldSDR
LAPs:	Loans and other placements	DeposLoans
NELOR:	Net equity of pension funds in life office reserves	Equity
NEqRs:	Net equity in reserves	Equity
OARec:	Other accounts receivable	DeposLoans
OneNP:	One name paper	DeposLoans
Preps:	Prepayments of premiums and reserves against outstanding claims	Equity
UFSup:	Unfunded superannuation claims	Equity

Table 2: Set mapping - FAGENTS to AGENT

FAGENTS	Description	AGENT
PNFIF:	Private non-financial investment funds	Inds
OPNFC:	Other Private Non-Financial Corporations	Inds
PNFC:	National Public Non-Financial Corporations	Govt
SLPNFC:	State and Local Public Non-Financial Corporations	Govt
CBank:	Central Bank	CB
Banks:	Banks	Banks
ODepCo:	Other Depository Corporations	NonBankFinIn
PFnds:	Pension Funds	Super
LIC:	Life Insurance Corporations	LifeIns
NLICs:	Non-Life Insurance Corporations	LifeIns
MMFIF:	Money Market Financial Investment Funds	NonBankFinIn
NMMFIF:	Non-Money Market Financial Investment Funds	NonBankFinIn
CBAs:	Central Borrowing Authorities	Govt
Secs:	Securitisers	NonBankFinIn
OFCos:	Other Financial Corporations	NonBankFinIn
NGenGov:	National General Government	Govt
SLGG:	State and Local General Government	Govt
Hou:	Households	Hlds
RoW:	Rest of the world	Foreigners

In addition to aggregating to the sets INST and AGENT, we make the following final adjustments to the data in creating the AT and FLOW matrices:

(i) We create two new agents: reproducible housing (RH) and non-reproducible housing (NRH). RH and NRH are industries that undertake the activity of holding (in the case of both RH and NRH) and developing (in the case of RH only) physical dwelling capital. We distinguish two housing sectors (RH and NRH) to provide for the possibility in future of modelling housing asset price bubbles. In particular, we expect that, while asset values for units and relatively new dwellings close to the urban fringe (that is, "reproducible housing") should not depart significantly from dwellings construction costs, this need not be the case for older housing stock in established inner-city suburbs ("non-reproducible housing") where land supply is limited and price pressure from new dwelling construction constrained.

(ii) RH and NRH finance their activities largely through the issuance of equity to households and debt instruments to other agents (particularly banks). In recognising the bank lending against housing capital, we shift liabilities from the household sector to the RH and NRH sectors.

3 Model Theory

3.1 Determination of end-of-year asset holdings by domestic agents

Domestic asset agent (d) is assumed to choose an allocation of their end-of-year portfolio across domestic and foreign assets in order to maximise a utility function in which the arguments are end-of-year asset allocations weighted by rates of return. More formally, domestic asset optimising agent (d) chooses $AT1_{s,f,d}$ for all s,f to maximise:

$$U\left[AT1_{(s,f,d)} \cdot R_{(s,f,d)}, \forall\, s,f\right] \qquad \left(d \in AALF\right)$$

Subject to:

$$\sum_{s,f} AT1_{(s,f,d)} = \sum_{s,f} \left(AT0_{(s,f,d)} \cdot V_{(s,f,d)} + FLOW_{(s,f,d)}\right)$$

$$\sum_{s,f} FLOW_{(s,f,d)} = NEWAACQ_{(d)}$$

Where

$R_{(s,f,d)}$	is the power of the rate of return (e.g., a number like 1.05) earned by agent (d) on its holding of instrument (f) issued by agent (s);
$AT1_{(s,f,d)}$	is the end-of-year holding by agent (d) of instrument (f) issued by agent (d);
$AT0_{(s,f,d)}$	is the start-of-year holding by agent (d) of instrument (f) issued by agent (s);
$V_{(s,f,d)}$	is a valuation power term (e.g., in the absence of valuation effects, a number like 1);
$FLOW_{(s,f,d)}$	is net new acquisitions by agent (d) of instrument (f) issued by agent (s);
$NEWAACQ_{(d)}$	is agent (d)'s budget for net new acquisitions of financial instruments over the year.

The solution to this optimisation problem, converted to percentage change form, is the set of equations E_a_t_1dom, E_ave_ror_d and E_big_budd (see Table 15). Equation E_a_t_1dom determines utility-optimising percentage changes in end-of-year asset allocations by domestic asset agents on the basis of changes in relative rates of return and changes in the portfolio values of asset agents. Equation E_ave_ror_d calculates the percentage change in the power of the return on agent (d)'s portfolio as the weighted average of the rates of return received on the individual financial assets held by the agent. Equation E_big_bud determines the aggregate value of the portfolio available to domestic agent (d) for asset purchases as the re-valued value of their start-of-year asset holdings plus the value of net new asset acquisitions during the year. We defer to Section 3.4 the explanation of the determination of the budgets available for new asset acquisitions during the period.

3.2 Determination of end-of-year asset holdings by foreign agents

The foreign agent chooses the end-of-year foreign currency value of Australian assets, and assets in all other countries, in order to maximise a utility function in which asset holdings, weighted by rates of return, appear as arguments. More formally, the foreign asset optimising agent chooses $AT1_{s,f,Foreign}$ for all *s,f* to maximise:

$$U\left[\Phi \cdot AT1_{(s,f,Foreign)} \cdot R_{(s,f,Foreign)}, \forall \text{ s,f \& assets in other countries}\right]$$

Subject to:

$$\sum_{s,f} AT1_{(s,f,Foreign)} = \sum_{s,f} AT0_{(s,f,Foreign)} \cdot V_{(s,f,Foreign)} + FLOW_{(s,f,Foreign)}$$

$$\sum_{s,f} \Phi \cdot FLOW_{(s,f,Foreign)} + NAIOC = S_{(Foreign)}$$

where

Φ is the nominal exchange rate.

NAIOC is the value, in foreign currency terms, of new asset purchases in other countries by the foreign agent.

$S_{(Foreign)}$ is the budget (in foreign currency terms) available to the foreign agent for new asset purchases during the year.

The solution to this optimisation problem, converted to percentage change form, is given by equations E_a_t_1f and E_big_budf (see Table 15). Equation E_a_t_1f determines the foreign currency value of foreign holdings of Australian assets on the basis of changes in relative rates of return and changes in the foreign currency value of the foreign agent's portfolio available for global asset purchases. In a typical application of the model, big_budf is exogenous. Equation E_big_budf determines the domestic currency value of the foreign agent's asset portfolio.

3.3 Year-on-year tracking of start-of-year asset values

Equation *E_a_t* calculates the percentage change in the value of start-of-year asset values. In dynamic simulations with the model, the value of the change variable del_unity is set equal to 1 in each period. With del_unity shocked equal to 1, then E_a_t ensures that, with *t*-1 levels values for start-of-year $\mathrm{AT\_B}_{(s,f,d)}$ and end-of-year $\mathrm{AT1\_B}_{(s,f,d)}$ asset values, and the current value of $\mathrm{AT}_{(s,f,d)}$, the value for $\mathrm{a\_t}_{(s,f,d)}$ will equal the percentage change in asset values at the beginning of year *t* relative to the beginning of year *t*-1.

3.4 Acquisitions of financial assets

Net acquisitions by agent (d) of financial instrument (f) issued by agent (s) is given as the difference between the value of end-of-period holdings of financial instrument (f,s) and revalued start-of-period holdings of financial instrument (f,s) via:

$$\mathrm{FLOW}_{(s,f,d)} = \mathrm{AT1}_{(s,f,d)} - \mathrm{AT0}_{(s,f,d)} \cdot \mathrm{V}_{(s,f,d)}$$

Converted to percentage change form, this provides equation E_d_flowd in Table 15.

Total new asset acquisitions by agent (d) is the sum of agent (d)'s acquisitions of individual financial instruments issued by individual liability agents:

$$\mathrm{NEWAACQ}_{(d)} = \sum_{s,f} \mathrm{FLOW}_{(s,f,d)}$$

The percentage change form of which is given by equation E_d_shift4 in Table 15.

3.5 Revaluation effects

In calculating end-of-year asset values, we allow for the possibility of asset revaluations over the simulation period via movements in the powers (1 + the rates) of asset price appreciation effects, $\mathrm{V}_{(s,f,d)}$. The values for these terms are largely determined via exogenous shift variables with varying degrees of instrument and agent specificity. However, in the case of foreign assets held by domestic agents, revaluation effects can also arise via movements in the nominal exchange rate.

$$\mathrm{V}_{(s,f,d)} = \mathrm{V}_{(s,f,d)}\mathrm{V}_{(s,f,d)}\mathrm{V}_{(s,f,d)} / \Phi^{\omega_{(s,f,d)}} \qquad (s \in \mathrm{LA})\ (f \in \mathrm{FI})\ (d \in \mathrm{AALF})$$

The parameter $\omega_{(s,f,d)}$ is a dummy variable transmitting the effects of exchange rate movements to domestic currency values of foreign assets, with $\omega_{(Foreigners,f,d)} = 1$ for all *f,d* but otherwise equal to 0. Converted to percentage change form, this provides equation E_v in Table 15.

3.6 Linking asset acquisitions by foreigners to the current account deficit financing requirement

The current account deficit (CAD) must be financed by a rise in the nation's net foreign liabilities. Expressed in the levels:

$$CAD = NEWAACQ_{Foreigners} - \sum_{f \in FI} \sum_{d \in AALF} FLOW_{Foreigners,f,d}$$

On the right hand side of the above equation we have the change in national net foreign liabilities, expressed as the difference between the change in national foreign liabilities (acquisitions of domestic financial instruments by foreigners, $NEWAACQ_{Foreigners}$) and the change in national foreign assets (acquisitions of foreign financial instruments by domestic agents, $\sum_{f \in FI} \sum_{d \in AALF} FLOW_{Foreigners,f,d}$). This is expressed in percentage change form in Table 15 as E_d_ff_phi.

In terms of the model's mechanics of causation, equation E_d_ff_phi can be viewed as largely determining the change in acquisitions of domestic assets by foreign agents, $d\_new\_assacq_{(Foreigners)}$. This follows from two aspects of the closure of the integrated real / financial CGE model. Firstly, in any given year of a dynamic simulation, our macroeconomic assumptions on the real side of the economy have the effect of largely determining movements in real GDP and real absorption, leaving the GDP expenditure identity to determine the balance of trade. With the balance of trade thus determined, and the net income components of the current account deficit in any given year largely determined by the current net foreign liability position and given returns on financial instruments, the value of d_CAD must be largely given to equation E_d_ff_phi. Purchases by domestic agents of foreign liabilities ($d\_flow_{(Foreigners,j,\ d)}$) are given by the solutions of the asset agent optimisation problems discussed in Section 3.1. With d_ff_phi exogenous, this leaves E_d_ff_phi the task of determining $d\_new\_assacq_{(Foreigners)}$.

3.7 Linking public sector liability accumulation with the public sector borrowing requirement

The accumulation of net liabilities by the public sector must be equal to the public sector's borrowing requirement, a condition described by:

$$GOVDEF = \sum_{f \in FI} \sum_{d \in AA} FLOW_{Govt,f,d} - NEWAACQ_{Govt}$$

Where GOVDEF is the public sector borrowing requirement, $\sum_{f \in FI} \sum_{d \in AA} FLOW_{Govt,f,d}$ is gross new liabilities of the public sector, and $NEWAACQ_{Govt}$ is gross new acquisitions of financial instruments by the public sector. Expressed in rate of change form, this provides equation E_d_ff_govt in Table 15.

Acquisitions of financial instruments by government ($NEWAACQ_{Govt}$) are at present determined by a simple indexing arrangement with nominal public consumption via equation E_shiftG. With new asset acquisitions by the public sector determined in this way, equation E_ff_govt can be viewed as largely determining the sum of gross new liability issuance by government.

3.8 Optimising behaviour on the part of liability agents

We assume that domestic liability agent (s), constrained by a need to raise a given amount of funds, aims to minimise a function in which the arguments are values for end-of-year liabilities weighted by the powers of the rates of interest / return paid on those liabilities. More formally:

Choose $AT1_{(s,f,d)}$ for all f,d to minimise:

$$Z_s = CET\left[AT1_{(s,f,d)} \cdot R_{(s,f,d)}, \forall f,d\right]$$

Subject to: $\left(s \in LALF\right)$

$$AT1_{(s,f,d)} = AT0_{(s,f,d)} \cdot V_{(s,f,d)} + FLOW_{(s,f,d)}$$

$$\sum_f \sum_d FLOW_{(s,f,d)} = NEWLACQ_{(s)}$$

where:

Z_s	is a constant elasticity of transformation function; and
$NEWLACQ_{(s)}$	are the new liabilities that must be raised by agent (s).

The solution this problem, converted to percentage change form, provide equations E_big_budl to E_a_t_1 in Table 15. Equation *E_big_budl* defines agent (s)'s end-of-year liabilities as revalued start-of-year liabilities plus new liabilities issued by (s) during the year. *E_ave_ror_s* calculates the percentage change in the power of the average rate of return paid by agent (s) on its liabilities. Equation *E_d_new_liaacq* aids in checking the model implementation: with values for $d\_flow_{(s,f,d)}$ determined on the asset demand side by by E_d_flowd, and values for the individual elements of d_new_liaacq determined by agent-specific assumptions regarding the accumulation of new liabilities, the values for $d\_shiftl4_{(s)}$ should be zero.

Equation *E_a_t_1_d* calculates the percentage change in the end-of-period value of the liabilities of agent (s) issued in the form of instrument (f) as the share-weighted-sum of liability holdings across asset agents. Equation E_a_t_1_d represents the first tier of the liability agent's decision problem, in which optimising choices are made on the issuance of liabilities across financial instruments irrespective of ultimate asset holding agent. Equation

E_a_t_1 opens the possibility of different rates of return on financial instrument (s,f) across asset agents, by introducing a second stage to the optimisation problem in which the liability agent has a preference over the asset agents to whom its financial instruments are issued. Equation *E_roipowl4* provides for flexible setting of the dimensionality of the endogenous determination of (powers of) rates of return on financial instruments issued by liability agents. Equation *E_roipowl_d* calculates the percentage change in the rate of return paid on financial instrument (f) by issuing agent (s) as the share-weighted-sum of the percentage changes in the rates of return paid on (s,f) across asset agents.

3.9 Capital accumulation in the reproducible housing sector

With del_unity shocked equal to 1 in each year of the dynamic simulation, Equation *E_cap_trh* calculates the percentage change in the quantity of capital available in the reproducible housing sector.

3.10 New liabilities issued by industry

Equation E_d_shiftind2 links new liability issuance by industry to the nominal value of industry investment (excluding public investment and dwellings investment) and the value of new purchases of financial assets by industry. The value of investment activity requiring financing by industry is defined by equation E_w2_ind as aggregate nominal investment plus aggregate nominal inventory accumulation, less public investment and investment in dwellings (financing of the latter two activities is via E_ff_govt and E_d_shiftRH).

3.11 Asset accumulation by households

Equation E_d_shiftH links the budget available for new asset acquisitions by households ($d\_new\_assacq_{Hlds}$) to household savings (the difference between disposable income and private consumption) plus the value of new liabilities incurred by households.

3.12 Liability accumulation by the reproducible housing sector

Equation *E_d_shiftRH* calculates the value of new liabilities issued by the reproducible housing sector to finance the construction of new dwellings. Issuance of new liabilities by reproducible housing is equal to the value of gross fixed capital formation in the dwellings sector, less dwellings investment by government (since any financing associated with government investment is already recorded within *d_gov_def* and hence captured by equation *E_ff_govt*), plus the value of the purchases (if any) of financial assets by the reproducible housing sector.

3.13 Revaluation of equity in industry, and in reproducible and non-reproducible housing

Equations *E_ff_v_inds_eq*, *E_ff_v_RH_eq* and *E_ff_v_NRH_eq* calculate the percentage changes in the revaluation of equity in industry and reproducible and non-reproducible housing ($v_{(Inds,Equity,d)}$, $v_{(RH,Equity,d)}$, $v_{(NRH,Equity,d)}$) as residual terms within balance sheet constraints. On the left hand side of each equation is the asset side of the total (physical and financial) balance sheet of each agent, comprising the sum of each agent's physical capital and (in the case of industry) financial capital.[1] The right hand side of each equation describes the liability side of each agent's balance sheet. With d_f_inds_eq, d_f_RH_eq and d_f_NRH_eq exogenous, the valuation variables adjust to ensure equality between the value of each agent's assets and liabilities. The exogenous status of d_f_inds_eq, d_f_RH_eq and d_f_NRH_eq is supported by the endogenous determination of $fff\_v_{(Inds,Equity)}$, $fff\_v_{(RH,Equity)}$ and $fff\_v_{(NRH,Equity)}$, which deliver equal (across asset owners) percentage movements in the valuation of the equity of three capital agents via Equation E_v.

3.14 Relationship between rates of return from the asset and liability sides of each financial instrument

Equation E_f_roipow establishes the relationship between rates of return from the asset and liability sides of each financial instrument. A natural starting point for considering the function of E_f_roipow is to begin with $f\_roipow_{(s,f,d)}$ exogenous, establishing equality between the percentage movements in rates of return from the asset and liability sides of each financial instrument. Indeed, a natural question to ask is why E_f_roipow is needed at all: why not replace $roipowa_{(s,f,d)}$ and $roipowl_{(s,f,d)}$ with a new single variable, $roipow_{(s,f,d)}$ (which would be functionally equivalent to $f\_roipow_{(s,f,d)}$ exogenous)?

The complication is the financial instrument equity, where realised rates of return, and rates of return offered on new equity, can differ. This possibility is addressed by equation E_f4_roipow, which makes the percentage change in the rate of return on equity expected by asset holders ($roipowa_{(s,Equity,d)}$) a weighted average of the realised return on equity ($roipoweqc_{(s)}$) and the rate of return on new equity issued by liability agents ($roipowl_{(s,Equity,d)}$). The weighting parameter, ALFA, has a value between 0 and 1, with values closer to 1 indicating higher degrees of difficulty on the part of liability agents in convincing asset agents that expected returns on new equity should differ significantly from realised returns on existing equity.

[1] Note that the reproducible and non-reproducible housing sectors do not own financial assets.

3.15 Relationship between rates of return from asset and liability sides of each financial instrument

Equations E_f_roipow_ie, E_f_roipow_rhe and E_f_roipow_nrhe calculate the percentage changes in the powers of the rates of return on equity issued by industry, reproducible housing, and non-reproducible housing. The basic structure of the three equations is the same, and so for explanatory purposes we focus on the determination of rates of return on industry equity. The level of the power of the rate of return on industry equity is given by:

$$\mathrm{ROI\_EQ\_D}_{(\mathrm{Inds})} = 1 + [\sum_{i \in NOD} \mathrm{V1CAP}_{(\mathrm{i})} + (\mathrm{P2TOT\_INF}-1) \times \sum_{i \in NOD} \mathrm{VCAP}_{(\mathrm{i})} - \sum_{i \in NOD} [\mathrm{DEP}_{(\mathrm{i})} \times \mathrm{VCAP}_{(\mathrm{i})}] - \sum_{f \in NEQ} \sum_{d \in AA} [\mathrm{AT}_{(\mathrm{Inds,f,dd})} \times \mathrm{VAL}_{(\mathrm{Inds,f,dd})} \times (\mathrm{ROIL}_{(\mathrm{Inds,f,dd})} - 1)]\,] \,/\, [\sum_{dd \in AA} \mathrm{AT}_{(\mathrm{Inds,Equity,dd})} \times \mathrm{VAL}_{(\mathrm{Inds,Equity,dd})}\,]$$

where definitions for each of the variables are the same as those for the identically-named coefficients in Table 16. On the right-hand-side of the above equation we find the rate of return on industry equity defined as:

- the gross operating surplus accruing to owners of industry physical capital ($\sum_{i \in NOD} \mathrm{V1CAP}_{(\mathrm{i})}$); plus,
- inflation in the asset value of industry physical capital ($(\mathrm{P2TOT\_INF}-1) \times \sum_{i \in NOD} \mathrm{VCAP}_{(\mathrm{i})}$); minus,
- the value of depreciation of industry physical capital ($\sum_{i \in NOD} [\mathrm{DEP}_{(\mathrm{i})} \times \mathrm{VCAP}_{(\mathrm{i})}]$); minus,
- the sum of the value of non-equity claims on the gross operating surplus of industry ($\sum_{f \in NEQ} \sum_{d \in AA} [\mathrm{AT}_{(\mathrm{Inds,f,dd})} \times \mathrm{VAL}_{(\mathrm{Inds,f,dd})} \times (\mathrm{ROIL}_{(\mathrm{Inds,f,dd})} - 1)]$); divided by,
- the market value of the equity issued by industry ($\sum_{dd \in AA} \mathrm{AT}_{(\mathrm{Inds,Equity,dd})} \times \mathrm{VAL}_{(\mathrm{Inds,Equity,dd})}$).

Equation E_f_roipow_ie is the percentage change form of the above levels expression. Note that equations E_f_roipow_rhe and E_f_roipow_nrhe, describing the determination of returns on equity in reproducible and non-reproducible housing, follow the same basic form as E_f_roipow_ie. The main point of difference is the absence of a percentage change term for the quantity of physical capital in the non-reproducible housing sector. This follows from the defining characteristic of this sector, namely, that it encompasses that part of the housing stock for which physical supply cannot be expanded.

3.16 The relationship between expected rates of return and capital growth rates

Figure 1 describes the relationship between the expected rate of return on physical capital and the capital growth rate. A simplified representation of the functional relationship described in Figure 1 is:

(1) $EROR_{(i)} = f(KGR_{(i)}) \times ROR_{(i)}$

where $EROR_{(i)}$ is the expected rate of return on physical capital in sector (i), $KGR_{(i)}$ is sector (i)'s capital growth rate, $ROR_{(i)}$ is the rate of return on sector (i)'s physical capital, and $f(KGR_{(i)})$ is a negative function of the capital growth rate with the logistic form described by KK in Figure 1. $f(KGR_{(i)})$ is parameterised so that it has the value 1 when $KGR_{(i)} = KGR\_BASE_{(i)}$. Hence, when the capital growth rate is maintained at its level from the previous year ($KGR\_BASE_{(i)}$), capital creators expect new investments will generate the prevailing rate of return ($ROR_{(i)}$). Because f is negatively-sloped, if capital growth exceeds $KGR\_BASE_{(i)}$, then capital creators anticipate that new investment will generate lower rates of return than the current rate. $KGR\_MIN_{(i)}$ and $KGR\_MAX_{(i)}$ establish the minimum and maximum rates of annual capital growth in sector (i). The equilibrium condition linking capital creation behaviour with movements in the cost of financial capital is given by:

(2) $EROR_{(i)} = WACC_{(i)}$

where $WACC_{(i)}$ is the weighted average cost of sector (i)'s financial capital. This equation imposes the condition that capital creators will raise new liabilities and invest in physical capital up to the point where the expected rate of return on physical capital is equal to the weighted average cost of financial capital.

Equations *E_d_wacc*, *E_fd_wacc*, *E_d_eriror*, and *E_del_k_gr* in Table 15 establish the above relationships between the weighted average cost of financial capital and the accumulation of physical capital. Equation *E_d_wacc* translates the value for the percentage change variable $ave\_ror\_s_{(s)}$ (the percentage change in the weighted average of the powers of the returns paid on the liabilities of agent *s*) into the change in the weighted average cost of capital for liability agent *s* ($d\_wacc_{(s)}$).Equation *E_fd_wacc* is a linking equation, taking the change in the weighted average cost of capital from the financial model ($d\_wacc_{(i)}$) and translating it to the corresponding variable in the model of the real economy ($d\_rwacc_{(i)}$). Equation *E_d_eriror* establishes condition (2) above, setting the expected rate of return on physical capital equal to the weighted average cost of financial capital. Equation *E_del_k_gr* is the rate of change form of equation (1).

3.17 Commercial banks

In modelling the activities of commercial banks, we begin by defining certain concepts useful for representing variables of potential interest to prudential regulators. In particular, we begin with variables related to the capital adequacy ratio, that is, the ratio of the sum of tier one and tier two capital to risk weighted assets. Broadly, tier one capital comprises those liabilities, such as ordinary equity, that can absorb losses without requiring the commercial bank to cease operations. Tier two capital comprises those liabilities can absorb losses in a winding up, such as subordinated debt and hybrid securities, without threatening repayment of depositor liabilities. Risk weighted assets comprise the sum of commercial bank assets individually weighted by indices of asset-specific risk. Equation *E_p_ra_bank1* begins by calculating the percentage change in the risk-weighted value of end-of-year bank assets. The risk weight on financial instrument *f* issued by liability agent *s* is given by $RISKWGT_{(s,f)}$. Table 3 reports initial values for the risk weights in *E_p_ra_bank1*. In choosing values for $RISKWGT_{(s,f)}$, we were guided by values reported in Attachments A and D of (Australian Prudential Regulatory Authority, 2013).

Table 3: Risk weights on commercial bank assets

Parameter	**Description**	**Value[(a)]**
$RISKWGT_{(CB,f)}$ $(\forall\ f \in FI)$	Liabilities issued by the Central Bank.	0
$RISKWGT_{(Govt,f)}$ $(\forall\ f \in FI)$	Liabilities issued by the domestic government.	0.1
$RISKWGT_{(s,Cash)}$ $(\forall\ s \in LA)$	Cash.	0
$RISKWGT_{(s,Equity)}$ $(\forall\ s \in LA)$	Equity.	3.0
$RISKWGT_{(Foreigners,DeposLoans)}$	Loans to foreign agents.	0.4
$RISKWGT_{(Inds,DeposLoans)}$	Loans to domestic industry.	0.4
$RISKWGT_{(NonBankFinIn,DeposLoans)}$	Loans to non-bank financial intermediaries.	0.4
$RISKWGT_{(NRH,DeposLoans)}$	Loans to the non-reproducible housing sector.	0.35
$RISKWGT_{(RH,DeposLoans)}$	Loans to the reproducible housing sector.	0.5
$RISKWGT_{(NonBankFinIn,Bonds)}$	Bonds issued by non-bank financial institutions.	0.4
$RISKWGT_{(Foreigners,Bonds)}$	Foreign bonds.	0.4
(a) In choosing values for RISKWGT, we were guided by Attachments A and D of Prudential Standard APS 112 (APRA 2013).		

Equations *E_p_eq_bank1* and *E_p_ratio_t1* allow for the possibility of a fixed ratio between risk-weighted bank assets and bank equity or tier one capital. Equation *E_p_eq_bank1* calculates the percentage change in end-of-year bank equity. Equation *E_p_ratio_t1* calculates the percentage change in the ratio of end-of-year bank equity to risk-weighted assets.

If equation *E_p_ratio_t1* is activated, in the sense that *p_ratio_t1* is determined exogenously, enforcing a given ratio of equity to risk-weighted assets, then we must provide for the non-equity component of bank financing to be determined outside of the usual liability optimisation mechanisms described in Section 3.8 above. This is provided by equations *E_big_budl_neq*, *E_ave_ror_sne* and *E_f_bank_eq*. Equation *E_big_budl_neq* calculates agent (s)'s non-equity financing needs ($big\_budl\_neq_{(s)}$) as the difference between its total financing needs ($big\_budl_{(s)}$) and that part of its financing needs satisfied by equity. Equation *E_ave_ror_sne* calculates the weighted average value of the cost of non-equity finance to agent (s). Equation *E_f_bank_eq* establishes liability optimising behaviour over the issuance by banks of non-equity financing instruments.

We allow for the possibility of the exogenous determination of the ratio of bank reserves to bank deposits. Equation *E_p_bankresr* defines bank reserves as the sum of bank cash holdings and deposits by banks with the central bank. Equation *E_p_bankdepo* defines end-of-year deposits by households with banks. The ratio of bank reserves to bank deposits is determined by *E_p_resratio*.

With *E_p_resratio* in place, the bank reserve ratio can be determined exogenously via the exogenous determination of p_resratio. However, with p_resratio exogenous, we have introduced a rival to the asset optimisation mechanism for the determination of bank reserve holdings. This requires us to deactivate that part of the bank's asset optimisation problem related to decision making over holdings of cash and central bank deposits. This is the function of equations *E_big_bud_nr*, *E_ave_ror_nr*, *E_f_bankres1*, *E_f_bankres2*, and *E_r_cash_cbdep*.

Equation *E_big_bud_nr* calculates $\text{big\_bud\_nr}_{(d)}$, the percentage change in each agent's total asset holdings excluding cash and central bank deposits. Equation E_ave_ror_nr calculates $\text{ave\_ror\_nr}_{(d)}$, the average rate of return on each agent's holdings of assets excluding cash and central bank deposits. Equations *E_f_bankres1* and *E_f_bankres2* allow for optimising behaviour by banks over all assets other than cash and central bank deposits. The two equations cover the two subsets of assets defined by the complement of the set of reserve assets (cash and central bank deposits): (i) all financial instruments $(\text{f} \in \text{FI})$ issued by agents other than the central bank $(\text{s} \in \text{LANCB})$; and (ii) all non-cash and non-deposit instruments $(\text{f} \in \text{NOTCD})$ issued by the central bank $(\text{s} \in \text{CBSET})$. Finally, equation *E_r_cash_cbdep* allows for the exogenous determination of the ratio of bank holdings of cash to bank deposits with the central bank.

Equations *E_d_bankrev* and *E_d_bankcst* calculate the change in the total revenue received by banks from their holdings of financial assets, and the change in the total costs incurred by banks on their financial liabilities. *E_d_bankprofit* calculates the change in the difference between bank financial revenue and bank financial costs. The banks' balance sheet constraint is given by Equation *E_d_f_liaacq_bank*, which calculates the difference between the change in bank liabilities and the change in bank assets. The chief function of *E_d_bankprofit* and *E_d_f_liaacq_bank* is to facilitate the endogenous determination of bank behaviour as it relates to the size of the banking sector. In particular, we determine bank asset acquisitions by endogenising $\text{d\_new\_assacq}_{(\text{Banks})}$ and exogenising $\text{d\_bankprofit}_{(\text{Banks})}$, and then enforcing equality of the asset and liability sides of bank balance sheets by endogenously determining $\text{d\_new\_liaacq}_{(\text{Banks})}$ and exogenously determining d_f_liaacq_bank. Under this closure, bank asset acquisition expands up to the point where the return on a dollar's worth of additional asset acquisition is equal to the cost of a dollar's worth of additional bank liabilities.

3.18 Superannuation

Equations *E_sup_con_rate* through to *E_ff_apc_gnp* describe the balance sheet and net revenue position of the superannuation sector. Equation *E_sup_con_rate* links the acquisition of new liabilities by the superannuation sector to movements in the economy-wide nominal wage bill via a given superannuation contribution rate. With fd_super_assac exogenous, equation *E_fd_super_assac* links new acquisitions of financial assets by the superannuation sector to the value of the new liabilities issued by the sector. Equation *E_p_superassets* calculates the percentage change in the start-of-year value of assets under management by the superannuation sector as the share weighted sum of the percentage changes in the values of the individual financial instruments held by the sector. For reporting purposes, equation *E_p_roipow_supa* calculates the percentage change in the power of the average rate of return on the assets under the management of the superannuation sector. *E_d_superrev* calculates the change in revenue of the superannuation sector over the simulation year as the weighted sum of the percentage changes in assets under management and the percentage changes in the rates of return on the individual financial securities representing those assets. Equation *E_d_supercst* calculates the change in the financial costs of the superannuation sector as the weighted sum of the percentage changes in the end-of-year value of the financial claims upon the superannuation sector and the percentage changes in the rates of return earned on those claims. Equation *E_d_superprofit* calculates the change in the superannuation sector's net financial revenue as the difference between the sector's financial revenues and financial costs.

Under a standard closure of the system of equations described by *E_sup_con_rate* through to *E_d_superprofit* , *sup_con_rate* is exogenous. With *sup_con_rate* exogenous, *E_sup_con_rate* determines the value of new liabilities issued by the superannuation sector as a fixed proportion of the national wage bill. The bulk of these liabilities are represented by equity claims by the household sector. With the household sector described as an asset optimiser, how do we ensure that households are willing to hold the new equities issued by the superannuation sector as described by *E_sup_con_rate*? Here we provide for two options.

First, we provide for the possibility of endogenous determination of a subsidy on returns from superannuation sufficient to reconcile the holdings of new superannuation liabilities given by E_sup_con_rate and those given by the household asset optimisation problem. This is the function of *d_super_sub* in equation *E_d_superprofit*. *d_super_sub* is the ordinary change in the value of federal government subsidies to the superannuation sector. They can be thought of as the endogenous tax expenditure via concessional tax rates necessary to ensure that households are comfortable holding the level of superannuation given by *E_sup_con_rate*. Note that *d_super_sub* also appears in the equation describing the government's borrowing requirement, and as such, has an influence on *d_gov_def* to the extent that the government does not take direct action to offset movements in *d_super_sub* via changes in tax rates, public consumption spending, or personal benefit payments. With *d_superprofit* exogenous, equation *E_d_superprofit* ensures that the movements in the return on superannuation equity received by households reflect movements in the returns on funds managed by the superannuation sector, together with any additional changes given by movements in *d_super_sub*.

Second, we allow *E_sup_con_rate* to determine household holdings of new superannuation liabilities, and remove superannuation from the household's asset optimisation decision problem. This is the function of equations *E_big_bud_ns*, *E_ave_ror_ns*, *E_f_Super1*, *E_f_Super2* and *E_r_dep_equity*. With household holdings of superannuation assets determined outside of the asset optimisation framework, we must define that part of the household asset pool that excludes superannuation. This is the function of Equation *E_big_bud_ns*, which calculates the value of agent (d)'s end-of-period period portfolio excluding the two types of financial instrument issued by superannuation, namely equity and deposits.[2] Equation *E_ave_ror_ns* calculates the percentage change in the power of rates of return on agent-specific holdings of non-superannuation liabilities. With f_Super1 and f_Super2 exogenous, Equations *E_f_Super1* and *E_f_Super2* establish asset optimisation behaviour over the non-superannuation component of household asset portfolios. Finally, *E_r_dep_equity* determines the division of household superannuation holdings between the two types of liability instrument (equity and deposits) issued by superannuation, via an assumption of a constant ratio of holdings of the two instruments.

There is evidence that compulsory superannuation has generated a net increase in household savings and wealth, with each $1 of additional superannuation contribution displacing perhaps $0.30 of other savings (Connolly, 2007). Equation *E_ff_apc_gnp* allows for this possibility, providing a mechanism for changes in the superannuation contribution rate to affect the savings rate (via movement in the average propensity to consume).

3.19 Non-bank financial intermediaries (NBFI)

Equations *E_d_nbfirev* through to *E_f_liaacq_nbfi* describe the balance sheet and net revenue position of the NBFI sector. *E_d_nbfirev* calculates the change in revenue of the NBFI sector over the simulation year as the weighted sum of the percentage changes in the NBFI sector's assets and the percentage changes in the rates of return earned on those assets. Equation *E_d_nbficst* calculates the change in the financial costs of the NBFI sector as the weighted sum of the percentage changes in the end-of-year value of the financial claims upon the NBFI sector and the percentage changes in the rates of return earned on those claims. Equation *E_d_nbfiprofit* calculates the NBFI sector's net financial revenue as the difference between the sector's financial revenues and financial costs. Equation *E_f_liaacq_nbfi* imposes a balance sheet constraint, linking the change in new liabilities issued by the NBFI sector to the change in new assets acquired by the sector.

[2] Data from ABS 5232.0 show that the bulk of the superannuation liabilities held by households as assets are in the form of equity (approximately 99.5%). The ABS statistics show that a small proportion of household claims on superannuation are in the form of deposits (approximately 0.5%).

3.20 Life insurance

Equations *E_d_liferev* through to *E_f_liaacq_life* describe the balance sheet and net revenue position of the life insurance sector. *E_d_liferev* calculates the change in revenue of the life insurance sector over the simulation year as the weighted sum of the percentage changes in the life insurance sector's assets and the percentage changes in the rates of return earned on those assets. Equation *E_d_lifecst* calculates the change in the financial costs of the life insurance sector as the weighted sum of the percentage changes in the end-of-year value of the financial claims upon the life insurance sector and the percentage changes in the rates of return earned on those claims. Equation *E_d_lifeprofit* calculates the life insurance sector's net financial revenue as the difference between the sector's financial revenues and financial costs. Equation *E_f_liaacq_life* imposes a balance sheet constraint, linking the change in new liabilities issued by the life insurance sector to the change in new assets acquired by the sector.

3.21 Central bank

Equations *E_big_bud_nf* through to *E_f_cb_asset2* help establish a closure in which the Central Bank distinguishes between domestic and foreign assets in its asset optimisation problem. While the equations are implemented in general form, allowing their implementation for any asset agent, their chief function is in facilitating modelling of the open market operations of the Central Bank. These operations are directed at transacting in domestic financial assets to affect changes in domestic interest rates. Equation *E_big_bud_nf* defines $\text{big\_bud\_nf}_{(d)}$, the value of domestic assets held by asset agent (d). Equation *E_ave_ror_nf* calculates the percentage change in the power of the average rate of return earned by agent (d) on its holdings of domestic financial assets. Equation *E_f_cb_asset1* provides for the possibility of asset optimising behaviour by agent (d) over the domestic asset portion of its financial assets. Equation E_big_bud_for defines the value of agent (d)'s holdings of foreign financial assets. Equation E_ave_ror_for calculates the percentage change in the power of the average return earned by agent (d) on its holdings of foreign financial assets. Equation E_f_cb_asset2 allows for asset optimising behaviour by agent (d) over its foreign financial assets, within the constraints imposed by its foreign asset budget, $\text{big\_bud\_for}_{(d)}$.

3.22 Relationship between nominal wage growth and labour market conditions

Figure 2 describes the relationship between desired real wage growth in year t and the strength of the labour market in year t-1. On the x axis, the strength of the labour market is described by the lagged employment rate (the ratio of employment to labour supply) divided by the non-accelerating inflation rate of employment (1-NAIRU). We set NAIRU = 0.05. When the lagged employment rate is equal to 1-NAIRU (i.e., x=1), desired real wage growth in year t is β. We set β=1.025, to reflect initial inflation expectations of 2.5%. The parameter γ reflects the lowest rate of wage deflation that workers will tolerate when labour market conditions reach a dire state described by ϕ. The relationship represented in Figure 2 is described by:

(1) $y = A/(e^{B(x-\alpha)} - 1)$

where:

y=[$W^{*}_{(t)}$/E($P_{(t)}$)]/[$W^{(t-1)}$/$P^{(t-1)}$]

x=$ER^{(t-1)}$/(1-NAIRU)

and where:

$W^{*}_{(t)}$	is the desired level for the nominal wage in year t
E($P_{(t)}$)	is the expected level of the CPI in year t
$W^{(t-1)}$	is the level of the nominal wage in year t-1
$P^{(t-1)}$	is the level of the CPI in the year t-1
$ER^{(t-1)}$	is the employment rate in year t-1
NAIRU	is the non-accelerating inflation rate of unemployment.

Equation (**1**) contains two unknowns, A and B. However values for A and B are determined by our requirement that (**1**) pass through (ϕ, γ) and (1, β).

The percentage change form of equation (**1**) is given by *E_fp1lab_oi4*.

Equation (**1**), and its percentage change form *E_fp1lab_oi4*, introduce a number of new variables, in particular, the percentage change in the expected level of the consumer price index in year *t* (*p3tot_exp*), the lagged rate of nominal wage growth (*p1lab_oi_l*), the lagged rate of consumer price inflation (*p3tot_l*), and the lagged employment rate (*emprate_l*). We now describe the determination of each of these in turn.

The expected level of the CPI index in year t is:

(2) $E(P_t^{(3)}) = P_{t-1}^{(3)} \cdot E(T_t^{(3)})$

where $P_t^{(3)}$ is the level of the CPI in year t, $T_t^{(3)}$ is the power (1 plus the rate) of consumer price inflation between year t-1 and year t, and E(x) denotes the expected value of x.

We assume that $E(T_t^{(3)})$ is determined in an adaptive fashion via:

(3) $E(T_t^{(3)}) = T_t^{(3)\mathrm{Trend}}$

where $T_t^{(3)\mathrm{Trend}}$ is the power of the trend inflation rate in year t. $T_t^{(3)\mathrm{Trend}}$ is determined as a moving average via:

(4) $T_t^{(3)\mathrm{Trend}} = \xi T_{t-1}^{(3)\mathrm{Trend}} + (1-\xi)T_{t-1}^{(3)}$

The percentage change forms of equations (2), (3) and (4) are given by E_fp3tot_exp2, E_p3tr_exp, E_p3tr_pow in Table 15.

Equation *E_p3tr_pow* introduces the lagged value of the percentage change in the power of the trend rate of CPI growth (*p3tr_pow_l*) and the lagged value of the percentage change in the power of the rate of CPI growth (*p3inf_pow_l*). These lagged values are brought into the simulation for year t via equations *E_dp3trpow_l* and *E_dp3inf_pow_l*.

Note that equation (1) defines the desired level for the nominal wage in year t, $\mathrm{W}_{(t)}^{*}$. Workers are assumed to gradually adjust their wage demands in line with the value of W_t^* given by equation (1), via:

(5) $W_t \ / W_{t-1} = \alpha(W_t^* / W_{t-1}) + (1-\alpha)(W_{t-1} / W_{t-2})$

The percentage change form of equation (5) is given by *E_d_f_w_pow*. This equation introduces the percentage change in the lagged value of the power of the growth rate in nominal wages. This lagged value is brought into the simulation for year t via equation *E_d_w_pow_l.*

4 Closure of the financial side of the CGE model

4.1 Introduction

As already discussed in Section 3, Table 17 describes the variables of the financial component of the CGE model, and a selection of variables from the real side of the model that are relevant to advancing the description of the operation of the model's financial side. The last two columns of the table describe the closure status of these variables. The first of these columns (headed "Real CGE") describes a closure in which the model's financial theory is deactivated, leaving the full CGE model to operate as a traditional real-side CGE model. The second of the two columns (headed "Financial CGE") describes a closure in which the financial theory described in Section 3 is activated, allowing the full CGE model to operate as a financial CGE model. In the remainder of Section 4 we describe, in a step-wise fashion, the closure changes that are required to move from a closure in which the model's financial theory is deactivated (the "real CGE" closure) to one in which it is activated (the "financial CGE" closure).

4.2 Closure rules for government

Table 4 describes the closure changes that are relevant to activating the government sector under a "financial" closure of the CGE model. Under the "real" closure in which the financial sector is inactive and the whole model operates as a traditional CGE model of the real side of the economy, the variables in column (A) of Table 4 are exogenous, and the variables in column (B) are endogenous. To activate the government sector under the "financial" closure, the variables in column (A) must be determined endogenously, and those in column (B) determined exogenously. The model's "financial" closure is somewhat complex, and so we approach the development and exposition of this closure in a row-by-row fashion below.

Table 4: Closure rules relating to the activation of the government sector

	(A) Exogenous under "real" closure, Endogenous under "financial" closure.	**(B) Endogenous under "real" closure, Exogenous under "financial" closure.**
(1)	$\text{d\_new\_liaacq}_{(\text{Govt})}$	d_ff_govt
(2)	$\text{d\_new\_assacq}_{(\text{Govt})}$	shiftg
(3)	$\text{roipowl}_{(\text{Govt,f,d})}$	$\text{liab\_shift}_{(\text{Govt,f,d})}$
(4)	$\text{d\_mtb}_{(\text{Govt,f})}$	$\text{liab\_sh\_d}_{(\text{Govt,f})}$
(5)	$\text{liab\_shift}_{\text{Govt,f,d}}\ (f \in \text{FI}, d \in \text{AA})$	$\text{f3\_roipowl}_{\text{Govt,f,d}}\ (f \in \text{FI}, d \in \text{AA})$
(6)	$\text{f2\_roipowl}_{\text{Govt,f}}\ (f \in \text{FI})$	$\text{d\_MTB}_{\text{Govt,f}}\ (f \in \text{FI})$
(7)	$\text{f3\_roipowl}_{\text{Govt,DeposLoans,d}}\ (d \in \text{AA})$	$\text{liab\_shift}_{\text{Govt,DeposLoans,d}}\ (d \in \text{AA})$
(8)	$\text{d\_MTB}_{\text{Govt,DeposLoans}}$	$\text{f2\_roipowl}_{\text{Govt,DeposLoans}}$

We begin at Row (1) by activating equation *E_ff_govt* via the exogenous determination of d_ff_govt, thereby linking new liability accumulation by government ($\text{d\_new\_liaacq}_{(\text{Govt})}$) with the public sector borrowing requirement and purchases of new financial assets by government. Acquisition of financial assets by government ($\text{d\_new\_assacq}_{(\text{Govt})}$) under the "financial" closure is linked to movements in nominal public consumption spending via exogenous determination of shiftg.

With the closure swaps described in rows (3) and (4), the shift variables $\text{liab\_sh\_d}_{(\text{Govt,f})}$ and $\text{liab\_shift}_{(\text{Govt,f,d})}$ $(f \in \text{FI})$ are determined exogenously under the "finance" closure, thereby activating those elements of equations *E_a_t_1_d2* and *E_a_t_1* relating to the Government sector. This establishes conventional optimising behaviour on the part of Government as a liability agent.

Under the "financial" closure described by rows (1)-(4) instrument- and agent-specific markets for the liabilities of government clear via endogenous determination of instrument- and agent-specific rates of return on government liabilities. This has the undesirable property of opening the possibility of, for example, different rates of return on the same type of government bond held by different asset agents. The adjustments to this standard closure described by rows (5)-(8) rectify this. Under the "financial" closure described in rows (5)-(8), the government sector as a liability agent offers identical rates of return to all asset agents holdings its liabilities, but has the capacity to offer different rates of return to asset agents from which it accepts deposits or takes out loans. Rows (5) and (6) begin by activating E_a_t_1_d and deactivating E_a_t_1_d2 for Government, thereby establishing a situation in which the Government sector does not distinguish between asset agents in its liability optimisation problem, ensuring that, via movements in $\mathrm{f2\_roipowl}_{\mathrm{Govt,f}}$, all asset agents see the same movements in rates of return on instrument *f* offered by Government. One element of this situation is then reversed in rows (7) and (8), deactivating *E_a_t_1_d2* and activating *E_a_t_1* for the financial instrument "Deposits and loans" issued by Government as a liability, and thereby, via the endogenous determination of $\mathrm{f3\_roipowl}_{\mathrm{Govt,f,d}}$, allowing for the possibility of Government offering different asset agents different returns on deposits and loans.

4.3 Closure rules for industry

Table 5 describes the closure changes that are relevant to activating the financial behaviour of industry under a "financial" closure of the CGE model. Under the "real" closure in which the financial sector is inactive and the whole model operates as a traditional CGE model of the real side of the economy, the variables in column (A) of Table 5 are exogenous, and the variables in column (B) are endogenous. To activate industry under the "financial" closure, the variables in column (A) must be determined endogenously, and those in column (B) determined exogenously. The model's "financial" closure is somewhat complex, and so we approach the development and exposition of this closure in a row-by-row fashion below.

Table 5: Closure rules relating to the activation of the financial behaviour of industry

	(A) Exogenous under "real" closure, Endogenous under "financial" closure.	**(B) Endogenous under "real" closure, Exogenous under "financial" closure.**
(1)	$\mathrm{d\_new\_liaacq}_{(\mathrm{Inds})}$	d_shiftind
(2)	$\mathrm{d\_new\_assacq}_{(\mathrm{Inds})}$	shiftind
(3)	$\mathrm{roipowl}_{(\mathrm{Inds,f,d})}\,(f \in \mathrm{FI}, d \in \mathrm{AA})$	$\mathrm{liab\_shift}_{(\mathrm{Inds,f,d})}\,(f \in \mathrm{FI}, d \in \mathrm{AA})$
(4)	$\mathrm{d\_mtb}_{(\mathrm{Inds,f})}\,(f \in \mathrm{FI})$	$\mathrm{liab\_sh\_d}_{(\mathrm{Inds,f})}\,(f \in \mathrm{FI})$
(5)	$\mathrm{liab\_shift}_{\mathrm{Inds,f,d}}\,(f \in \mathrm{FI}, d \in \mathrm{AA})$	$\mathrm{f3\_roipowl}_{\mathrm{Inds,f,d}}\,(f \in \mathrm{FI}, d \in \mathrm{AA})$
(6)	$\mathrm{f2\_roipowl}_{\mathrm{Inds,f}}\,(f \in \mathrm{FI})$	$\mathrm{d\_MTB}_{\mathrm{Inds,f}}\,(f \in \mathrm{FI})$
(7)	$\mathrm{f3\_roipowl}_{\mathrm{Inds,DeposLoans,d}}\,(d \in \mathrm{AA})$	$\mathrm{liab\_shift}_{\mathrm{Inds,DeposLoans,d}}\,(d \in \mathrm{AA})$
(8)	$\mathrm{d\_MTB}_{\mathrm{Inds,DeposLoans}}$	$\mathrm{f2\_roipowl}_{\mathrm{Inds,DeposLoans}}$
(9)	$\mathrm{fff\_v}_{(\mathrm{Inds,Equity})}$	d_f_inds_eq
(10)	$\mathrm{f\_roipow}_{(\mathrm{Inds,Equity,d})}$	$\mathrm{f4\_roipow}_{(\mathrm{Inds,d})}$

We begin at Row (1) by activating equation *E_d_shiftind2* via the exogenous determination of d_shiftind, thereby linking new liability accumulation by industry ($\text{d\_new\_liaacq}_{(\text{Inds})}$) with nominal gross fixed capital formation and acquisition of financial assets by industry. Acquisition of financial assets by industry ($\text{d\_new\_assacq}_{(\text{Inds})}$) under the "financial" closure is linked to movements in nominal GDP via exogenous determination of shiftind (row 2).

With the closure swaps described in rows (3) and (4), the shift variables $\text{liab\_sh\_d}_{(\text{Inds,f})}$ and $\text{liab\_shift}_{(\text{Inds,f,d})}$ $(\text{f} \in \text{FI})$ are determined exogenously under the "finance" closure, thereby activating those elements of equations *E_a_t_1_d2* and *E_a_t_1* relating to industry. This establishes conventional optimising behaviour on the part of industry as a liability agent.

Under the "financial" closure described by rows (1)-(4) instrument- and agent-specific markets for the liabilities of industry clear via endogenous determination of instrument- and agent-specific rates of return on industry liabilities ($\text{roipowl}_{(\text{Inds,f,d})}$). This has the potentially undesirable property of opening the possibility of different rates of return on the same type of liability held by different asset agents, when in reality a single market exists for the liability in question (e.g. equity). The adjustments to this standard closure described by rows (5)-(8) rectify this. Under the "financial" closure described in rows (5)-(8), industry offers identical rates of return to all asset agents holdings its liabilities, except in the case of deposits/loans, where it has the capacity to borrow at differential rates across asset agents. Rows (5) and (6) begin by activating E_a_t_1_d and deactivating E_a_t_1_d2 for industry, thereby establishing a situation in which industry does not distinguish between asset agents in its liability optimisation problem, ensuring that, via movements in $\text{f2\_roipowl}_{\text{Inds,f}}$, all asset agents see the same movements in rates of return on instrument *f* offered by industry. One element of this situation is then reversed in rows (7) and (8), deactivating *E_a_t_1_d2* and activating *E_a_t_1* for the financial instrument "Deposits and loans" issued by industry as a liability, and thereby, via the endogenous determination of $\text{f3\_roipowl}_{\text{Inds,f,d}}$, allowing for the possibility of industry offering different asset agents different returns on deposits and loans.

Row (9), under the financial closure, activates equation *E_ff_v_inds_eq*, allowing movements in the valuation term for industry equity (via movements in $\text{fff\_v}_{(\text{Inds,Equity})}$ in equation *E_v*) to adjust as a residual in line with movements in the values of industry physical capital, financial capital, and financial liabilities.

4.4 Closure rules for the reproducible housing sector

Table 6 describes the closure changes that are relevant to activating the financial behaviour of the reproducible housing sector under the model's "financial" closure. Under the "real" closure, in which the financial sector is inactive and the model operates as a traditional CGE model of the real side of the economy, the variables in column (A) of Table 6 are exogenous, and the variables in column (B) are endogenous. To activate reproducible housing under the "financial" closure, the variables in column (A) must be determined endogenously, and those in column (B) determined exogenously. We expand below on the development of the financial closure as it relates to reproducible housing in a row-by-row fashion.

Table 6: Closure rules relating to the activation of the financial behaviour of reproducible housing

	(A) Exogenous under "real" closure, Endogenous under "financial" closure.	(B) Endogenous under "real" closure, Exogenous under "financial" closure.
(1)	$\mathrm{d\_new\_liaacq}_{(RH)}$	d_shiftRH
(2)	$\mathrm{roipowl}_{(RH,f,d)}\ (f \in FI, d \in AA)$	$\mathrm{liab\_shift}_{(RH,f,d)}\ (f \in FI, d \in AA)$
(3)	$\mathrm{d\_mtb}_{(RH,f)}\ (f \in FI)$	$\mathrm{liab\_sh\_d}_{(RH,f)}\ (f \in FI)$
(4)	$\mathrm{liab\_shift}_{RH,f,d}\ (f \in FI, d \in AA)$	$\mathrm{f3\_roipowl}_{RH,f,d}\ (f \in FI, d \in AA)$
(5)	$\mathrm{f2\_roipowl}_{RH,f}\ (f \in FI)$	$\mathrm{d\_MTB}_{RH,f}\ (f \in FI)$
(6)	$\mathrm{f3\_roipowl}_{RH,DeposLoans,d}\ (d \in AA)$	$\mathrm{liab\_shift}_{RH,DeposLoans,d}\ (d \in AA)$
(7)	$\mathrm{d\_MTB}_{RH,DeposLoans}$	$\mathrm{f2\_roipowl}_{RH,DeposLoans}$
(8)	$\mathrm{fff\_v}_{(RH,Equity)}$	d_f_RH_eq
(10)	$\mathrm{f\_roipow}_{(RH,Equity,d)}$	$\mathrm{f4\_roipow}_{(RH,d)}$

Under the financial closure, liability accumulation by the reproducible housing sector ($\mathrm{d\_new\_liaacq}_{(RH)}$) is determined endogenously by activating equation *E_d_shiftRH* via the exogenous determination of d_shiftRH (row 1, Table 6). This links new liability issuance by the reproducible housing sector to the value of gross fixed capital formation in the dwellings sector, plus purchases, if any, of financial instruments by the reproducible housing sector.

With the closure swaps described in rows (2) and (3), the shift variables $\mathrm{liab\_sh\_d}_{(RH,f)}$ and $\mathrm{liab\_shift}_{(RH,f,d)}$ $(f \in FI)$ are determined exogenously under the "finance" closure, thereby activating those elements of equations *E_a_t_1_d2* and *E_a_t_1* relating to reproducible housing. This establishes conventional optimising behaviour on the part of reproducible housing as a liability agent.

Under the "financial" closure described by rows (1)-(3) instrument- and agent-specific markets for the liabilities of reproducible housing clear via endogenous determination of instrument- and agent-specific rates of return on reproducible housing liabilities ($\mathrm{roipowl}_{(RH,f,d)}$). This opens the possibility of different rates of return on the same type of reproducible housing liability held by different asset agents, when in reality a single market exists for the liability in question. The adjustments to this standard closure described by rows (4)-(7) rectify this. Under the "financial" closure described in rows (5)-(8), reproducible housing offers identical rates of return to all asset agents holdings its liabilities, except in the case of deposits/loans, where it has the capacity to borrow at differential rates across asset agents. Rows (4) and (5) begin by activating E_a_t_1_d and deactivating E_a_t_1_d2 for reproducible housing, thereby establishing a situation in which reproducible housing does not distinguish between asset agents in its liability optimisation problem, ensuring that, via movements in $f2\_roipowl_{RH,f}$, all asset agents see the same movements in rates of return on instrument *f* offered by reproducible housing. One element of this situation is then reversed in rows (6) and (7), deactivating *E_a_t_1_d2* and activating *E_a_t_1* for the financial instrument "Deposits and loans" issued by reproducible housing as a liability, and thereby, via the endogenous determination of $f3\_roipowl_{RH,f,d}$, allowing for the possibility of reproducible housing offering different asset agents different returns on deposits and loans.

Row (8), under the financial closure, activates equation *E_ff_v_RH_eq*, allowing movements in the valuation term for reproducible housing equity (via movements in $fff\_v_{(RH,Equity)}$ in equation *E_v*) to adjust as a residual in line with movements in the values of reproducible housing's physical capital, financial capital, and financial liabilities.

4.5 Closure rules for the non-reproducible housing sector

Table 7 describes the status of key variables relevant to the non-reproducible housing sector under the "financial" and "real" closures of the model. Under the "real" closure, in which the financial sector is inactive and the model operates as a traditional CGE model of the real side of the economy only, the variables in column (A) of Table 7 are exogenous, and the variables in column (B) are endogenous. To activate non-reproducible housing under the "financial" closure, the variables in column (A) must be determined endogenously, and those in column (B) determined exogenously. We expand below on the development of the financial closure as it relates to non-reproducible housing in a row-by-row fashion.

Table 7: Closure rules relating to the activation of the financial behaviour of the non-reproducible housing sector

	(A) Exogenous under "real" closure, Endogenous under "financial" closure.	(B) Endogenous under "real" closure, Exogenous under "financial" closure.
(1)	$roipowl_{(NRH,f,d)}\ (f \in FI, d \in AA)$	$liab\_shift_{(NRH,f,d)}\ (f \in FI, d \in AA)$
(2)	$d\_mtb_{(NRH,f)}\ (f \in FI)$	$liab\_sh\_d_{(NRH,f)}\ (f \in FI)$
(3)	$liab\_shift_{NRH,f,d}\ (f \in FI, d \in AA)$	$f3\_roipowl_{NRH,f,d}\ (f \in FI, d \in AA)$
(4)	$f2\_roipowl_{NRH,f}\ (f \in FI)$	$d\_MTB_{NRH,f}\ (f \in FI)$
(5)	$f3\_roipowl_{NRH,DeposLoans,d}\ (d \in AA)$	$liab\_shift_{NRH,DeposLoans,d}\ (d \in AA)$
(6)	$d\_MTB_{NRH,DeposLoans}$	$f2\_roipowl_{NRH,DeposLoans}$
(7)	$fff\_v_{(NRH,Equity)}$	$d\_f\_NRH\_eq$
(10)	$f\_roipow_{(NRH,Equity,d)}$	$f4\_roipow_{(NRH,d)}$

With the closure swaps described in rows (1) and (2), the shift variables $liab\_sh\_d_{(NRH,f)}$ and $liab\_shift_{(NRH,f,d)}\ (f \in FI)$ are determined exogenously under the "finance" closure, thereby activating those elements of equations *E_a_t_1_d2* and *E_a_t_1* relating to non-reproducible housing. This establishes conventional optimising behaviour on the part of non-reproducible housing as a liability agent.

Under the "financial" closure described by rows (1) and (2) instrument- and agent-specific markets for the liabilities of non-reproducible housing clear via endogenous determination of instrument- and agent-specific rates of return on non-reproducible housing liabilities ($\text{roipowl}_{(RH,f,d)}$). This opens the possibility of different rates of return on the same type of non-reproducible housing liability held by different asset agents, when in reality a single market might exist for the liability in question. The adjustments to this standard closure described by rows (3)-(6) rectify this. Under the "financial" closure established by the closure changes in rows (3)-(6), non-reproducible housing offers identical rates of return to all asset agents holdings its liabilities, except in the case of deposits/loans, where it has the capacity to borrow at differential rates across asset agents. Rows (3) and (4) begin by activating E_a_t_1_d and deactivating E_a_t_1_d2 for non-reproducible housing, thereby establishing a situation in which non-reproducible housing does not distinguish between asset agents in its liability optimisation problem, ensuring that, via movements in $\text{f2\_roipowl}_{NRH,f}$, all asset agents see the same movements in rates of return on instrument *f* offered by non-reproducible housing. One element of this situation is then reversed in rows (5) and (6), deactivating *E_a_t_1_d2* and activating *E_a_t_1* for the financial instrument "Deposits and loans" issued by non-reproducible housing as a liability, and thereby, via the endogenous determination of $\text{f3\_roipowl}_{NRH,f,d}$, allowing for the possibility of non-reproducible housing offering different asset agents different returns on deposits and loans.

Row (8), under the financial closure, activates equation *E_ff_v_NRH_eq*, allowing movements in the valuation term for non-reproducible housing equity (via movements in $\text{fff\_v}_{(NRH,Equity)}$ in equation *E_v*) to adjust as a residual in line with movements in the values of non-reproducible housing's physical capital, financial capital, and financial liabilities.

4.6 Closure rules for the central bank

Under the "real CGE" closure, we begin with $\text{d\_shiftl4}_{(CB)}$, $\text{a\_t\_1}_{(Foreigners,f,CB)}$ $(f \in FI)$, and $\text{f\_cb\_asset1}_{(s,f,CB)}$ $(s \in DOMAGENT, f \in FI)$ endogenous, and $\text{d\_new\_liaacq}_{(CB)}$, $\text{f\_a\_t\_1}_{(Foreigners,f,CB)}$ $(f \in FI)$ and $\text{f\_a\_t\_1}_{(s,f,CB)}$ $(s \in DOMAGENT, f \in FI)$ exogenous.

To activate Central Bank behaviour in which optimisation over domestic assets is distinguished from optimisation over foreign assets, we undertake the following closure changes:

(i) $\text{d\_shiftl4}_{(CB)}$ is moved to the set of exogenous variables, and $\text{d\_new\_liaacq}_{(CB)}$ is moved to the set of endogenous variables;

(ii) $a\_t\_1_{(Foreigners,f,CB)}$ $(f \in FI)$ is moved to the set of exogenous variables, and $f\_a\_t\_1_{(Foreigners,f,CB)}$ $(f \in FI)$ is moved to the set of endogenous variables;

(iii) $f\_cb\_asset1_{(s,f,CB)}$ $(s \in DOMAGENT, f \in FI)$ is moved to the set of exogenous variables, and $f\_a\_t\_1_{(s,f,CB)}$ $(s \in DOMAGENT, f \in FI)$ is moved to the set of endogenous variables.

Note that $d\_new\_assacq_{(CB)}$ remains exogenous under both "real" and "financial" closures. Under a closure described by (i)-(iii), new acquisitions of financial assets by the Central Bank are an exogenous policy variable, with Central Bank liabilities adjusting endogenously to maintain balance of the Central Bank's balance sheet. With holdings of foreign assets exogenous (i.e. with $a\_t\_1_{(Foreigners,f,CB)}$, $f \in FI$, exogenous) changes in aggregate Central Bank asset holdings must be accommodated by movements in holdings of domestic assets only. With $f\_cb\_asset1_{(s,f,CB)}$ ($s \in DOMAGENT, f \in FI$) exogenous, the corresponding components of equation E_f_cb_asset1 are activated, establishing asset optimising behaviour on the part of the Central Bank over individual domestic financial assets.[3] With $f\_a\_t\_1_{(s,f,CB)}$ $(s \in LA, f \in FI)$ endogenous, the standard asset optimisation equation (*E_a_t_1dom*) is deactivated for the Central Bank, consistent with the exogenous status of $a\_t\_1_{(Foreigners,f,CB)}$ and activation for the Central Bank of *E_f_cb_asset1*.

4.7 Closure rules for the household sector

Under the model's "real" closure, new asset acquisitions by the household sector ($d\_new\_assacq_{(Hlds)}$) are exogenous, and equation *E_d_shiftH* is inactive via the endogenous determination of d_shiftH. Under the finance closure, equation *E_d_shiftH* is activated via exogenous determination of d_shiftH and endogenous determination of $d\_new\_assacq_{(Hlds)}$. This links acquisition of financial instruments by households the value of the savings plus the value of new household financial liabilities.

4.8 Closure rules for the foreign sector

Under the model's "real" closure, new asset acquisitions by the foreign sector ($d\_new\_assacq_{(Foreigners)}$) are exogenous, and equation *E_d_ff_phi* is inactive via the endogenous determination of d_ff_phi. Under the finance closure, equation *E_d_ff_phi* is activated via exogenous determination of d_ff_phi and endogenous determination of $d\_new\_assacq_{(Foreigners)}$. This links acquisition of domestic financial instruments by foreign

[3] We can go further, rendering exogenous Central Bank decision making over all elements of the asset side of its balance sheet. This will be necessary when we move to a more granular modelling of Central Bank policy action, requiring us to distinguish Central Bank purchases and sales of government liabilities in the implementation of conventional open market operations, and the purchase and sale of long-dated government liabilities and selected private financial liabilities in the implementation of unconventional monetary policy.

agents with the need to finance the current account deficit plus domestic purchases of foreign financial assets.

Table 8: Closure rules relating to the activation of the model's foreign sector

	(A) Exogenous under "real" closure, Endogenous under "financial" closure.	(B) Endogenous under "real" closure, Exogenous under "financial" closure.
(1)	$\text{d\_new\_assacq}_{(\text{Foreigners})}$	d_ff_phi
(2)	phi	$\text{d\_shift4}_{(\text{Foreigners})}$

4.9 Closure rules for the superannuation sector

Table 9 describes the closure changes that are relevant to activating the superannuation sector in moving from the "real" to the "financial" closure of the CGE model. Under the "real" closure in which the financial sector is inactive and the whole model operates as a traditional CGE model of the real side of the economy, the variables in column (A) of Table 9 are exogenous, and the variables in column (B) are endogenous. To activate the superannuation sector under the "financial" closure, the variables in column (A) are endogenous, and those in column (B) exogenous. The "financial" closure of the superannuation sector is somewhat complex, and so we approach the development and exposition of this closure in a row-by-row fashion below.

Starting with row (1), we begin by endogenously determining the new liabilities of the superannuation sector ($\text{d\_new\_liaacq}_{(\text{Super})}$), and linking the determination of these liabilities with movements in the aggregate wage bill (via *E_sup_con_rate*) by exogenously determining the superannuation contribution rate (d_sup_con_rate). Under this closure, the superannuation sector acquires new liabilities (almost entirely in the form of equity held by households) in proportion with movements in the economy-wide wagebill.

Table 9: Closure rules relating to the activation of the model's superannuation sector

	(A) Exogenous under "real" closure, Endogenous under "financial" closure.	(B) Endogenous under "real" closure, Exogenous under "financial" closure.
(1)	$\text{d\_new\_liaacq}_{(\text{Super})}$	sup_con_rate
(2)	$\text{d\_mtb}_{(\text{Super,f})}$ $(f \in FI)$	$\text{liab\_sh\_d}_{(\text{Super,f})}$ $(f \in FI)$
(3)	$\text{roipowl}_{(\text{Super,f,d})}$ $(f \in FI, d \in AA)$	$\text{liab\_shift}_{(\text{Super,f,d})}$ $(f \in FI, d \in AA)$
(4)	$\text{d\_new\_assacq}_{(\text{Super})}$	fd_super_assac
(5)	d_super_sub	d_superprofit
(6)	$\text{liab\_shift}_{\text{Super,f,d}}$ $(f \in FI, d \in AA)$	$\text{f3\_roipowl}_{\text{Super,f,d}}$ $(f \in FI, d \in AA)$
(7)	$\text{f2\_roipowl}_{\text{Super,f}}$ $(f \in FI)$	$\text{d\_MTB}_{\text{Super,f}}$ $(f \in FI)$
(8)	$\text{f3\_roipowl}_{\text{Super,DeposLoans,d}}$ $(d \in AA)$	$\text{liab\_shift}_{\text{Super,DeposLoans,d}}$ $(d \in AA)$
(9)	$\text{d\_MTB}_{\text{Super,DeposLoans}}$	$\text{f2\_roipowl}_{\text{Super,DeposLoans}}$
(10)	apc_gnp	ff_apc_gnp

(11)	$f\_a\_t\_1_{Super,Equity,Hlds}$	d_super_sub
(12)	$f\_a\_t\_1_{Super,DeposLoans,Hlds}$	r_dep_equity
(13)	$f\_a\_t\_1_{s,f,Hlds}$ $(s \in LANSUPER, f \in FI)$	$f\_Super1_{s,f}$ $(s \in LANSUPER, f \in FI)$

With the closure swaps described in rows (2) and (3), the shift variables $liab\_sh\_d_{(Super,f)}$ and $liab\_shift_{(Super,f,d)}$ $(f \in FI)$ are determined exogenously under the "finance" closure, thereby activating those elements of E_a_t_1_d2 and E_a_t_1 relating to the superannuation sector. This establishes conventional liability optimising behaviour on the part of the superannuation sector.

At row (4), in moving from the "real" to the "financial" closure, we exogenously determine fd_super_assac and endogenously determine $d\_new\_assacq_{(Super)}$. This activates equation E_fd_super_assac, thereby ensuring that the superannuation sector acquires new assets in line with movements in the new liabilities that acquires with equation *E_sup_con_rate* active.

At row (5), under the "financial" closure, d_superprofit, the difference between the financial revenues and financial costs of the superannuation sector, is determined exogenously, and d_super_sub, a federal subsidy on post-tax superannuation returns is endogenous. At this point in the development of the closure of the superannuation sector, with d_superprofit exogenous and $roipowl_{(Super,f,d)}$ endogenous, the superannuation sector passes any movements in returns on its holdings of financial assets through to returns to holders of superannuation liabilities (i.e. largely households holding superannuation equity) via movements in $roipowl_{(Super,f,d)}$. The endogenous determination of d_super_sub allows the post-subsidy returns on offer by the superannuation sector to adjust to ensure that the holdings of superannuation liabilities implied by the exogenous status of sup_con_rate are consistent with the desired holdings by households of superannuation equity as determined by the household asset optimisation problem. This closure is consistent with the idea that the present apparent high levels of comfort that households seem to have with a superannuation system that imposes a certain level of non-discretionary savings (Connolly, 2007), mandates the flow of a significant proportion of discretionary and non-discretionary savings into a particular legal vehicle (superannuation), imposes significant access restrictions on assets within the vehicle, and is subject to long-term policy risk, is supported largely by generous federal taxation concessions. Note that rows (11)-(13) (discussed below) offer an alternative closure to the endogenous determination of d_super_sub.

Under the "financial" closure described in rows (6) – (9), the superannuation sector as a liability agent offers identical rates of return to all asset agents holdings its equity, but has the capacity to offer different rates of return to asset agents from which it accepts deposits or takes out loans.[4] Rows (6) and (7) begin by activating E_a_t_1_d and deactivating

[4] For superannuation, these closure swaps are not very important, because nearly all its liabilities are in the form of one instrument (equity) held by one agent (household). As discussed elsewhere in this paper, the matter of the

E_a_t_1_d2 for Superannuation, thereby establishing a situation in which the Superannuation sector does not distinguish between asset agents in its liability optimisation problem, ensuring that, via movements in $f2\_roipowl_{Super,f}$, all asset agents see the same movements in rates of return on instrument *f* offered by Superannuation. One element of this situation is then reversed in rows (8) and (9), deactivating *E_a_t_1_d2* and activating *E_a_t_1* for the financial instrument "Deposits and loans" issued by Superannuation as a liability, and thereby, via the endogenous determination of $f3\_roipowl_{Super,f,d}$, allowing for the possibility of Superannuation offering different asset agents different returns on deposits and loans.

The closure described at row (10) provides for changes in the superannuation contribution rate to affect household savings. There is evidence that compulsory superannuation has generated a net increase in household savings, with each $1 of additional superannuation contribution displacing perhaps $0.30 of other savings (Connolly, 2007). Equation *E_ff_apc_gnp* allows for this possibility, providing a mechanism for changes in the superannuation contribution rate to affect the savings rate (via movement in the average propensity to consume). Under the "real" CGE closure, apc_gnp is exogenous, with *E_ff_apc_gnp* inactive via endogenous determination of ff_apc_gnp. Activation of the "financial" closure requires the movement of ff_apc_gnp to the set of exogenous variables, and the movement of apc_gnp to the set of endogenous variables. This activates *E_ff_apc_gnp,* allowing movements in the superannuation contribution rate to have an effect on the aggregate savings rate

Rows (11) – (13) of Table 9 provide an alternative to the closure described at row (5). With the closure at row (5) in place under the "financial" closure, d_super_sub adjusts to ensure households accommodate independently determined movements in their superannuation holdings within the standard asset optimisation framework described by equation *E_a_t_1dom*. In contrast, under the "financial" closure described by rows (11) – (13), holdings of superannuation are removed from the household's asset optimisation problem. Under the "financial" closure, row (11) returns d_super_sub to the set of exogenous variables, and removes determination of household holdings of equity in Superannuation from the standard asset optimisation framework described by *E_a_t_1dom*. Row (12), under the "financial" closure, removes the remaining instrument issued by superannuation as a liability (deposits and loans) from the household's standard asset optimisation framework. With r_dep_equity exogenous, households hold the equity and debt issued by superannuation as liability instruments in fixed proportions (see equation *E_r_dep_equity*). Row (13) completes the deactivation of *E_a_t_1dom* for households. With Superannuation removed from the standard asset optimisation framework described by equation *E_a_t_1dom,* we must activate asset optimisation by households over the non-Superannuation component of their portfolios. This is implemented via the exogenous determination of f_Super1, which has the effect of activating equation *E_f_Super1*, which describes household asset optimisation over non-Superannuation assets.

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capacity to offer different returns on liability instruments across asset agents is of more specific importance to other financial agents.

To summarise, the effect of the "financial" closure described in rows (1) to (13) is to establish a situation in which:

(i) New liabilities of the superannuation sector move in line with changes in the economy-wide wagebill and the superannuation contribution rate;

(ii) New assets of the superannuation sector move in line with the new liabilities of the superannuation sector;

(iii) Movements in the returns that the superannuation sector receives on its holdings of financial assets are passed through to asset agents as movements in the returns on their holdings of superannuation liabilities.

(iv) The sector has the capacity to offer lending rates on deposits and loans that differ across asset agents.

(v) Households accommodate their new acquisitions of superannuation liabilities either through (a) movement in an endogenous government-funded return inducement; or (b) confinement of the household's asset optimisation problem to the non-superannuation component of their portfolios.

4.10 Closure rules for commercial banks

Table 10 describes the status of variables relevant to the financial behaviour of commercial banks under both the "real" and "financial" closures of the model. Under the "real" closure, in which the financial sector is inactive and the whole model operates as a traditional CGE model of the real side of the economy only, the variables in column (A) of Table 10 are exogenous, and the variables in column (B) are endogenous. To activate commercial bank behaviour under the "financial" closure, the variables in column (A) must be determined endogenously, and those in column (B) determined exogenously. We approach the development and exposition of the "financial" closure as it relates to commercial banks in a row-by-row fashion below.

Table 10: Closure rules relating to the activation of the financial behaviour of commercial banks

	(A) Exogenous under "real" closure, Endogenous under "financial" closure.	**(B) Endogenous under "real" closure, Exogenous under "financial" closure.**
(1)	$\text{d\_new\_assacq}_{(\text{Banks})}$	d_bankprofit
(2)	$\text{d\_new\_liaacq}_{(\text{Banks})}$	d_f_liaacq_bank
(3)	$\text{d\_mtb}_{(\text{Banks,f})}$ $(f \in \text{FI})$	$\text{liab\_sh\_d}_{(\text{Banks,f})}$ $(f \in \text{FI})$
(4)	$\text{roipowl}_{(\text{Banks,f,d})}$ $(f \in \text{FI}, d \in \text{AA})$	$\text{liab\_shift}_{(\text{Banks,f,d})}$ $(f \in \text{FI}, d \in \text{AA})$
(5)	$\text{liab\_sh\_d}_{(\text{Banks,Equity})}$	p_ratio_t1
(6)	$\text{liab\_sh\_d}_{(\text{Banks,f})}$ $(f \in \text{FINEQ})$	$\text{f\_bank\_eq}_{(f)}$ $(f \in \text{FINEQ})$

(7)	$f\_a\_t\_1_{(s,f,Banks)}$ ($s \in$ LANCB $f \in$ FI)	$f\_bankres1_{(s,f)}$ ($s \in$ LANCB $f \in$ FI)
(8)	$f\_a\_t\_1_{(s,f,Banks)}$ ($s \in$ CBSET $f \in$ NOTCASHDEP)	$f\_bankres2_{(s,f)}$ ($s \in$ CBSET $f \in$ NOTCASHDEP)
(9)	$f\_a\_t\_1_{(CB,DeposLoans,Banks)}$	$p\_resratio$
(10)	$f\_a\_t\_1_{(CB,Cash,Banks)}$	r_cash_cbdep
(11)	$liab\_shift_{Banks,f,d}$ ($f \in FI, d \in AA$)	$f3\_roipowl_{Banks,f,d}$ ($f \in FI, d \in AA$)
(12)	$f2\_roipowl_{Banks,f}$ ($f \in FI$)	$d\_MTB_{Banks,f}$ ($f \in FI$)
(13)	$f3\_roipowl_{Banks,DeposLoans,d}$ ($d \in AA$)	$liab\_shift_{Banks,DeposLoans,d}$ ($d \in AA$)
(14)	$d\_MTB_{Banks,DeposLoans}$	$f2\_roipowl_{Banks,DeposLoans}$

Beginning with rows (1) and (2), under the "financial" closure the endogenous status of $d\_new\_assacq_{(Banks)}$ and $d\_new\_liaacq_{(Banks)}$ is supported by the exogenous status of $d\_bankprofit$ and $d\_f\_liaacq\_bank$. With the latter two variables exogenous, equations *E_d_bankprofit* and *E_d_f_liaacq_bank* are active, thereby implementing a rule ensuring that banks expand asset acquisitions to the point where marginal revenue equals marginal cost (*E_d_bankprofit*), and a financial balance sheet constraint (*E_d_f_liaacq_bank*).

With the closure rules described in rows (3) and (4), the shift variables $liab\_sh\_d_{(Banks,f)}$ and $liab\_shift_{(Banks,f,d)}$ $(f \in FI)$ are determined exogenously under the "finance" closure, thereby activating those elements of equations *E_a_t_1_d2* and *E_a_t_1* relating to commercial banks. This establishes conventional optimising behaviour on the part of commercial banks as a liability agent.

Rows (5) and (6) provide for the possibility of bank equity requirements being determined by a capital adequacy rule. With p_ratio_t1 exogenous, equation E_p_ratio_t1 is activated, linking movements in bank equity requirements to movements in risk-weighted assets. With bank equity requirements now determined by E_p_ratio_t1, equation E_a_t_1_d2 can no longer determine bank equity, requiring that $liab\_sh\_d_{(Banks,Equity)}$ now be determined endogenously. But with E_a_t_1_d2 deactivated for one bank liability, it must be deactivated for all bank liabilities. Hence at row (6), optimisation over the non-equity component of bank liabilities is implemented via the exogenous status of $f\_bank\_eq_{(f)}$, thereby activating E_f_bank_eq. With E_f_bank_eq activated, the remaining (non-equity) components of E_a_t_1_d2 must be deactivated for banks, requiring that $liab\_sh\_d_{(Banks,f)}$ be determined endogenously.

The closure described by rows (7)-(10) deactivates, for commercial banks, the standard asset optimisation equations governing financial asset demand (*E_a_t_1dom*), establishing in their place the operation of equations *E_f_bankres1*, *E_f_bankres2*, *E_r_cash_cbdep*, *E_p_resratio*. With the latter four equations active, demand by commercial banks for reserve assets (cash and deposits with the central bank) are linked to deposits by households, while demand for non-reserve assets is determined by equations *E_f_bankres1* and *E_f_bankres2* as a function of aggregate non-reserve bank assets and relative rates of return across non-reserve assets.

Under the "financial" closure described by rows (1)-(4) instrument- and agent-specific markets for the liabilities of commercial banks clear via endogenous determination of instrument- and agent-specific rates of return on bank liabilities ($\text{roipowl}_{(\text{Banks,f,d})}$). This raises the possibility of different rates of return on the same type of bank liability held by different asset agents, when in reality a single market exists for the liability in question (e.g. bank equity). The adjustments to this standard closure described by rows (11)-(14) rectify this. Under the "financial" closure described in rows (11)-(14), the commercial bank sector offers identical rates of return to all asset agents holdings its liabilities, except in the case of deposits/loans, where it has the capacity to offer different rates of return to different asset agents. Rows (11) and (12) begin by activating E_a_t_1_d and deactivating E_a_t_1_d2 for the commercial bank sector, thereby establishing a situation in which the sector does not distinguish between asset agents in its liability optimisation problem, ensuring that, via movements in $\text{f2\_roipowl}_{\text{Banks,f}}$, all asset agents see the same movements in rates of return on instrument *f* offered by commercial banks. One element of this situation is then reversed in rows (9) and (10), deactivating *E_a_t_1_d2* and activating *E_a_t_1* for the financial instrument "Deposits and loans" issued by commercial banks as a liability, and thereby, via the endogenous determination of $\text{f3\_roipowl}_{\text{Banks,f,d}}$, allowing for the possibility of banks offering different asset agents different returns on deposits and loans.

4.11 Closure rules for life insurance and non-bank financial institutions

Table 11 describes the closure status of variables relevant to the financial behaviour of life insurance and non-bank financial institutions (NBFIs) under both the "real" and "financial" closures of the model. Under the "real" closure, in which the financial sector is inactive and the whole model operates as a traditional CGE model of the real side of the economy only, the variables in column (A) of Table 11 are exogenous, and the variables in column (B) are endogenous. To activate the financial behaviour of the life insurance and NBFI sectors under the "financial" closure, the variables in column (A) must be determined endogenously, and those in column (B) determined exogenously. We approach the development and exposition of the "financial" closure as it relates to life insurance and NBFIs in a row-by-row fashion below.

Table 11: Closure rules relating to the activation of the financial behaviour of life insurance and non-bank financial institutions

	(A) Exogenous under "real" closure, Endogenous under "financial" closure.	**(B) Endogenous under "real" closure, Exogenous under "financial" closure.**
(1)	$\text{d\_new\_assacq}_{(\text{LifeIns})}$	d_lifeprofit
(2)	$\text{d\_new\_assacq}_{(\text{NonBankFinIn})}$	d_nbfiprofit

(3)	$d\_new\_liaacq_{(LifeIns)}$	$d\_f\_liaacq\_life$
(4)	$d\_new\_liaacq_{(NonBankFinIn)}$	$d\_f\_liaacq\_nbfi$
(5)	$d\_mtb_{(LifeIns,f)}\ (f \in FI)$	$liab\_sh\_d_{(LifeIns,f)}\ (f \in FI)$
(6)	$d\_mtb_{(NonBankFinIn,f)}\ (f \in FI)$	$liab\_sh\_d_{(NonBankFinIn,f)}\ (f \in FI)$
(7)	$roipowl_{(LifeIns,f,d)}\ (f \in FI, d \in AA)$	$liab\_shift_{(LifeIns,f,d)}\ (f \in FI, d \in AA)$
(8)	$roipowl_{(NonBankFinIn,f,d)}\ (f \in FI, d \in AA)$	$liab\_shift_{(NonBankFinIn,f,d)}\ (f \in FI, d \in AA)$
(9)	$liab\_shift_{LifeIns,f,d}\ (f \in FI, d \in AA)$	$f3\_roipowl_{LifeIns,f,d}\ (f \in FI, d \in AA)$
(10)	$liab\_shift_{NonBankFinIn,f,d}\ (f \in FI, d \in AA)$	$f3\_roipowl_{NonBankFinIn,f,d}\ (f \in FI, d \in AA)$
(11)	$f2\_roipowl_{LifeIns,f}\ (f \in FI)$	$d\_MTB_{LifeIns,f}\ (f \in FI)$
(12)	$f2\_roipowl_{NonBankFinIn,f}\ (f \in FI)$	$d\_MTB_{NonBankFinIn,f}\ (f \in FI)$
(13)	$f3\_roipowl_{LifeIns,DeposLoans,d}\ (d \in AA)$	$liab\_shift_{LifeIns,DeposLoans,d}\ (d \in AA)$
(14)	$f3\_roipowl_{NonBankFinIn,DeposLoans,d}\ (d \in AA)$	$liab\_shift_{NonBankFinIn,DeposLoans,d}\ (d \in AA)$
(15)	$d\_MTB_{LifeIns,DeposLoans}$	$f2\_roipowl_{LifeIns,DeposLoans}$
(16)	$d\_MTB_{NonBankFinIn,DeposLoans}$	$f2\_roipowl_{NonBankFinIn,DeposLoans}$

Beginning with rows (1) - (4) of Table 11, under the “financial” closure the endogenous status of $d\_new\_assacq_{(LifeIns)}$, $d\_new\_assacq_{(NonBankFinIn)}$, $d\_new\_liaacq_{(LifeIns)}$, and $d\_new\_liaacq_{(NonBankFinIn)}$ is supported by the exogenous status of $d\_lifeprofit$, $d\_nbfiprofit$, $d\_f\_liaacq\_life$ and $d\_f\_liaacq\_nbfi$. With the latter four variables exogenous, equations *E_d_lifeprofit*, *E_d_nbfiprofit*, *E_f_liaacq_life* and *E_d_f_liaacq_nbfi* are active, thereby implementing: (i) rules ensuring that the life insurance and NBFI sectors expand asset acquisitions to the point where marginal revenue equals marginal cost (via *E_d_lifeprofit* and *E_d_nbfiprofit*), and (ii) financial balance sheet constraints (via *E_f_liaacq_life* and *E_d_f_liaacq_nbfi*).

With the closure rules described in rows (5) - (8), the shift variables $liab\_sh\_d_{(LifeIns,f)}$ $liab\_sh\_d_{(NonBankFinIn,f)}$ $liab\_shift_{(LifeIns,f,d)}$ $liab\_shift_{(NonBankFinIn,f,d)}$ are determined exogenously under the “finance” closure, thereby activating those elements of equations *E_a_t_1_d2* and *E_a_t_1* relating to life insurance and NBFIs. This establishes conventional optimising behaviour on the part of life insurance and NBFIs as liability agents.

Under the “financial” closure described by rows (5)-(8) instrument- and agent-specific markets for the liabilities of life insurance and NBFIs clear via endogenous determination of instrument- and agent-specific rates of return life insurance and NBFI liabilities ($roipowl_{(LifeIns,f,d)}$ and $roipowl_{(NonBankFinIn,f,d)}$). This raises the possibility of different rates of return on the same type of life insurance or NBFI liability held by different asset agents, when in reality a single market exists for the liability in question (e.g. equity). The adjustments to this standard closure described by rows (9)-(16) rectify this. Under the "financial" closure described in rows (9)-(16), the life insurance and NBFI sectors offer identical rates of return to all asset agents holdings their liabilities, except in the case of deposits/loans, where they have the capacity to offer different rates of return to different asset agents. Rows (9) - (12) begin by activating E_a_t_1_d and deactivating E_a_t_1_d2 for the life insurance and NBFI sectors, thereby establishing a situation in which these sectors do not distinguish between asset agents in their liability optimisation problems, ensuring that, via movements in $f2\_roipowl_{LifeIns,f}$ and $f2\_roipowl_{NonBankFinIn,f}$, all asset agents see the same movements in rates of return on instrument *f* offered by life insurance or NBFIs. One element of this situation is then reversed in rows (13) - (16), deactivating *E_a_t_1_d2* and activating *E_a_t_1* for the financial instrument "Deposits and loans" issued by life insurance and NBFIs as a liability, and thereby, via the endogenous determination of $f3\_roipowl_{LifeIns,DeposLoans,d}$ and $f3\_roipowl_{NonBankFinIn,DeposLoans,d}$, allowing for the possibility of life insurance and NBFIs offering different asset agents different returns on deposits and loans.

5 Simulation: exploring the consequences of expansion of the superannuation sector

5.1 Introduction

We examine the economic effects of the superannuation sector by examining the consequences of a one percentage point increase in the proportion of the national wage bill allocated to superannuation. This can be interpreted as describing the effects of an increase in the compulsory superannuation contribution rate. We undertake the simulation under two assumptions. First, we assume that the household savings rate is unaffected by the shock. Then, following the findings of Connolly (2007), we recognise that an increase in compulsory allocation to superannuation can generate a net increase in national savings.

An increase in the superannuation contribution rate under an unchanged household savings rateFigure 3 describes our shock: a 0.01 increase in the ratio of new liabilities acquired by the superannuation sector to the national wage bill. As discussed in Section 5.1, in our first simulation we assume that the household savings rate is unaffected by this shock. Hence, the shock has the effect of increasing the proportion of the household savings stream diverted into the superannuation sector while largely leaving the size of the household savings stream unchanged. With the household savings rate unchanged, this has the effect of decreasing the share of the household's portfolio (directly) allocated to liabilities issued by non-superannuation agents (Figure 4). However, the final impact on the demand for the liabilities of non-superannuation agents depends on the liability acquisition behaviour of the superannuation sector. That is, there is the potential for change to the composition of the economy-wide pattern of liability acquisition when decision making over the allocation of a dollar's worth of household savings is taken from the hands of the household sector directly, and placed in the hands of intermediaries like the superannuation sector or indeed the financial sector more generally. Table 13 sheds some light on this. Table 13 uses the same data as Table 12, but consolidates the financial sector and the housing sector. Examining column (5), we see that the household sector allocates approximately 54% of its portfolio on a direct basis, that is, directly holding the liabilities of foreigners, government, industries and the housing sector. The remaining 46% of the household's portfolio is allocated on an indirect basis, with the household relying on the intermediation services of the finance sector.

If we exclude funds managed on behalf of households by the finance sector, in column (5) of Table 13 we see households directly purchase the liabilities of non-financial liability agents in the proportions: foreign (4%), government (13%), industries (21%) and housing (63%). Compared with the consolidated finance sector (column 1), this reveals a relatively high propensity on the part of households to invest in housing (63% v 43%) and government securities (13% v 5%), and a relatively low propensity to invest offshore (4% v 20%) and in domestic industry (21% v 32%). Hence, relative to baseline, the increase in contributions to superannuation have the effect of decreasing the proportion of household savings directed to the purchase of government bonds and housing equity, and increasing the proportion of household savings directed to the purchase of securities issued by domestic industry and the purchase of foreign securities. As we shall see, it is the latter, the increase in demand for foreign securities, that proves important in understanding the initial macroeconomic consequences of the policy change.

Figure 5 reports outcomes for the nominal exchange rate, and two price indices: the GDP deflator, and the private consumption deflator. We begin by noting the sharp depreciation in the nominal exchange rate. This is a result of the superannuation sector's high propensity to invest offshore, relative to the household sector (see Table 13). As a first approximation, the policy can be expected to have little effect on the current account deficit, because it has little effect on GNE relative to GDP. We see this confirmed in Figure 8, which reports the ratio of the current account deficit to GDP. The current account deficit must be financed by net acquisitions by foreigners of domestic assets. With little impetus for the shock to change the current account deficit, there must be little impetus for change in net acquisitions by foreigners of domestic assets. However, the reallocation of savings towards superannuation has the effect of increasing domestic demand in $A terms for foreign assets. Hence, we require a matching rise in foreign demand for domestic assets in $A terms. The mechanism that achieves this is nominal depreciation. By reducing the value, in foreign currency terms, of holdings of domestic assets by foreigners, nominal depreciation creates something akin to a rebalancing demand for domestic assets. More formally, this result can be understood in terms of the joint effect of equations E_a_t_1f, E_d_flow, E_d_shift4, E_d_ff_phi. The starting point is E_d_ff_phi. With little change in d_CAD, and with $\sum_{d \in AA} \sum_{j \in FI} \text{d\_flow}_{(\text{Foreigners,j, d})}$ rising because of the shift in the composition of household savings towards superannuation, $\text{d\_new\_assacq}_{(\text{Foreigners})}$ must rise. Via E_d_shift4, we see that this must generate an increase in the value of $\sum_j \sum_f \text{d\_flow}_{(\text{j,f,Foreign})}$. Turning to E_d_flowd, with $\text{a\_t}_{(\text{s,f,d})}$ tied down by E_a_t, and with $\text{v}_{(\text{s,f,d})}$ exogenous, we see that an increase in the value of

$\sum_j \sum_f \text{d\_flow}_{(j,f,Foreign)}$ requires an increase in the value of

$\sum_{s \in LA} \sum_{f \in FI} [\text{AT1}_{(s,f,Foreigners)}] \cdot \text{a\_t\_1}_{(s,f,Foreigners)}$. Turning to E_a_t_1f, with big_budf and ave_ror_row exogenous, and with $\text{roipowa}_{(s,j,Foreigners)}$ largely tied down by the demand/supply equilibrium in domestic financial markets and the exogeneity of ave_ror_row, the positive deviation in the weighted average of $\text{a\_t\_1}_{(s,f,Foreigners)}$ requires a negative deviation in phi, that is, a nominal depreciation.

Returning to Figure 5, we see that the negative deviation in the nominal exchange rate is correlated with positive deviations in the GDP deflator and the consumption price deflator. Nominal depreciation causes domestic prices to rise for two reasons: first, it causes the prices of imports in local currency terms to rise; second, it causes demand to rise for import competing and export commodities.

As explained in Section 3.22, our wage determination process is described by equations E_fp1lab_oi4 and E_d_f_w_pow. These two equations establish a regime in which wages are initially sticky, but adjust gradually to return the employment rate to its natural level. Figure 6 describes key labour market variables. We begin by noting that in the simulation's first year, with the nominal wage sticky, but the price level rising relative to baseline (Figure 5), the real producer wage must fall (Figure 6). With the capital stock sticky in the short-run (Figure 7), the negative deviation in the real producer wage causes employment to rise relative to baseline (Figure 6). With the population level unaffected by the shock, the positive deviation in employment is generated by a positive deviation in the employment rate. Via E_fp1lab_oi4 and E_d_f_w_pow, this generates a growing positive deviation in the wage rate, until such time as the employment rate has returned to its baseline level (Figure 6).

Figure 9 and Figure 10 describe outcomes relevant to capital formation. The short-run positive deviation in employment, with the capital stock sticky, generates a positive deviation in the labour/capital ratio. This generates a short-run positive deviation in the return on physical capital. This is reflected in Figure 9 by a positive deviation in the average rental price of capital that exceeds, in the short-run, the positive deviation in the average cost of physical capital (i.e. the investment price deflator). In terms of the mechanisms described in Section 3.16 in reference to Figure 1**,** this represents a short-run positive deviation in $ROR_{(i)}$, shifting the KK schedule upwards, and generating a higher rate of capital accumulation for any given level of the weighted average cost of capital. This accounts for much of the short-run positive deviation in real investment (Figure 11). However, the shock also affects the cost of financial capital for industry and reproducible housing (Figure 10). In the short-run, the positive deviation in investment (Figure 11) carries with it a short-run increase in demand for financial capital by industry to finance physical capital construction. To attract these funds, industry offers a higher rate of return on its liabilities relative to baseline (Figure 10). The process of physical capital accumulation gradually generates a convergence of the deviations in the rental price and construction cost of capital (Figure 9), damping the investment deviation (Figure 11), and with it the demand for financial capital to finance investment. This accounts for the initial peak and then decline in the cost of financial capital to industry

(Figure 10). However we see in Figure 10 a continuation in the decline in the cost of financial capital to industry from 2017 onwards. This reflects the shift in the structure of funds supply arising from the reallocation of savings from the household sector to the financial sector. Returning to Table 12 and Table 13, we see that Superannuation specifically (Table 12), and the finance sector more generally (Table 13), have higher propensities to purchase the liabilities of industry than does the household sector directly. Following the initial investment-led spike in required returns on industry liabilities, this supply effect has the effect of depressing the return on the liabilities of industry (Figure 10). Note however that this effect is not large: ten years after the shock, the deviation in the weighted average cost of capital to industry is -0.0001, a one basis point fall.[5]

Figure 7 reports outcomes for employment, physical capital, and real GDP. The policy generates a short-run positive deviation in real GDP, in large part because the shock generates a short-run positive deviation in employment (Figure 6). In the medium to long-run, the policy generates a small positive deviation in the capital stock (Figure 7). As discussed in reference to Figure 9 and Figure 10, this is due to the initial positive deviation in the rate of return on physical capital (Figure 9) and the longer-run fall in the cost of capital to industry (Figure 10). However, with employment gradually returning to baseline, and with the capital stock deviation relatively small, real GDP returns close to baseline approximately five years after the initial shock (Figure 7).

5.2 An increase in the superannuation contribution rate together with a rise in the household savings rate

There is evidence that compulsory superannuation has generated a net increase in household savings, with each $1 of additional superannuation contribution displacing perhaps $0.30 of other savings (Connolly, 2007). While there will be a subset of households with savings rates in excess of those implied by the superannuation contribution rate alone, and thus for whom a rise in the contribution rate might simply displace discretionary savings, as Gruen & Soding (2011) argue, for other households, particularly those characterised by certain behavioural biases, myopia, or a simple inability to do the financial mathematics required to solve for the personal savings rate implied by their retirement income target, a rise in the contribution rate may well generate a rise in household savings. In Section 0 we explored the effects of a rise in the contribution rate under an assumption that of an unchanged household savings rate. We now explore the effects of a rise in the savings rate generated by a rise in the contribution rate. We calibrate the rise in the savings rate on the 70/30 ratio of new/displaced savings of Connolly (2007). As discussed in Section 3.18, this is implemented via Equation *E_ff_apc_gnp*.

[5] For example, a WACC of 8% is represented in the model as 0.08. Hence a change in WACC of -0.0001 describes a one basis point fall.

5.2.1 The effects of a rise in the household savings rate alone

In this section, we discuss the effect of the rise in the household savings rate generated by the increase in the superannuation contribution rate. In the first instance, we separate this from the effects of a rise in fund flows to the superannuation sector (discussed in Section 0 above). Equation *E_ff_apc_gnp* suggests that a one percentage point rise in the superannuation contribution rate (d_sup_con_rate = 0.01) will generate a fall in the average propensity to consume of approximately -0.69 per cent.[6] Hence, we simulate a once-off fall in apc_gnp of -0.69, with d_sup_con_rate unchanged. In **Section 4.3.2**, we investigate the joint effect of the change in fund flows to superannuation and the change in the propensity to consume.

We begin with Figure 12, which reports the shock: a -0.69 per cent deviation in the average propensity to consume (defined here as the ratio of nominal private consumption to nominal GNP). We see the immediate impact of this in Figure 13, with a sharp negative deviation in real consumption in the simulation's first year. The initial deviation in real consumption (-0.8 per cent) is greater than the fall in the propensity to consume (-0.69 per cent) because the shock generates a short-run negative deviation in real GDP (-0.3 per cent, see Figure 13). Turning to Figure 14, we see that the source of the initial fall in real GDP relative to baseline is a negative deviation in employment.

The proximate cause of the short-run negative deviation in employment can be seen in Figure 15, where we see a positive deviation in the real producer wage in the first years of the simulation period. This is caused by a negative deviation in the terms of trade in the presence of short-run nominal wage stickiness. As discussed in Section 3.22, we model nominal wages as sticky in the short-run, responding gradually to movements in the unemployment rate away from its natural rate. In Figure 15, we see short-run nominal wage stickiness expressed as zero deviation in the nominal wage in the simulation's first year, followed by a gradually growing negative deviation to 2016. With the nominal wage sticky, and the terms of trade declining relative to baseline (Figure 16), the real producer wage experiences a sharp positive deviation in the first years of the simulation period (Figure 15), causing a fall in employment relative to baseline (Figure 15).

Returning to Figure 14, we see that real GDP lies below baseline over the first three years of the simulation period. We see in Figure 14 that this is due to the negative deviation in employment, since the capital stock lies on or above its baseline value over the same period. Because the labour / capital ratio lies below baseline over the simulation's first three years, we expect the marginal product of capital to also be below baseline over this period, and with it, the rate of return on physical capital. We see this expressed in Figure 17, where we see an initial sharp deviation in the average rental price of capital, with it falling well below the deviation in the investment price deflator in the simulation's first year. This signals an initial negative deviation in the rate of return on physical capital. This explains why, in Figure 13, we see a negative deviation in investment in the simulation's first year. However thereafter, the investment deviation turns positive. Part of the explanation for the turnaround in the investment deviation is the path of gradual recovery in the labour market (Figure 15).

[6] Using database values for SCROWD (=0.30) and the wage bill / consumption ratio (=0.99).

However the main story is the reduction in the weighted average cost of capital caused by the increase in savings (Figure 18). We look at each factor (employment recovery, and cost of capital) in turn.

Following an initial negative deviation over the simulation's first two years, we see a recovery of employment back to baseline from 2015 onwards. As described in Section 3.22, wage adjustment is the main mechanism responsible for the gradual return of employment towards baseline. The negative nominal wage deviation grows steadily over the early years of the simulation period, gradually attenuating the initial spike in the real producer wage, and thus steadily returning employment back towards baseline. The steady return of employment back to baseline allows the capital / labour ratio, which initially falls below baseline, to also gradually return to baseline by year 3 (Figure 14). It is this initial path of trough and recovery in the labour / capital ratio which accounts for the pattern of trough and partial recovery in the average capital rental rate (and with it, rate of return on capital) apparent over the first four years of the simulation (Figure 17). The short-run path of trough and recovery in the labour / capital ratio (Figure 15), and with it the rate of return on capital (Figure 17) accounts for the initial short-run path of negative deviation and then recovery of real investment (Figure 13). However thereafter, a second factor, namely the impact of the higher savings rate on the cost of financial capital, begins to exert a more important influence on the real investment deviation.

Figure 19 reports the change in the weighted average cost of capital for the two financial agents responsible for raising funds to finance physical capital accumulation. In the simulation's first year, the weighted average cost of capital of both sectors falls by approximately 0.0006 (six basis points) relative to baseline. By the end of the simulation period, the weighted average cost of capital for industries is approximately 8 basis points below baseline, while that for reproducible housing is approximately 10 basis points below baseline. The fall in the weighted average cost of capital is due to the rise in the savings rate. The increase in the savings rate raises demand by asset agents for financial instruments, allowing liability agents to raise a given amount of financial capital at lower rates of return. The deviation in the weighted average cost of capital for reproducible housing lies below that for industries because the rise in the savings rate damps private consumption spending relative to baseline (Figure 13). The negative deviation in private consumption spending reduces demand for dwelling services relative to baseline, thereby reducing housing rental rates, and damping housing investment relative to non-housing investment (Figure 20). Relative to the non-housing sector, this reduces demand by the housing sector for financial capital to fund physical capital formation, thus reducing rates of return on the liabilities of the reproducible housing sector relative to that of industries (Figure 19).

As discussed in Section 3.16, a decline in the weighted average cost of capital (for any given rate of return on physical capital) causes a rise in the capital growth rate, and with it, a rise in real investment. Hence, we expect the negative deviation in the weighted average cost of capital described in Figure 19 to exert a positive influence on the real investment deviation. This is confirmed in Figure 13, where, after the initial unemployment-induced slump in real investment, we see a strong positive deviation in real investment over the remainder of the simulation period. This accounts for the growing deviation in physical capital reported in Figure 14. It is this growth in the physical capital stock that accounts for the non-convergence after 2016 of the deviations in the average capital rental rate and investment price deflators (Figure 17). That is, the growth in the physical capital stock generates a permanent reduction in the average rate of return on physical capital. Put another way, the negative deviation in the weighted average cost of financial capital is eventually expressed, via physical capital accumulation, in a reduction in the average rate of return on physical capital.

The positive deviation in the capital stock generates a positive deviation in real GDP. We see this in Figure 14, where, with employment tending back towards baseline from 2015 onwards, it is the positive deviation in the capital stock that accounts for the positive deviation in real GDP after the initial unemployment-induced negative GDP deviation. With employment returning to baseline in Figure 14, but a growing capital deviation, we find the deviation in the capital / labour ratio growing over time. This raises the marginal physical product of capital, and, ceteris paribus, buoys the real wage deviation (Figure 15). This accounts for the positive deviation in the real wage in Figure 15 in the latter part of the simulation period, even after the employment deviation has returned to close to its baseline level.

We turn now to examine the real and nominal exchange rate movements caused by the rise in the national savings rate. Figure 21 reports movements in the nominal exchange rate, and two domestic price deflators. It is clear that the positive deviation in the savings rate induces a positive deviation in the nominal exchange rate and a negative deviation in the domestic price level. The absolute value of the negative deviation in the domestic price level exceeds the size of the nominal appreciation, indicating that the real exchange rate has depreciated relative to baseline. To understand the movement in nominal and real exchange rates, we begin with Figure 13, where, as discussed above, we see that the rise in the savings rate, by damping private consumption, causes the real GNE deviation to lie below the real GDP deviation. This requires the real balance of trade to move towards surplus (Figure 16). A movement towards surplus in the balance of trade requires domestic prices to fall relative to foreign prices in common currency terms, that is, it requires real depreciation (Figure 21).

The movement towards surplus in the balance of trade also moves the current account balance towards surplus (Figure 22). This lowers the Australian economy's foreign capital requirements. The fall in domestic rates of return (Figure 19) makes some contribution to lowering foreign willingness to supply financial capital to Australia, but not enough to match the fall in foreign financing requirements implied by the movement towards current account surplus. Further inducement to foreign agents to reduce their $A demand for financial assets is supplied by nominal appreciation (Figure 21). By increasing the value, in foreign currency terms, of holdings of domestic assets by foreigners, nominal appreciation reduces the $A demand for financial assets by foreigners, at any given level of domestic and foreign rates of return (via Equation E_a_t_1f).

5.2.2 The joint effect of a rise in the household savings rate and an increase in the superannuation contribution rate

Figure 34 describe the combined effects on selected variables of the rise in the household savings rate and the rise in the intermediation of household savings via the superannuation sector. In each case, the joint effect is presented together with a decomposition of the individual contributions made by the two sub-shocks: the rise in the savings rate, and the rise in the share of household savings intermediated by the superannuation sector. The figures are generated by undertaking three simulations:

(i) One in which only the savings rate rises (the "Savings effect"). This is the simulation discussed in Section 5.2.1.

(ii) One in which only the share of household savings flowing to superannuation rises (the "Intermediation effect"). This is the simulation discussed in Section 0.

(iii) One in which both the savings rate and the share of household savings flowing to superannuation rises (the "Joint effect").

Because the model is non-linear, the sum of (i) and (ii) need not equal (iii). The difference is reported in Figure 34 as "Residual". In each figure, the value of this decomposition residual is small. As such, the effects of a rise in the superannuation contribution rate can be readily understood as the sum of the individual contributions made by the "Savings effect" and the "Intermediation effect" (that is, as the sum of the effects described individually in Sections 0 and 5.2.1 above). As we shall see, for most real variables, the "Savings effect" makes the dominant contribution. For two important nominal variables: the nominal exchange rate (Figure 23), and the GDP deflator (Figure 24) the Savings and Intermediation effects make countervailing contributions of similar magnitude, albeit with an overall net movement towards real depreciation.

As discussed in Section 5.2.1, the Savings effect creates pressure for nominal appreciation (Figure 23) via a need to attenuate foreign capital inflow in an environment in which higher domestic savings induced by the Savings effect reduces our call on foreign savings (Figure 25). By damping the prices of traded goods relative to baseline, the nominal appreciation induced by the Savings effect generates a negative deviation in the GDP deflator (Figure 24).

As discussed in Section 0, the Intermediation effect creates pressure for nominal depreciation (Figure 23), via a need to encourage foreign capital inflow to match the rise in Australian demand for foreign financial assets in an environment in which there is little direct pressure for the current account deficit to change via the Intermediation effect alone (Figure 25). By raising traded goods prices relative to baseline, the nominal depreciation induced by the Intermediation effect generates a positive deviation in the GDP deflator (Figure 24).

In terms of their impacts on the nominal exchange rate, the Savings and Intermediation effects are nearly offsetting, leaving only a small tendency towards nominal depreciation, of the order of approximately -0.05 per cent on average (Figure 23). However, for the GDP deflator, the Savings effect dominates, generating a net negative deviation in the GDP deflator of the order of -0.25 per cent on average (Figure 24). This leaves a clear tendency towards net negative deviation in the real exchange rate, with the Savings effect the dominant contributor (Figure 26). The need for real exchange rate depreciation is clear from Figure 27 , where we see a net movement towards surplus in the ratio of the balance of trade to GDP, with the Savings effect again the dominant contributor. The proximate cause of the movement towards balance of trade surplus is apparent in Figure 28, which reports the decomposition in the real GNE deviation, together with, for reference, the joint result for the real GDP deviation. Figure 28 makes clear that the Savings effect creates pressure for a negative deviation in real GNE. While apparent already in the negative deviation in the ratio of the balance of trade to GDP, Figure 28 also makes clear that the real GNE deviation lies below the real GDP deviation, signalling a movement towards surplus in the real balance of trade. Figure 29 presents the real GDP decomposition. In the first two years of the simulation period, the real GDP deviation is negative, the net result of a positive contribution via the Intermediation effect, and a negative contribution via the Savings effect. Thereafter, the contribution of the Savings effect comes to dominate that of the Intermediation effect, with a net positive outcome to real GDP. To better understand the outcome for real GDP, we turn to the decomposition graphs for the outcomes for factor supply: Figure 30 (employment) and Figure 31(physical capital).

As discussed in Section 3.22, our characterisation of the labour market is one in which nominal wages are sticky in the short-run, but sufficiently flexible in the medium to long-run to return the employment rate to its natural level. This accounts for the deviation path for employment in Figure 30, where we see employment deviating from baseline in the first years of the simulation, but thereafter gradually returning to baseline. As discussed in Section 0, the Intermediation effect, by generating a positive deviation in the GDP deflator via nominal depreciation, creates a short-run negative deviation in the real producer wage. This accounts for the short-run positive contribution to employment by the Intermediation effect in Figure 30. However the Savings effect makes a negative contribution to the employment deviation in the short-run. By creating short-run pressure for a negative deviation in the GDP deflator (Figure 24), with nominal wages sticky in the short-run, the Savings effect generates a short-run negative contribution to employment (Figure 30). In the simulation's first two years, this more than offsets the positive contribution to the employment deviation made by the Intermediation effect. Thereafter, real wage adjustment gradually returns the employment deviation to baseline.

Despite the gradual return of employment to baseline, the real GDP deviation grows in the latter years of the simulation (Figure 29). This is due to the growing deviation in the capital stock (Figure 31). While both the Intermediation and Savings effects make positive contributions to the capital stock deviation, it is clear from Figure 31 that Savings effect is by far the largest contributor. This is consistent with Figure 32, which shows that much of the positive deviation in real investment is due to the Savings effect. The Savings investment raises real investment relative to baseline because it lowers the weighted average cost of capital relative to baseline. As discussed in Section 5.2.1, the Savings effect generates a positive deviation in the demand for the liabilities issued by industry and reproducible housing, causing a negative deviation in the weighted average cost of capital of these agents (Figure 33, Figure 34).

Figure 1: The relationship between capital growth rates and expected rates of return.

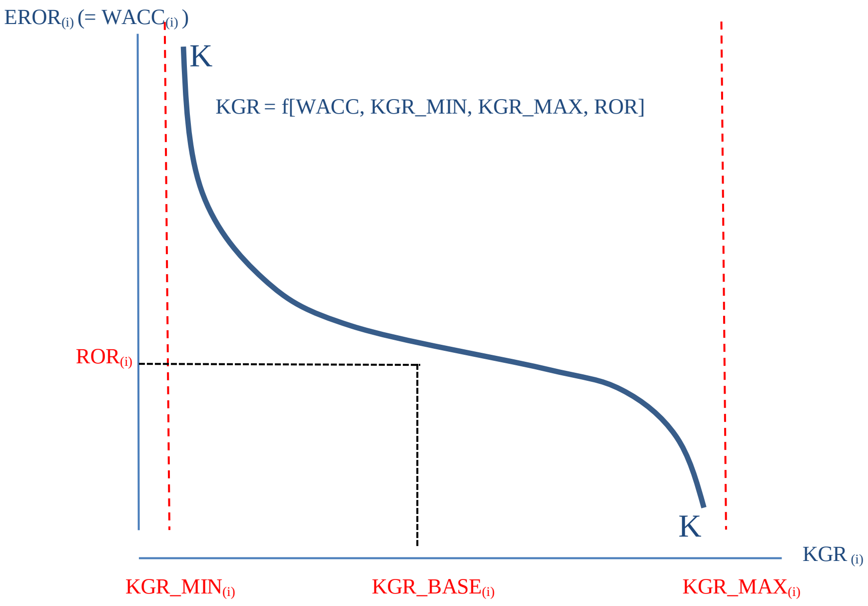

Figure 2: Asymmetric wage adjustment

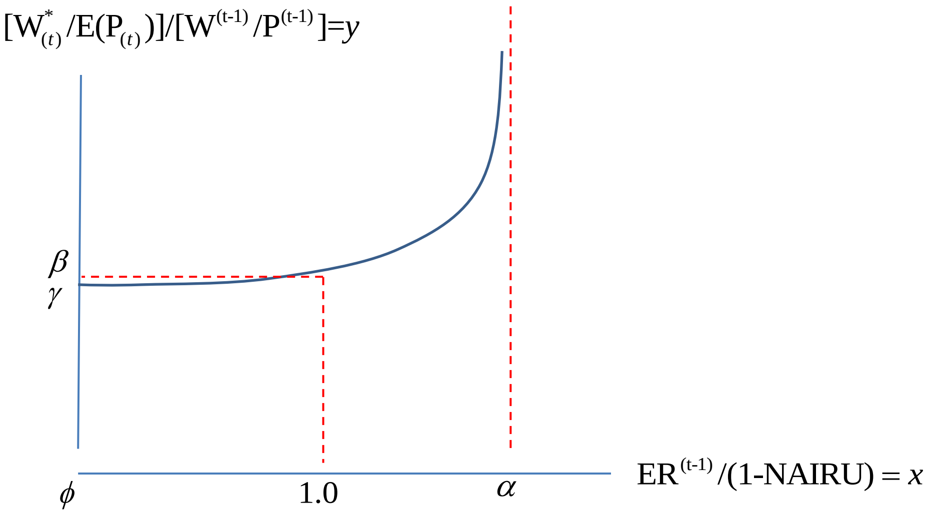

Figure 3: Ratio of superannuation contributions to national wage bill (change from baseline)

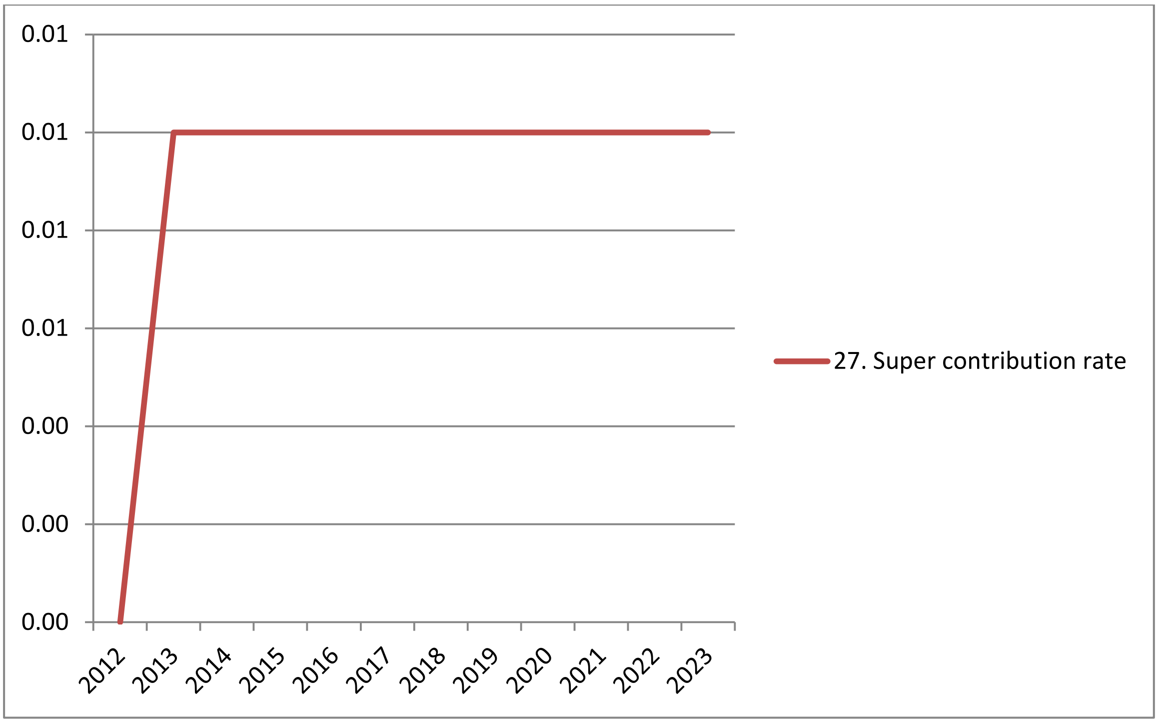

Figure 4: Household portfolio shares (by liability agent) (% deviation from baseline)

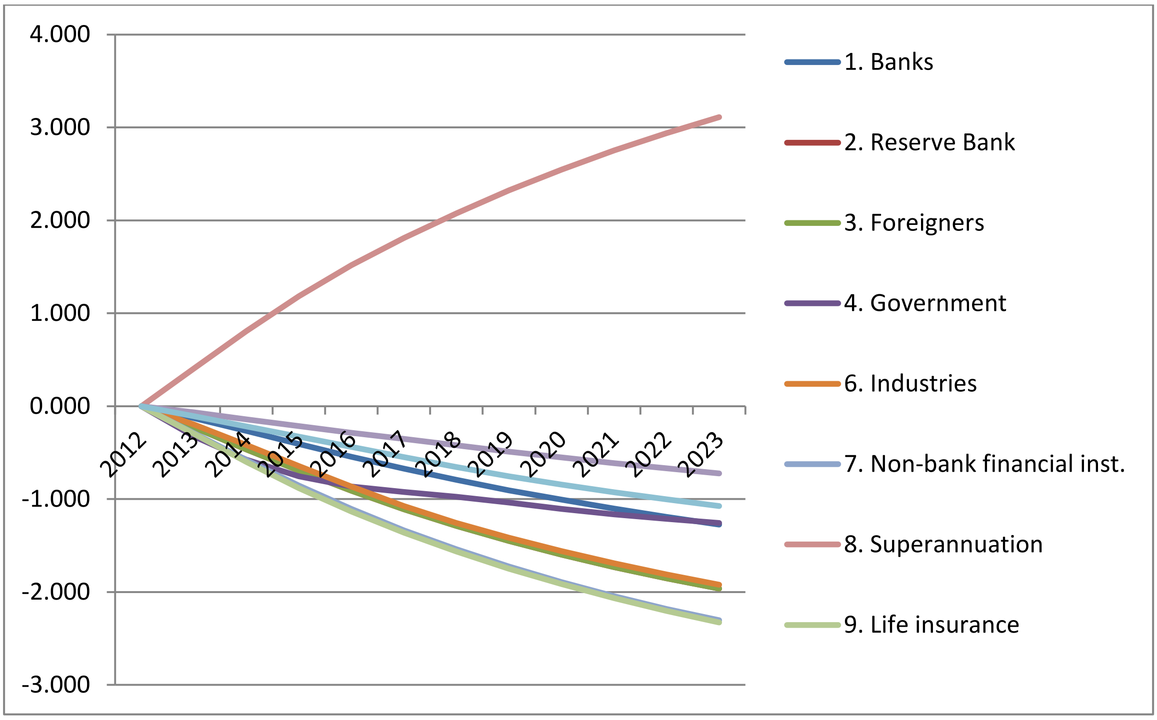

Figure 5: Nominal exchange rate, GDP deflator, CPI (% deviation from baseline)

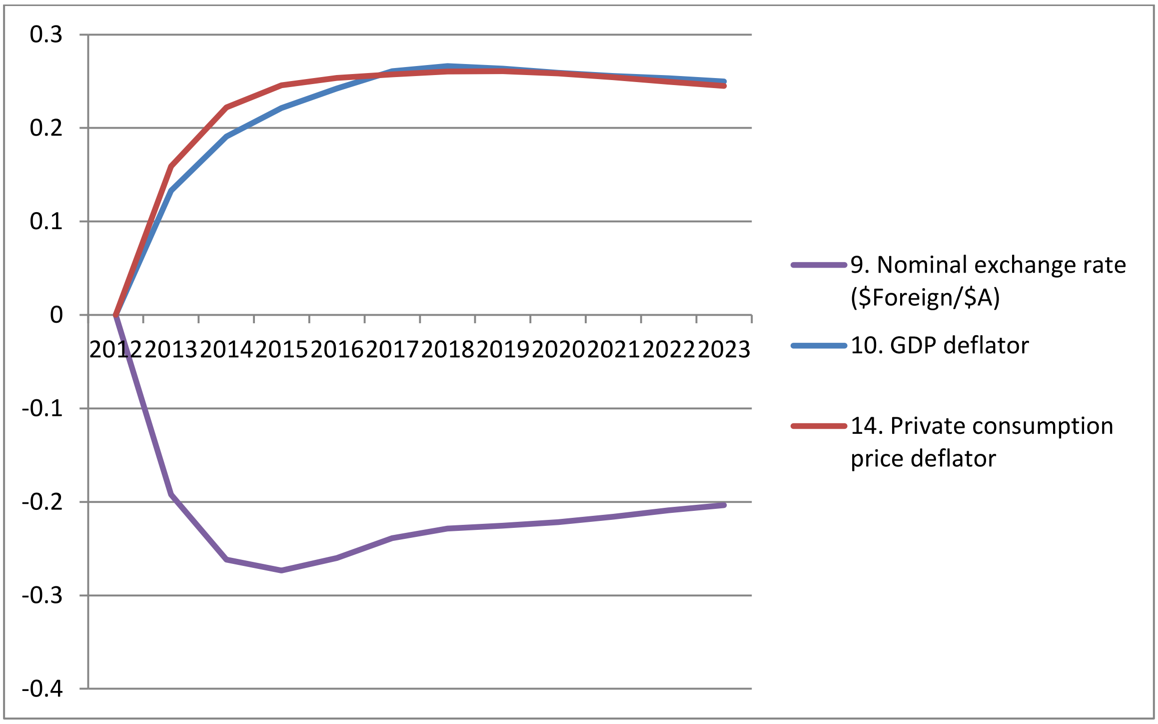

Figure 6: Employment, nominal wage, real wage (% deviation from baseline)

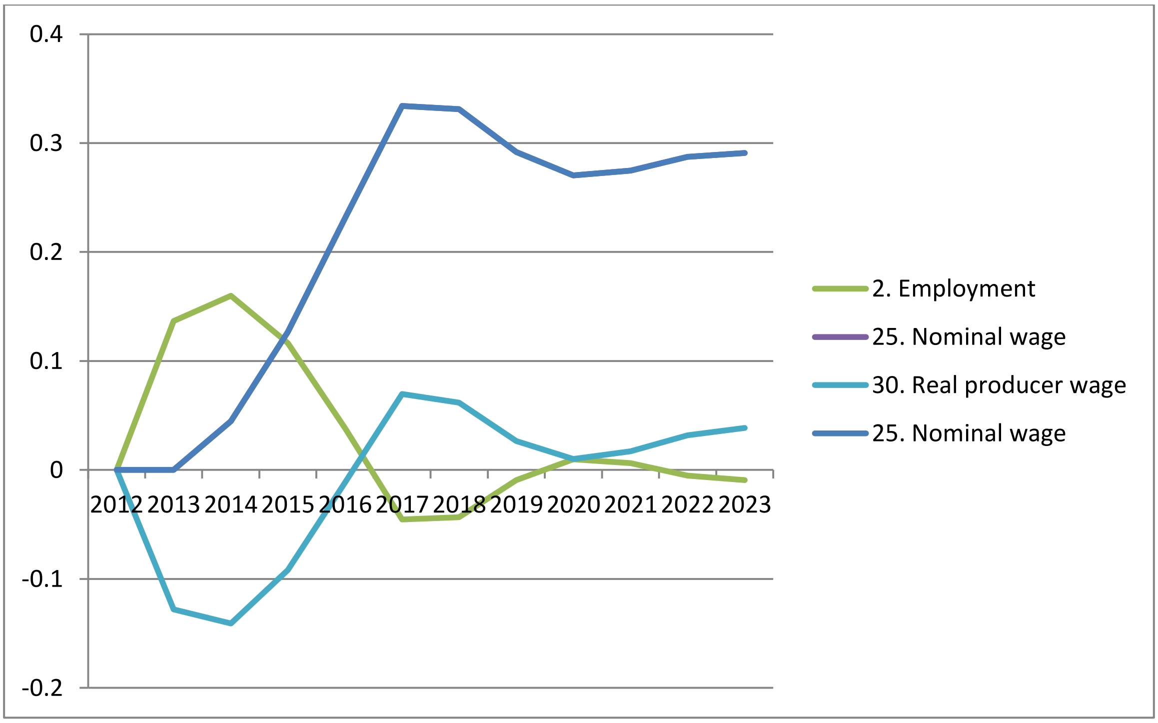

Figure 7: Employment, capital stock, real GDP (% deviation from baseline)

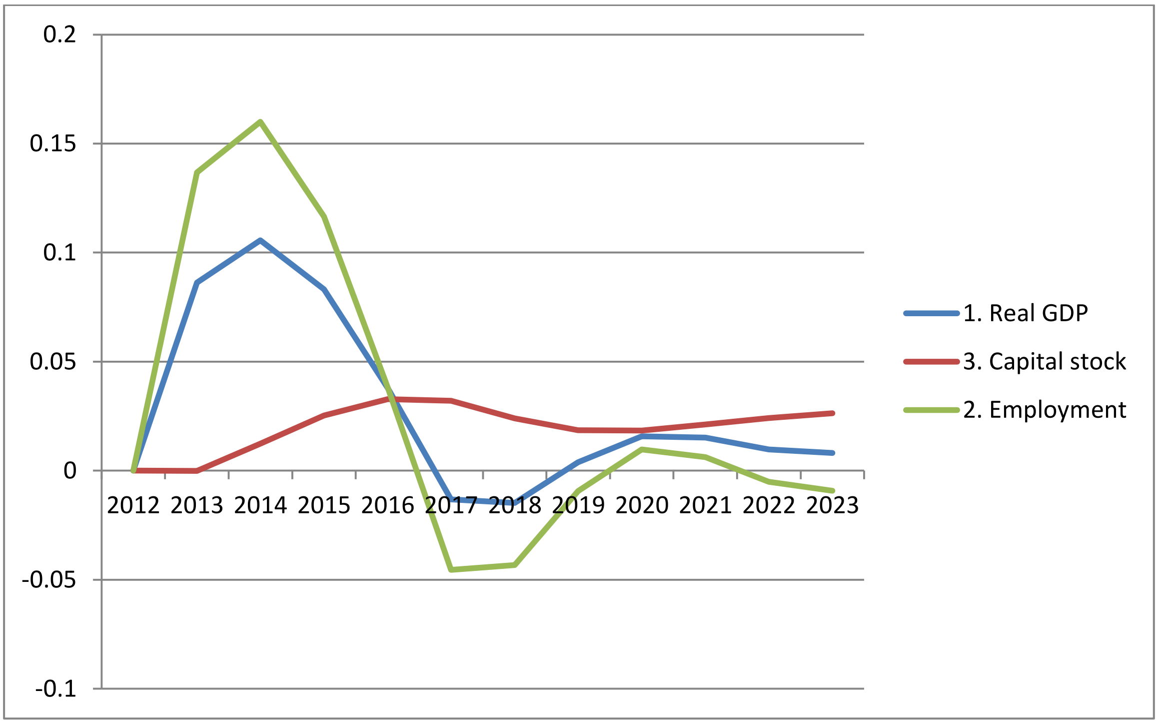

Figure 8: Ratio of the current account deficit to GDP (change from baseline)

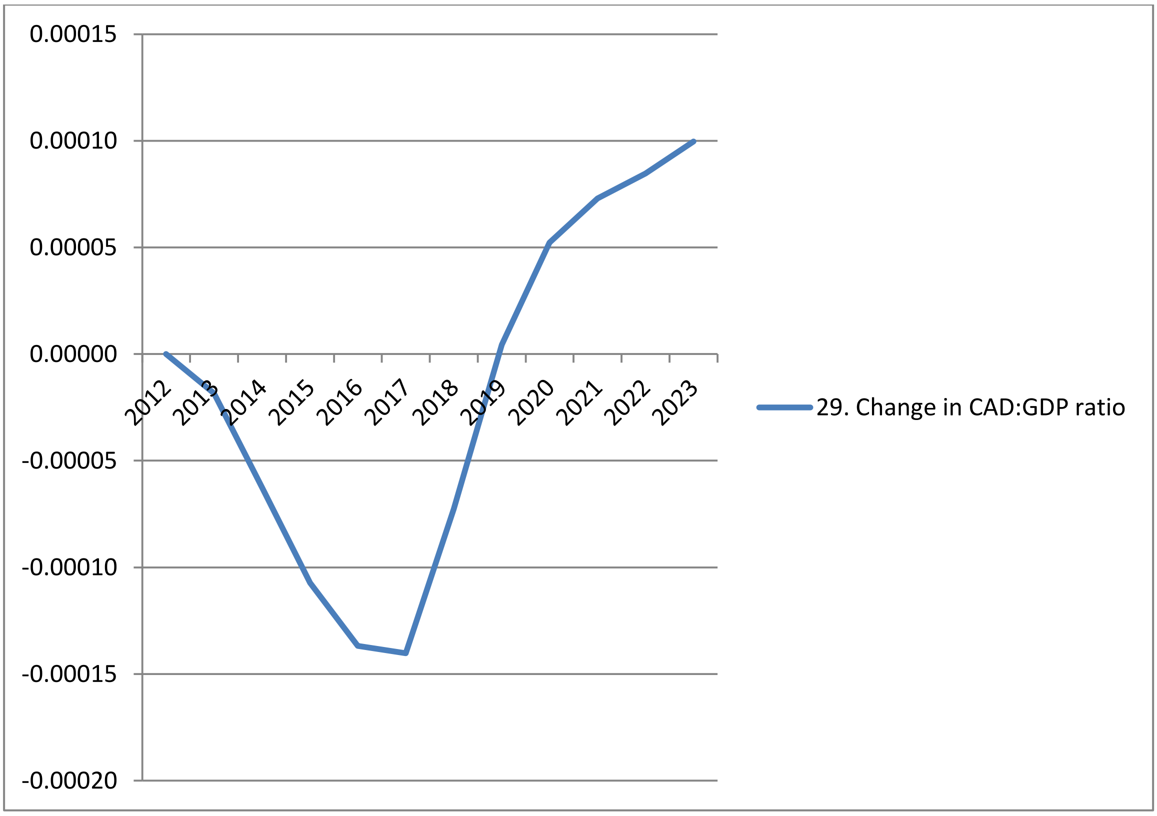

Figure 9: Average capital rental price and investment price deflator (% deviation from baseline)

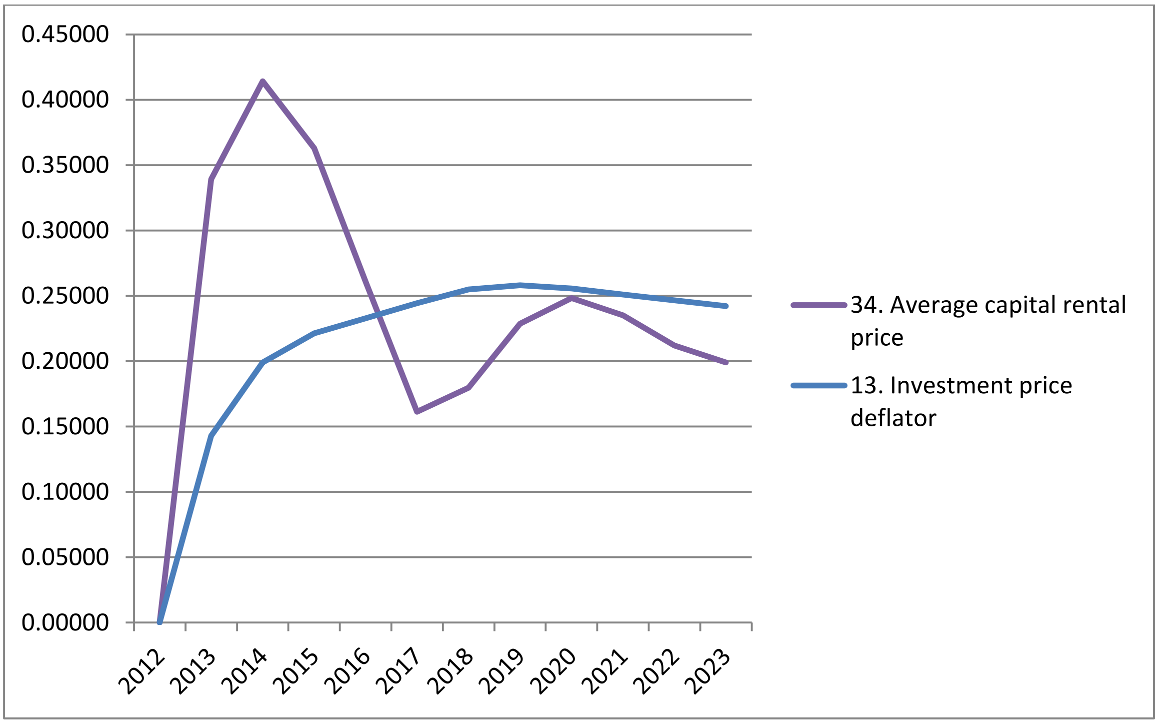

Figure 10: Weighted average cost of capital, industry and housing (change from baseline)

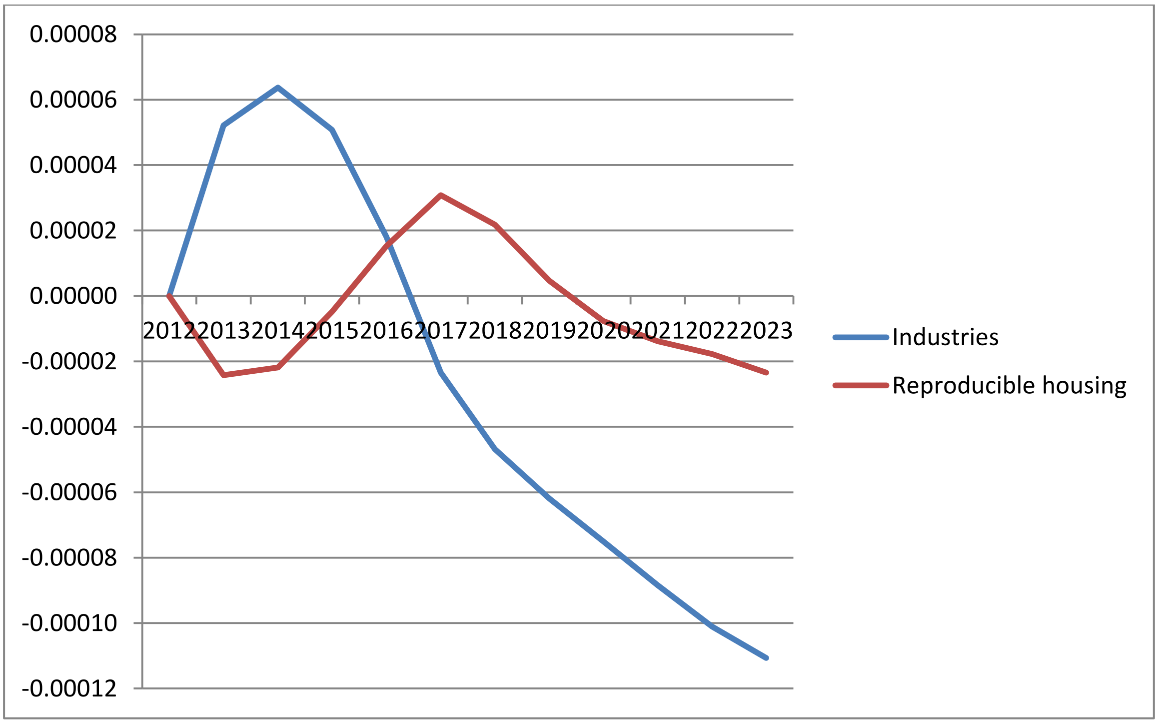

Figure 11: Real GDP and the components of real GNE (% deviation from baseline)

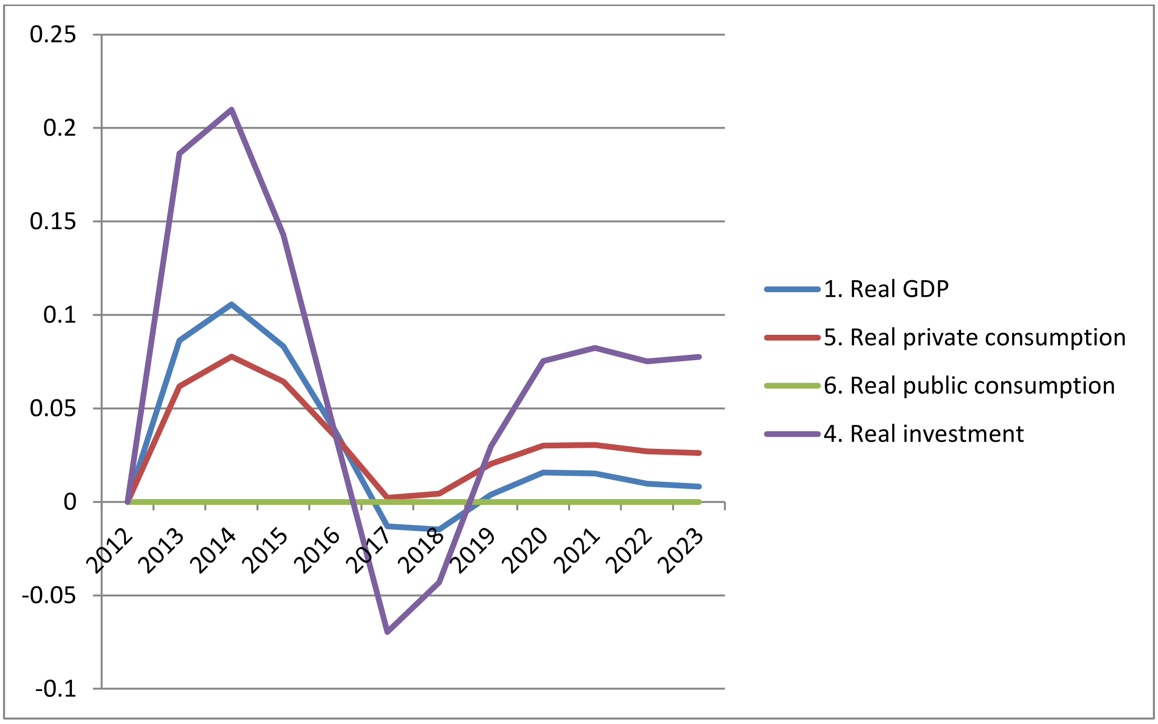

Figure 12: Average propensity to consume (% deviation from baseline)

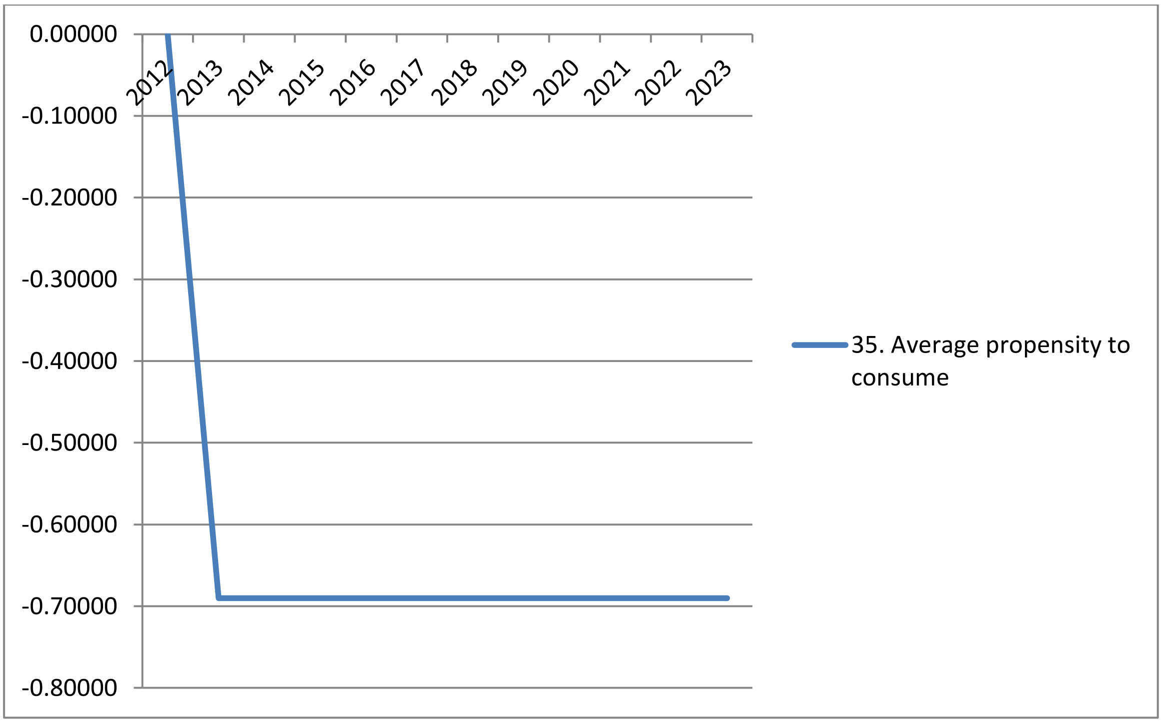

Figure 13: Real GDP and the components of real GNE (% deviation from baseline)

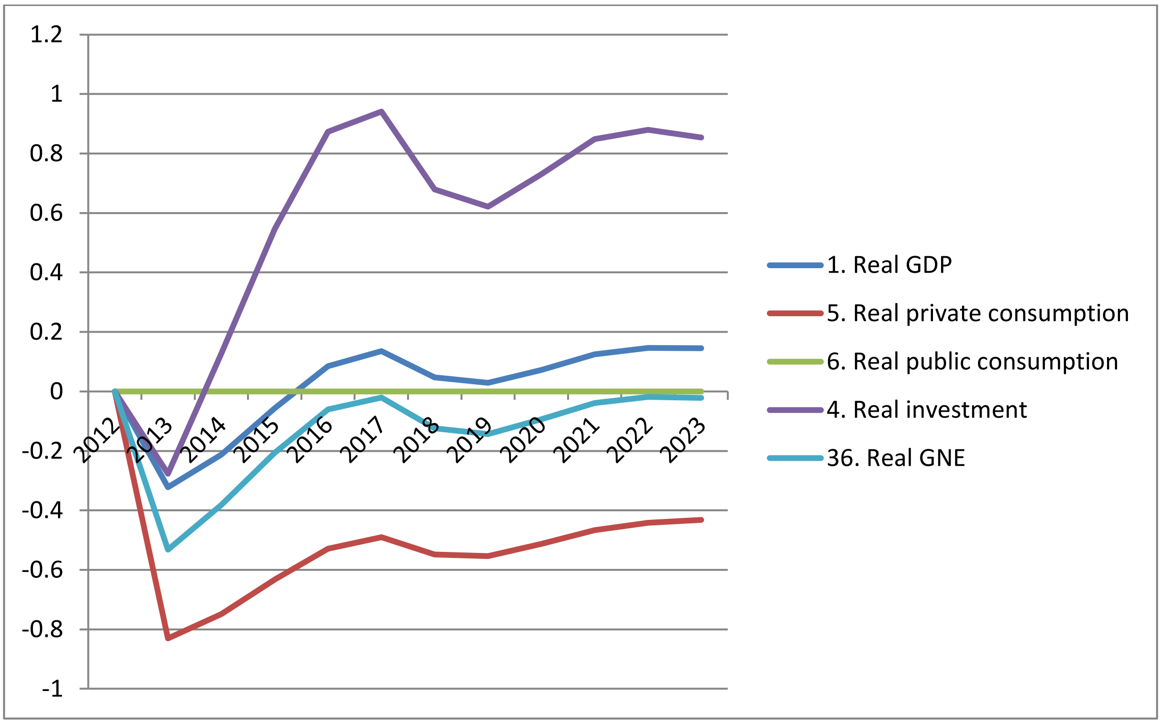

Figure 14: Employment, capital stock, real GDP (% deviation from baseline)

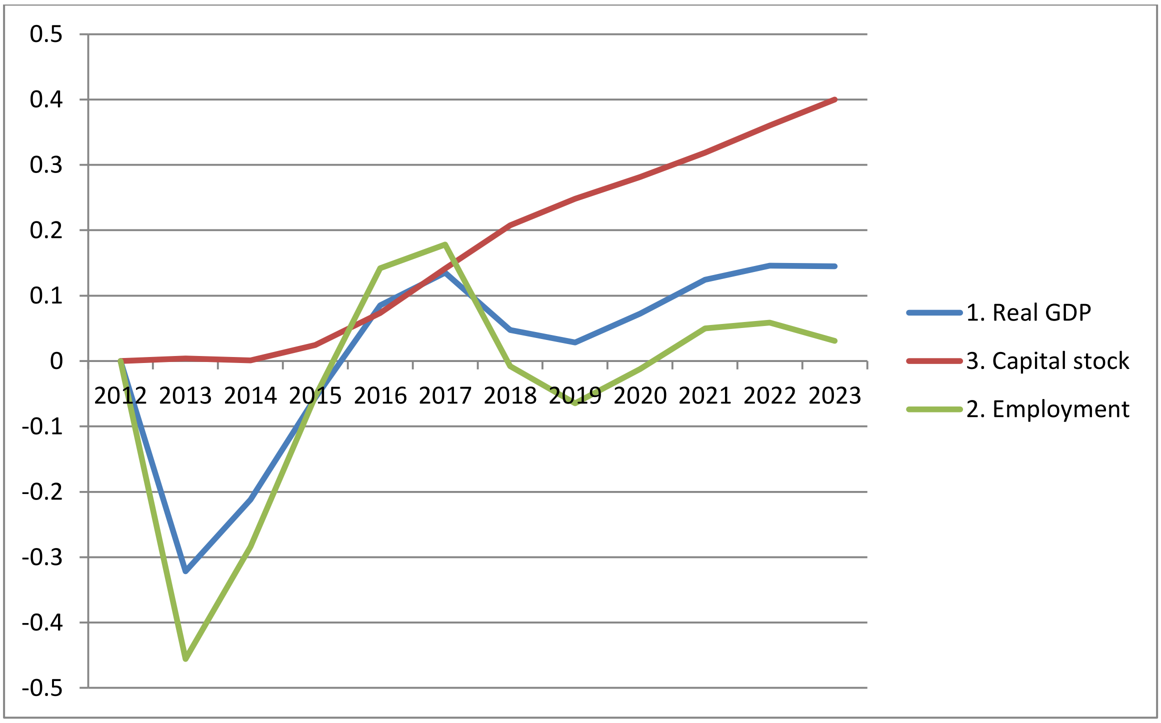

Figure 15: Employment, nominal wage, real consumer and producer wages (% deviation from baseline)

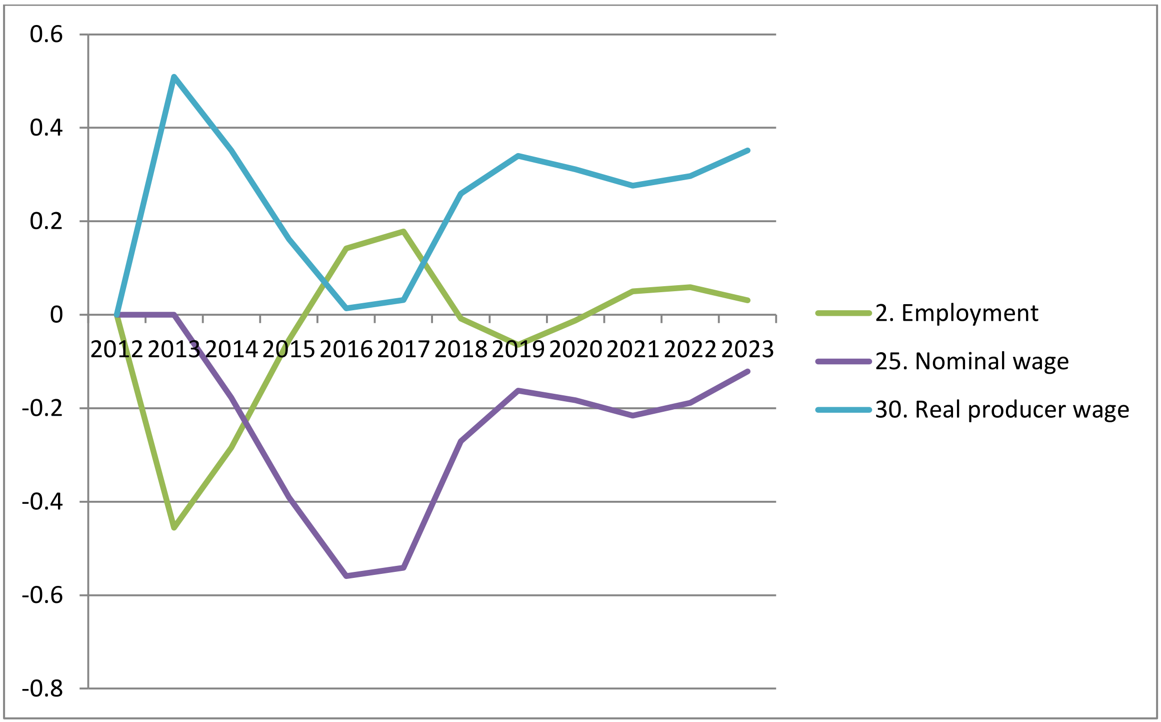

Figure 16: Export volumes, import volumes, and the terms of trade (% deviation from baseline)

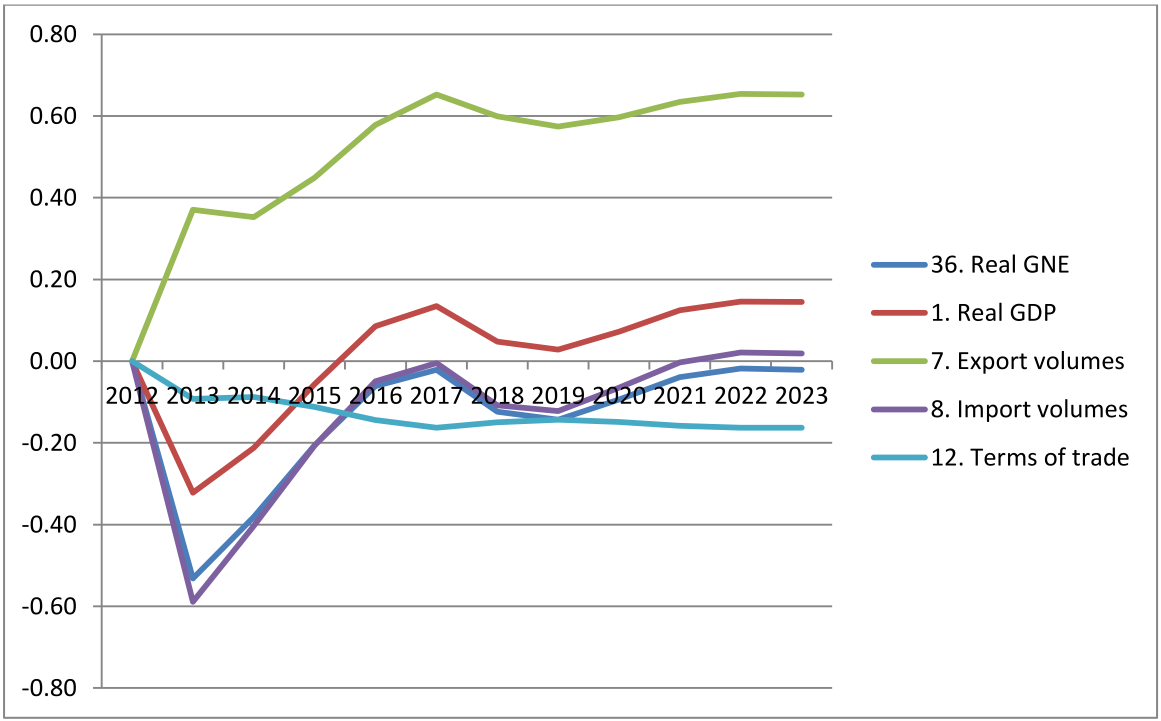

Figure 17: Average capital rental price and investment price deflator (% deviation from baseline)

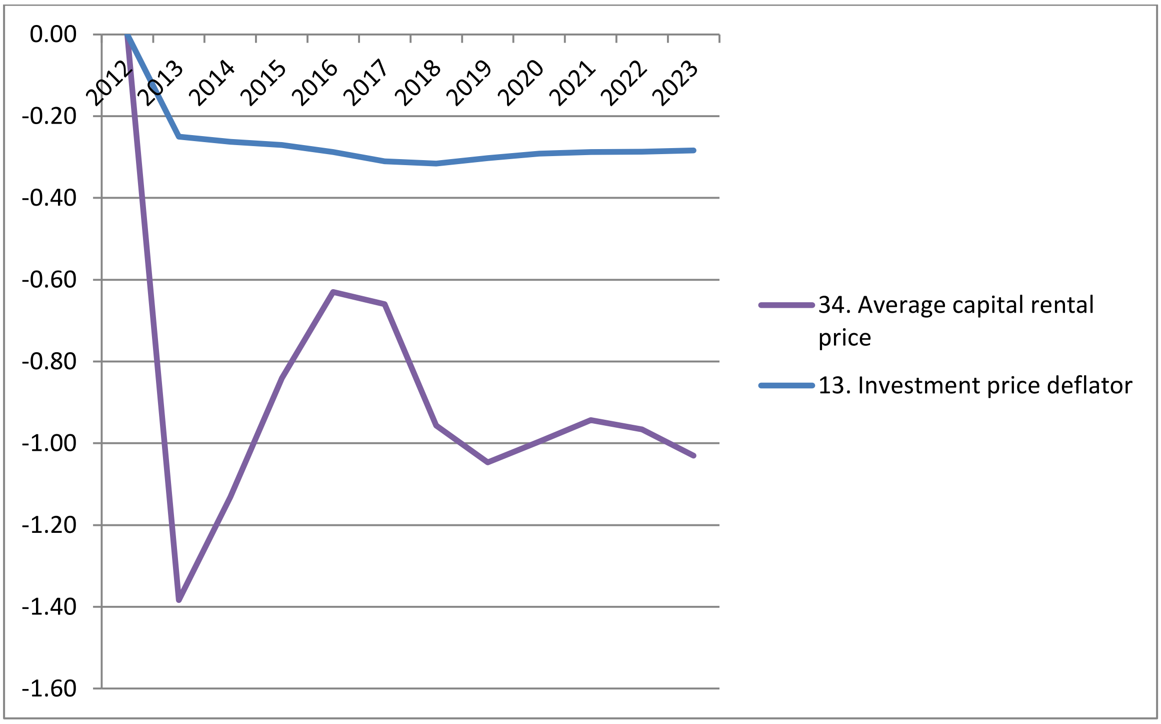

Figure 18: Average rates of return offered by capital-creating liability agents

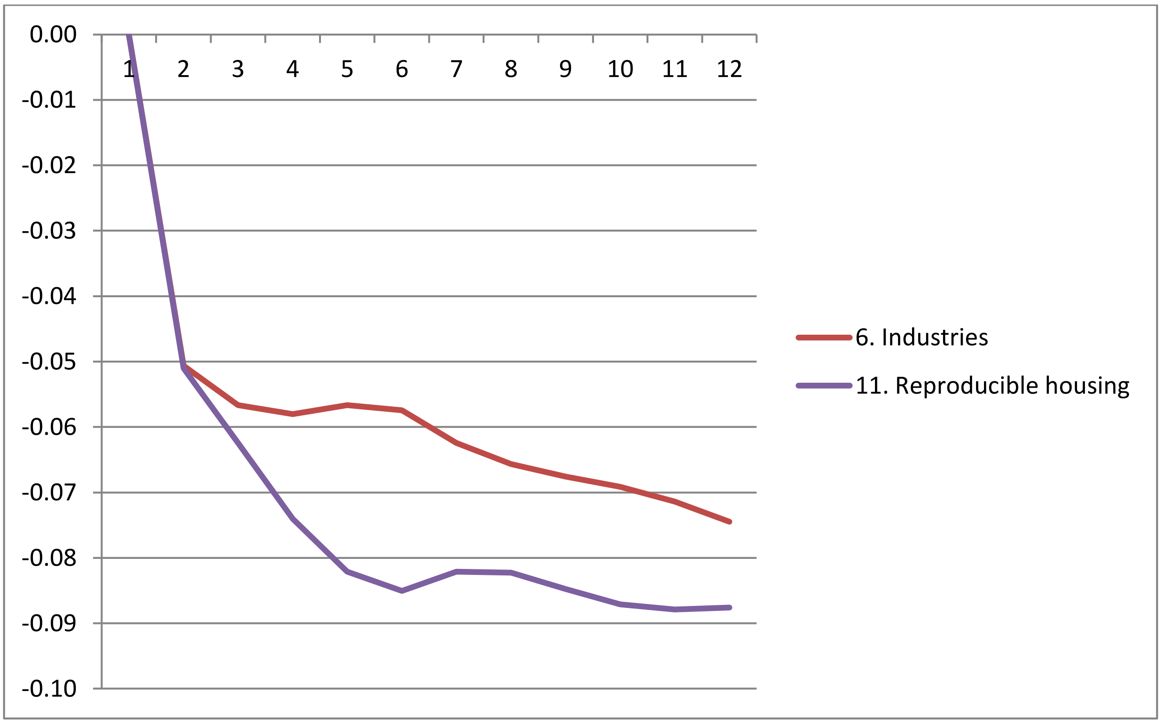

Figure 19: Weighted average cost of capital, industry and housing (change from baseline)

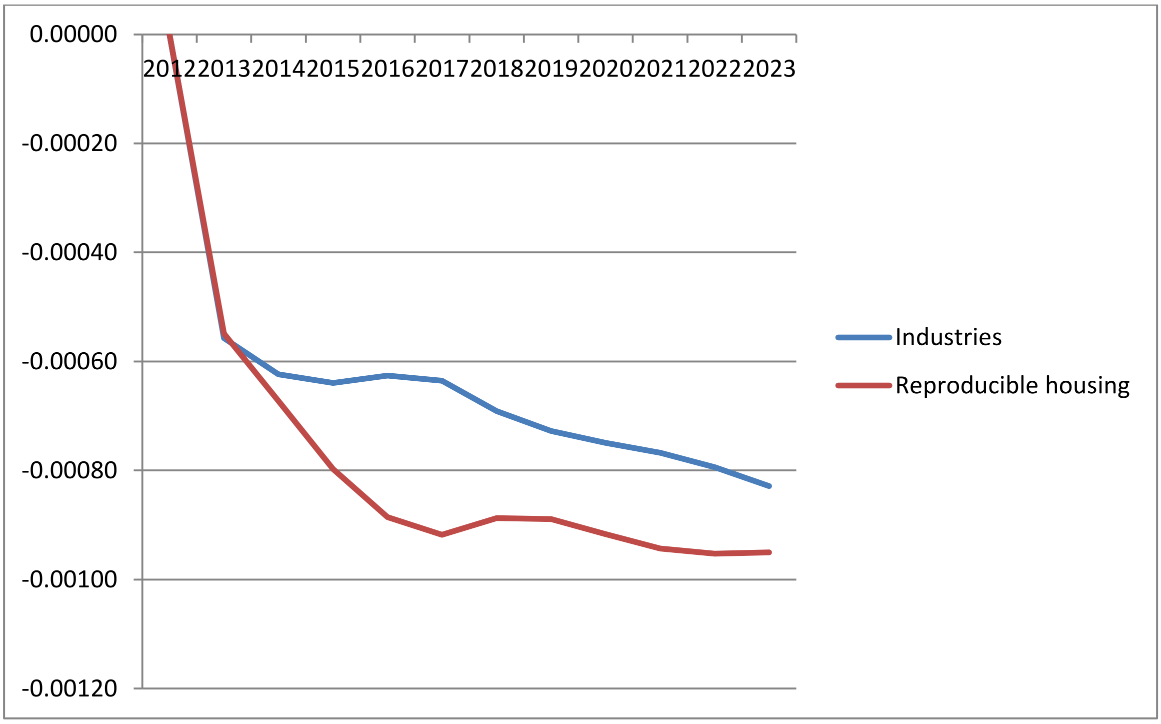

Figure 20: Real housing and non-housing investment (% deviation from baseline)

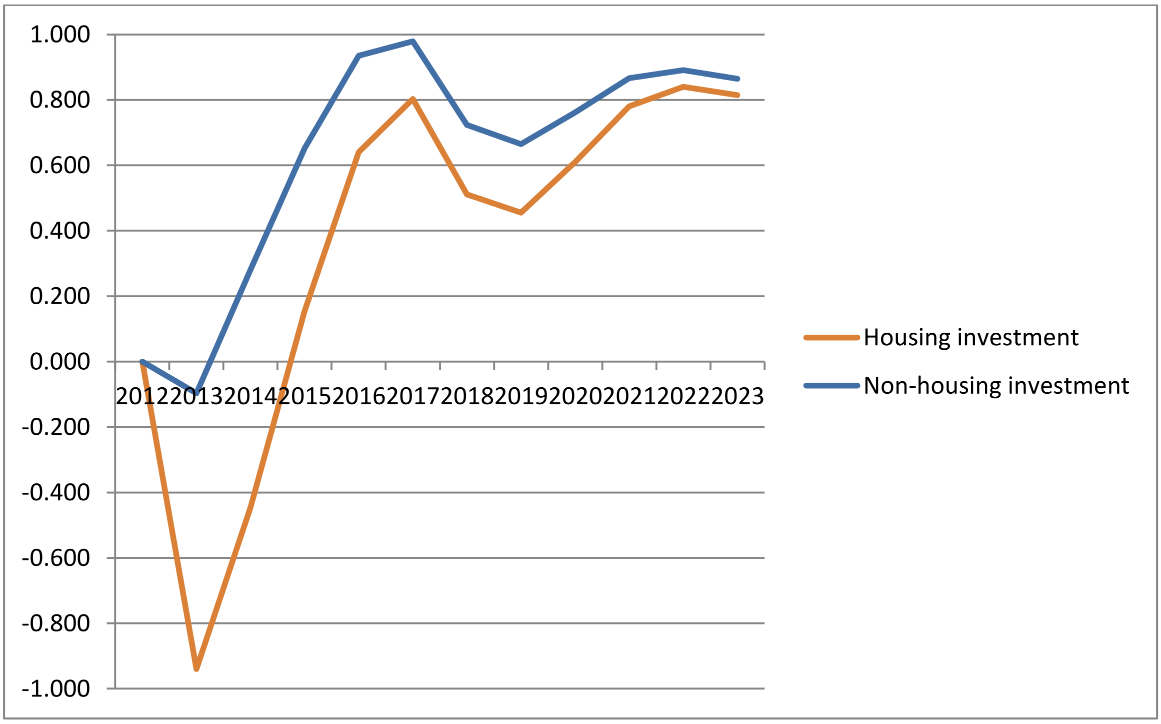

Figure 21: Nominal exchange rate, GDP deflator, CPI (% deviation from baseline)

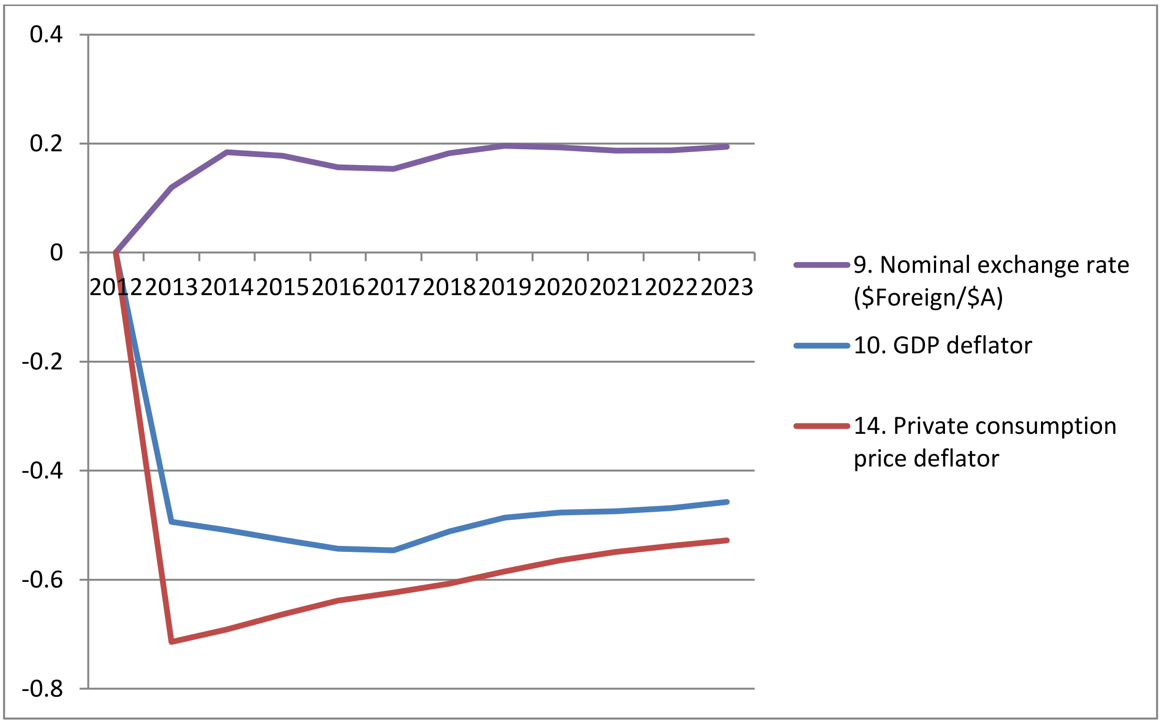

Figure 22: Ratio of the current account deficit to GDP (change from baseline)

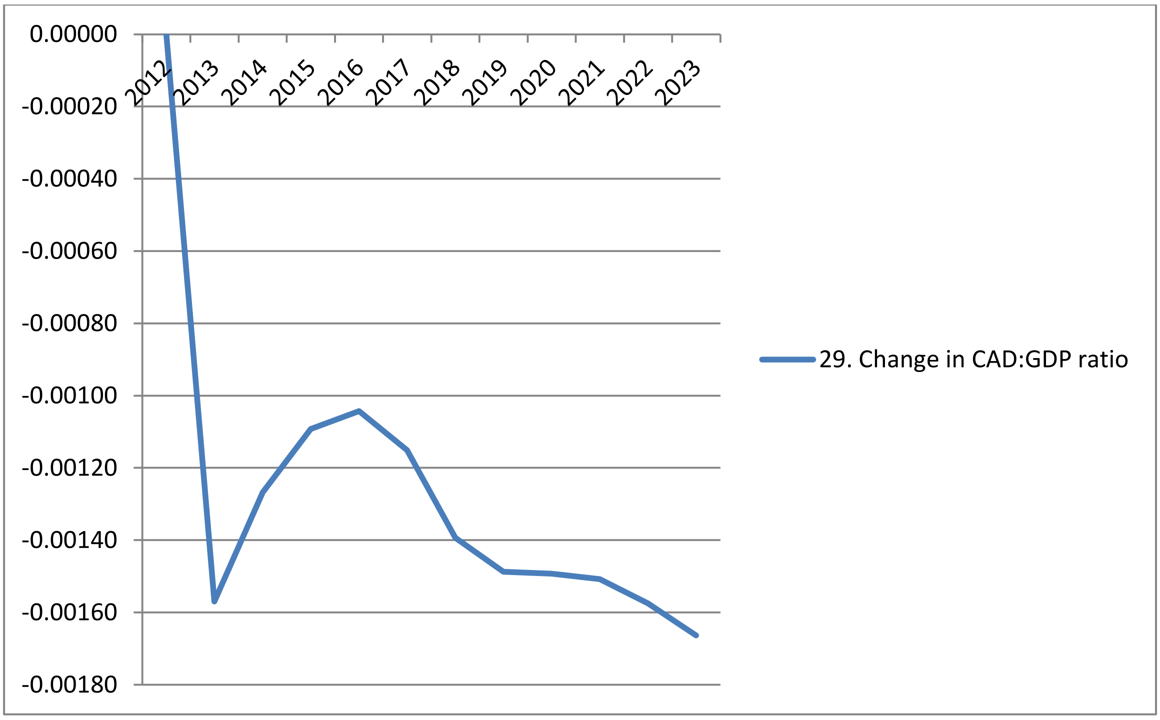

Figure 23: Decomposition of deviation in nominal exchange rate ($Foreign/$A) (% deviation from baseline)

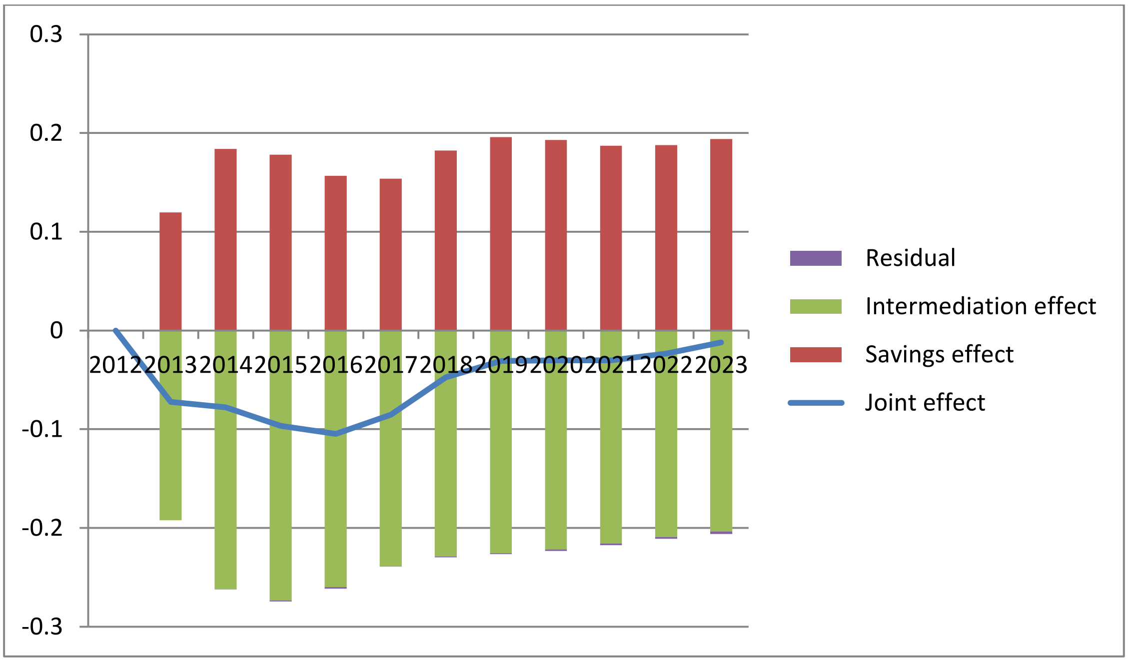

Figure 24: Decomposition of GDP deflator (% deviation from baseline)

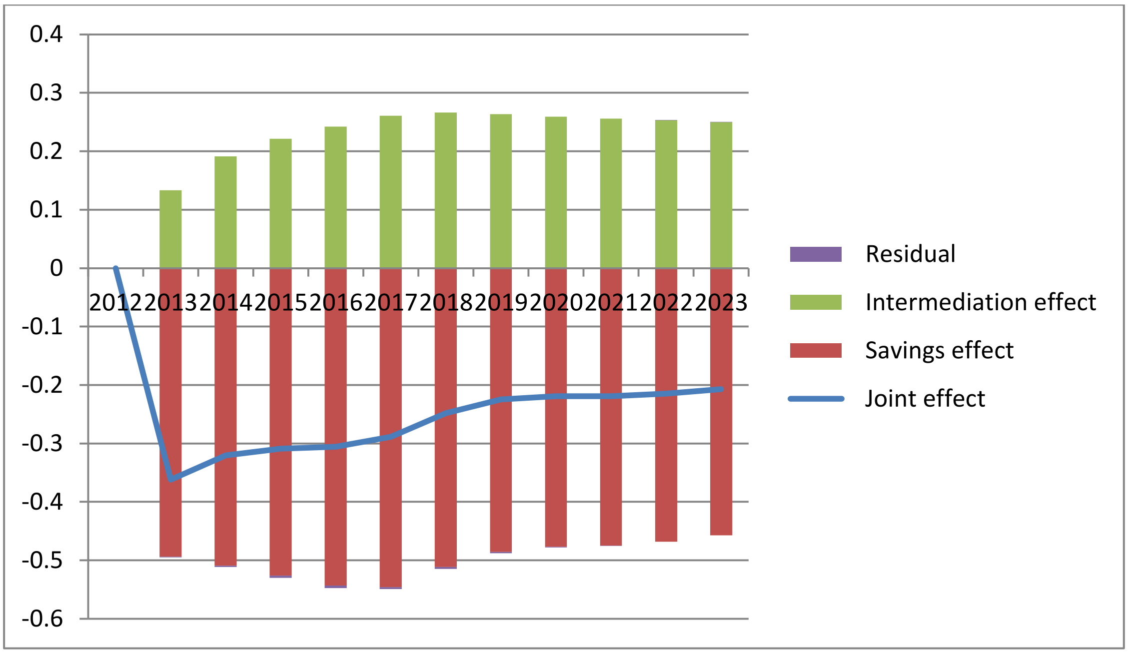

Figure 25: Decomposition of the deviation in the CAD / GDP ratio (% deviation from base)

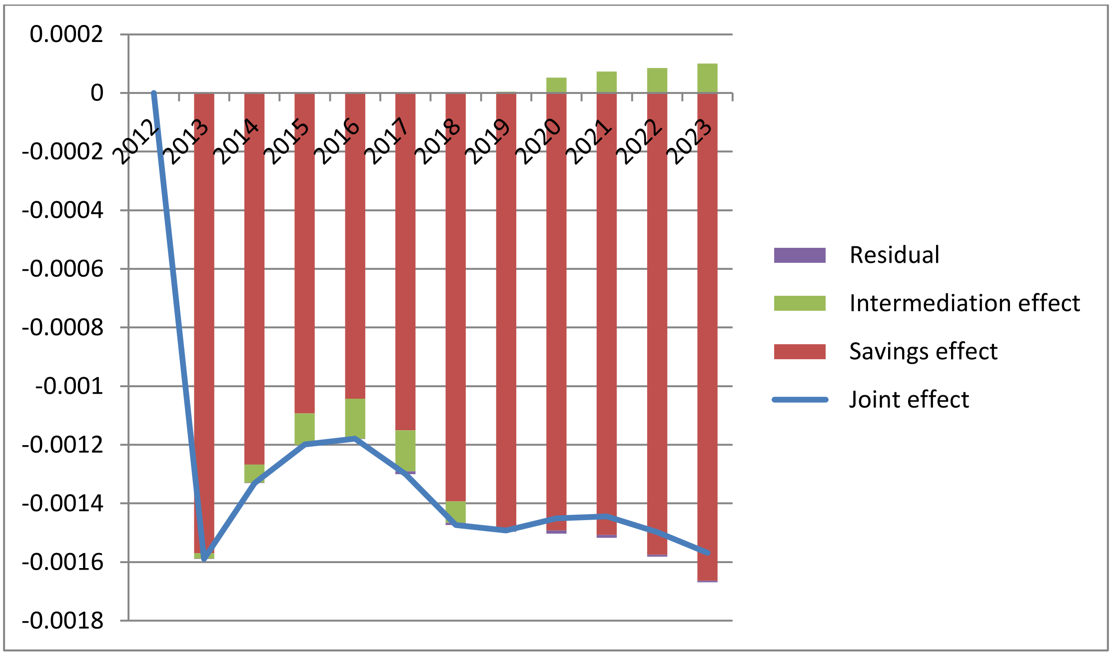

Figure 26: Decomposition of the real exchange rate appreciation (% deviation from base)

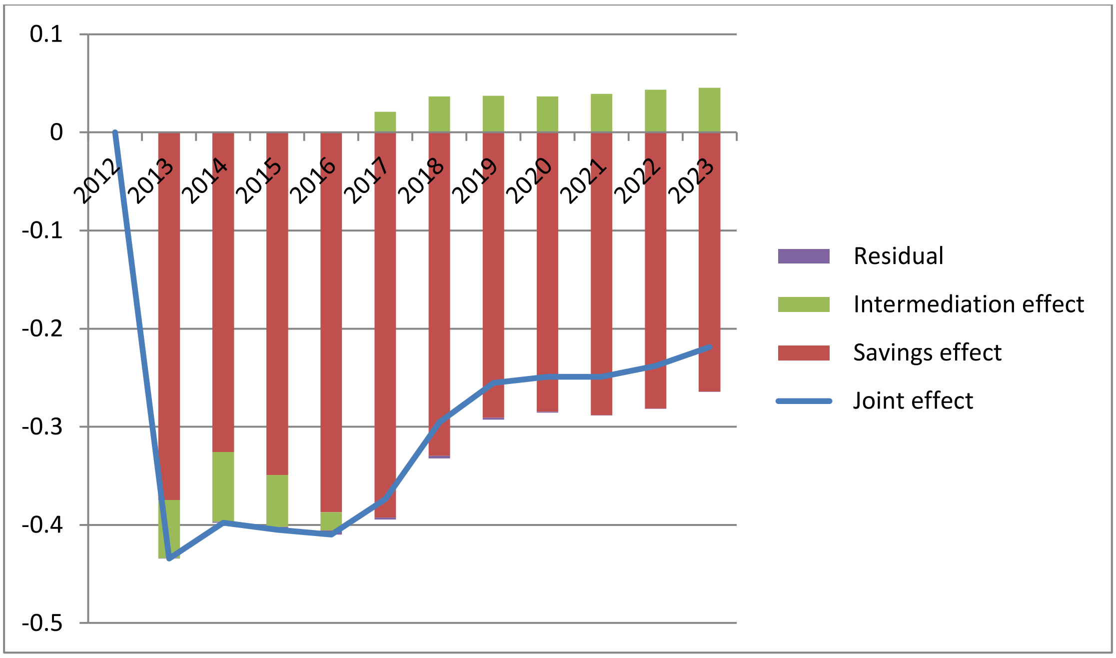

Figure 27: Decomposition of the BOT / GDP ratio (% deviation from base)

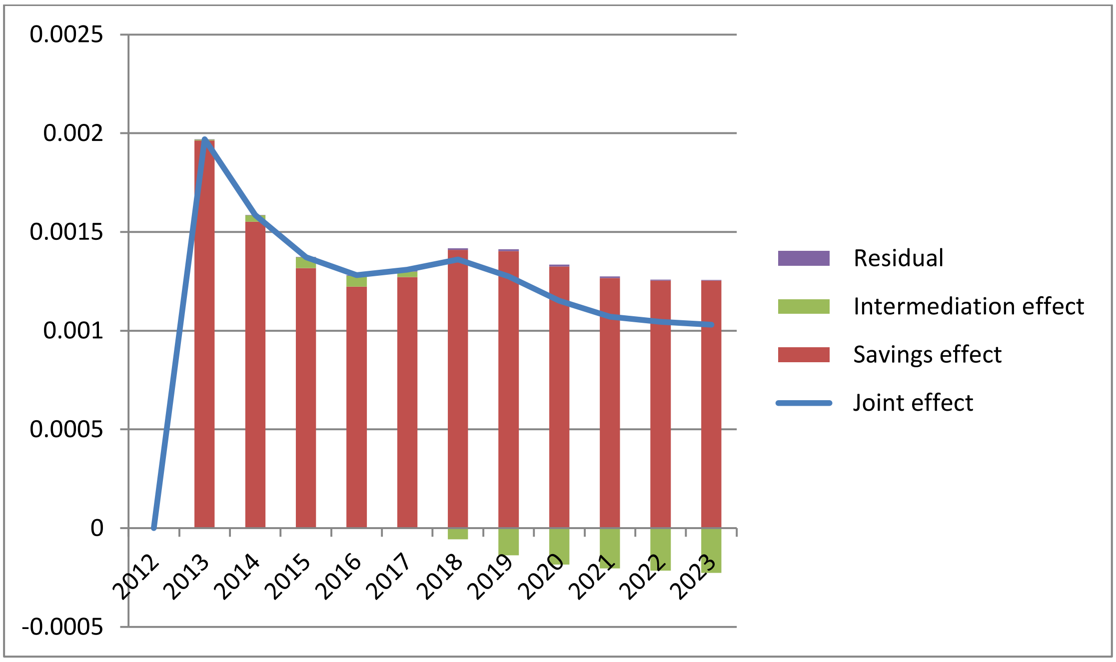

Figure 28: Decomposition of real GNE deviation (% deviation from base)

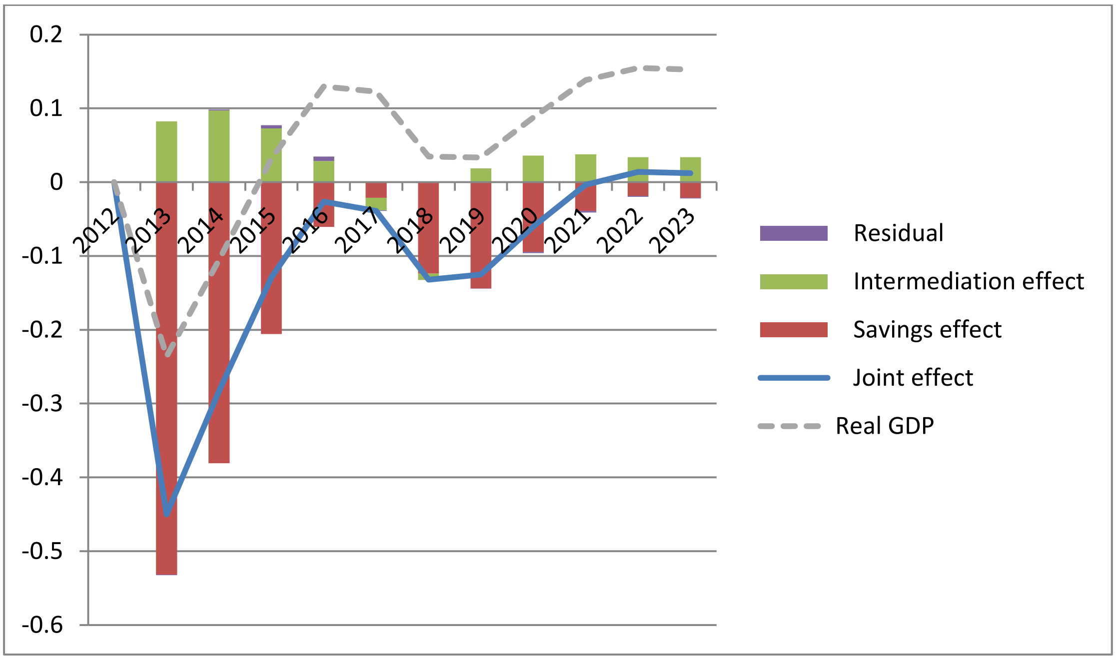

Figure 29: Decomposition of real GDP deviation (% deviation from base)

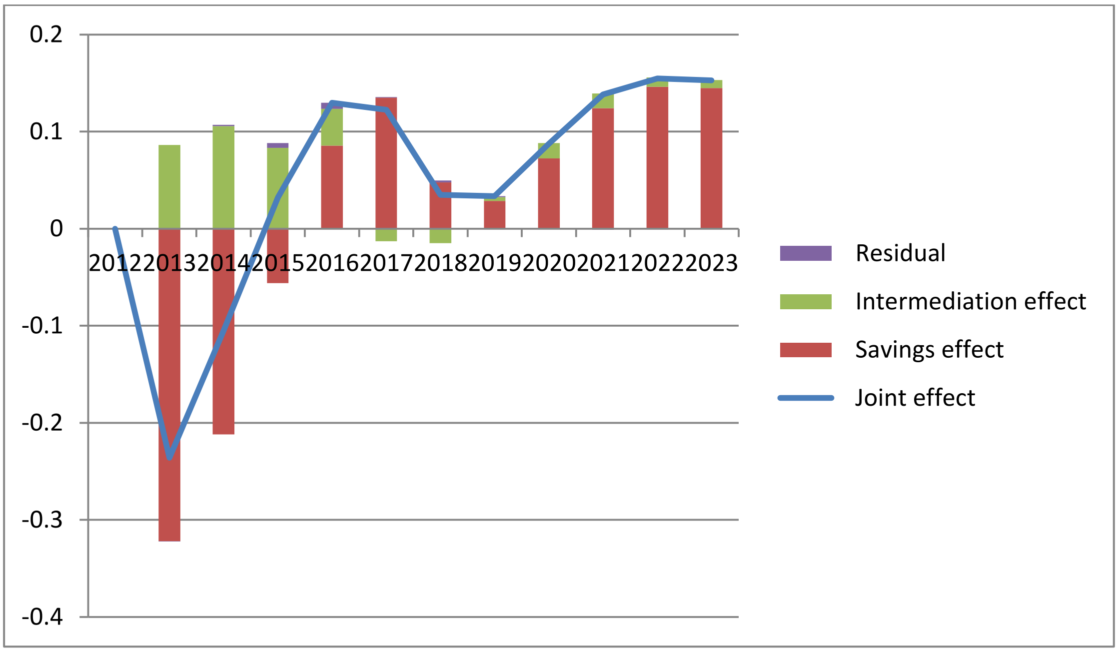

Figure 30: Decomposition of employment deviation (% deviation from base)

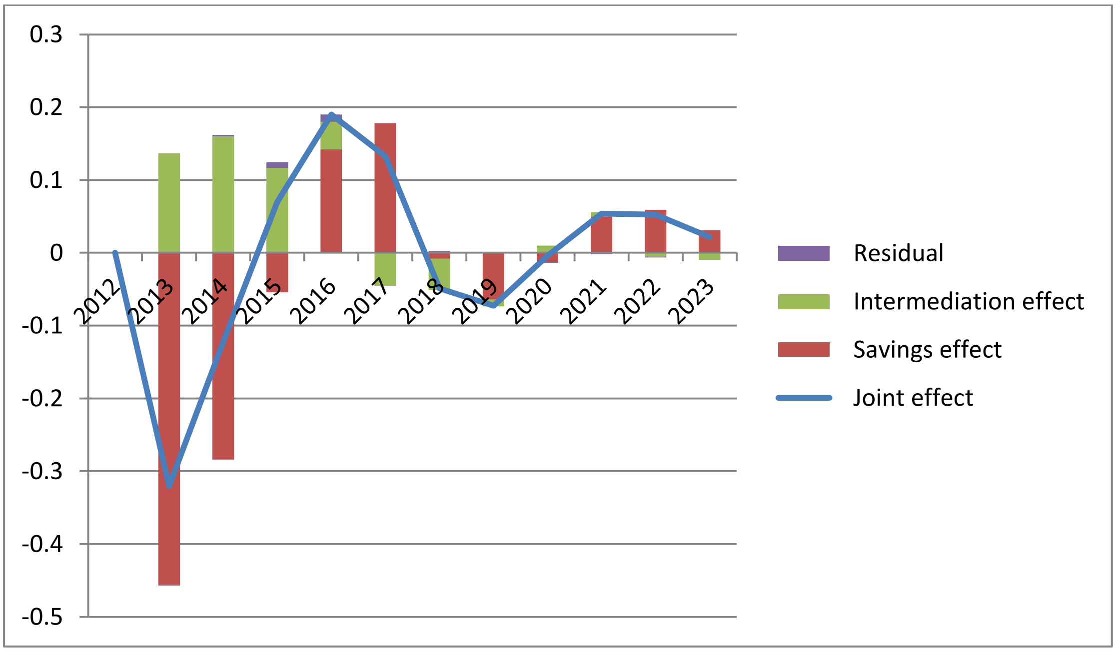

Figure 31: Decomposition of capital deviation (% deviation from base)

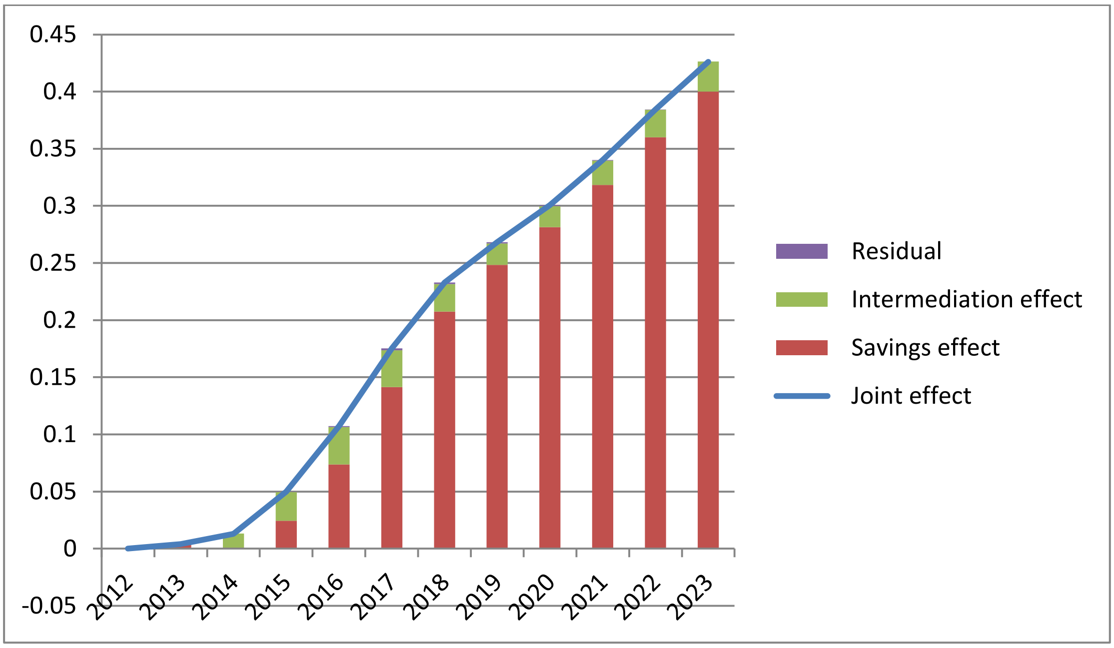

Figure 32: Decomposition of real investment deviation (% deviation from base)

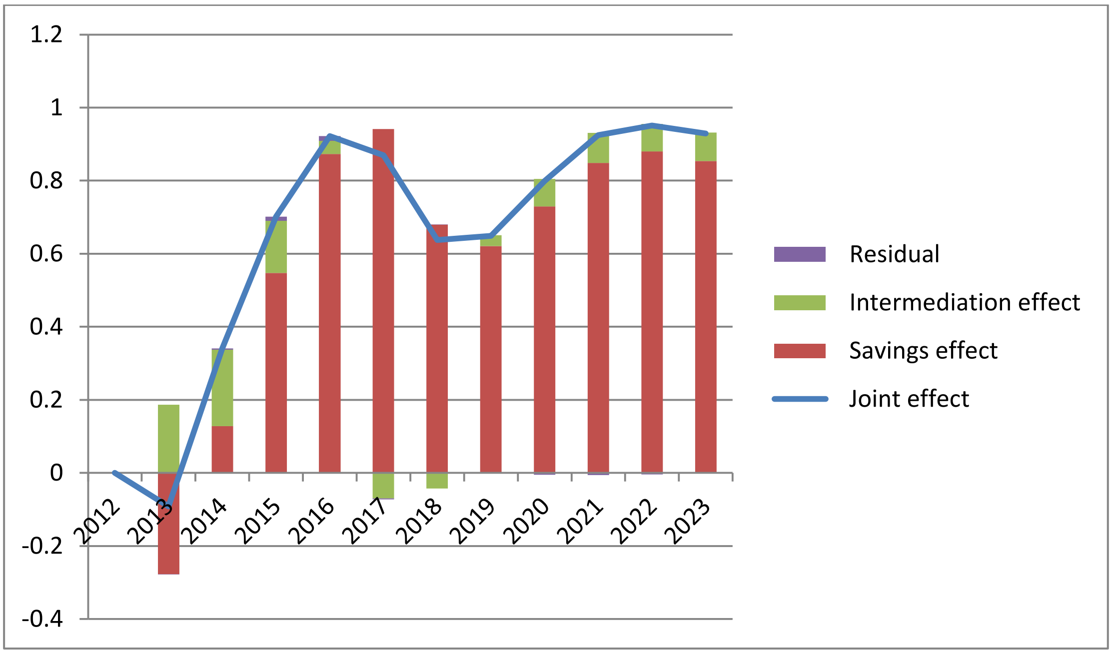

Figure 33: Decomposition of weighted average cost of capital of industry (change from base)

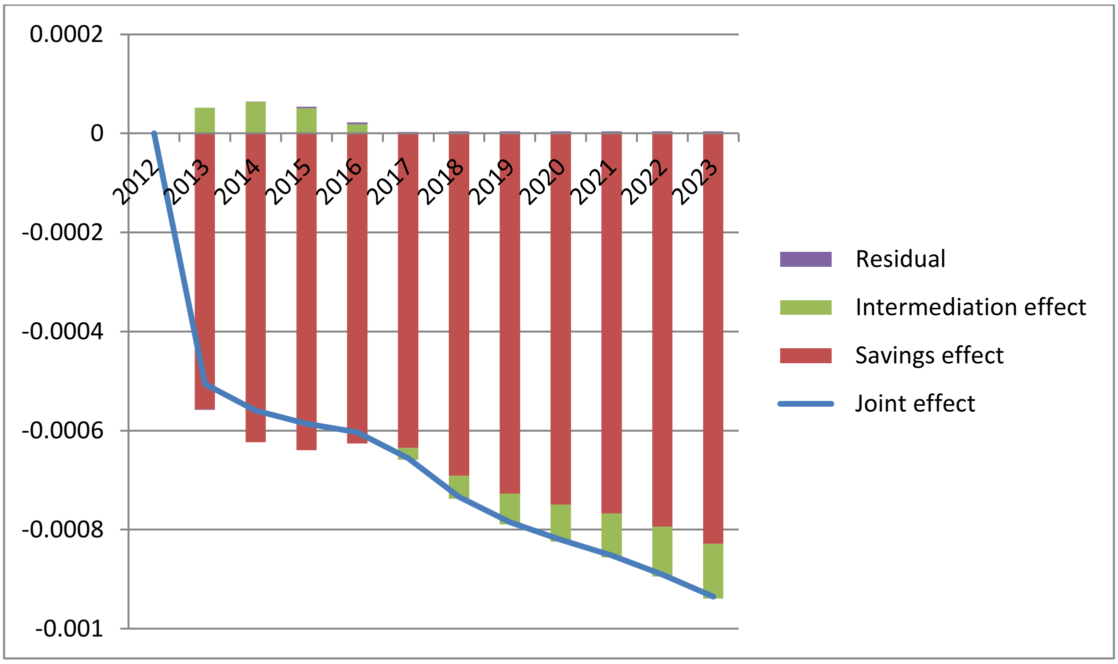

Figure 34: Decomposition of weighted average cost of capital of reproducible housing (change from base)

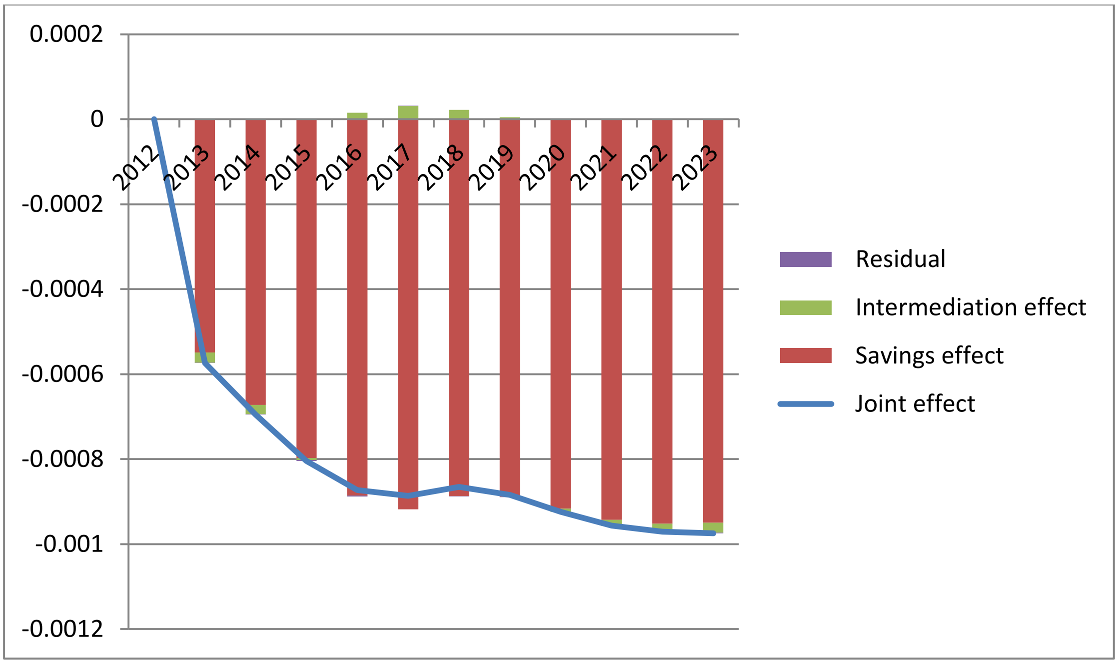

Table 12: Composition of asset agent portfolios, by liability agent (shares)

	(1) Banks	(2) Central Bank	(3) Foreigners	(4) Government	(5) Households	(6) Industry	(7) NBFI	(8) Superannuation	(9) Life Insurance	(10) Non-reproducible housing	(11) Reproducible housing	(12) Total
(1) Banks	0.0%	15.9%	40.3%	29.9%	15.4%	40.2%	21.7%	25.5%	12.5%	9.1%	9.1%	19.9%
(2) Central Bank	0.5%	0.0%	0.0%	8.0%	0.5%	2.5%	0.0%	0.0%	0.0%	8.9%	8.9%	0.7%
(3) Foreigners	12.1%	52.8%	0.0%	17.0%	2.1%	44.9%	13.3%	18.4%	5.2%	8.9%	8.9%	9.8%
(4) Government	4.4%	25.5%	10.8%	0.0%	7.5%	3.1%	4.2%	2.5%	6.0%	9.9%	9.9%	6.3%
(5) Households	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	8.9%	8.9%	0.0%
(6) Industries	24.8%	0.0%	39.1%	23.9%	11.1%	0.0%	26.1%	21.5%	8.4%	9.1%	9.1%	19.3%
(7) NBFI	9.6%	5.8%	7.7%	11.0%	2.7%	8.7%	0.0%	16.8%	67.7%	9.1%	9.1%	7.9%
(8) Superannuation	0.0%	0.0%	0.1%	0.2%	27.0%	0.0%	0.1%	0.0%	0.0%	9.3%	9.3%	10.2%
(9) Life Insurance	0.1%	0.0%	0.4%	0.0%	1.4%	0.0%	0.3%	14.3%	0.0%	9.2%	9.2%	2.0%
(10) Non-reproducible housing	24.9%	0.0%	0.9%	5.1%	24.8%	0.3%	17.6%	0.5%	0.1%	8.5%	8.5%	15.4%
(11) Reproducible housing	23.5%	0.0%	0.8%	4.8%	7.4%	0.2%	16.7%	0.5%	0.1%	9.1%	9.1%	8.5%
(12) Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 13: Composition of asset agent portfolios (consolidated financial and housing sectors) (shares)

	(1) Finance Sector	(3) Foreigners	(4) Government	(5) Households	(6) Industry	(7) Housing	(8) Total
(1) Finance Sector	0%	49%	49%	46%	52%	0%	34%
(3) Foreigners	20%	0%	17%	2%	45%	0%	11%
(4) Government	5%	10%	0%	7%	3%	0%	6%
(5) Households	0%	0%	0%	0%	0%	0%	0%
(6) Industries	32%	40%	24%	11%	0%	0%	22%
(7) Housing	43%	2%	10%	34%	1%	0%	27%
(8) Total	100%	100%	100%	100%	100%	0%	100%

Table 14: Set names and definitions

Set name	Description	Elements
AA	Set of all asset agents.	Banks, CB, Foreigners, Govt, Hlds, Inds, NonBankFinIn, Super, LifeIns, NRH, RH
AALF	Set of all asset agents, excluding foreigners.	Banks, CB, Govt, Hlds, Inds, NonBankFinIn, Super, LifeIns, NRH, RH
B_DL	Bonds, deposits and loans.	Bonds, DeposLoans.
CBSET	The central bank.	CB.
DOMAGENT	Set of all domestic liability agents.	Banks, CB, Govt, Hlds, Inds, NonBankFinIn, Super, LifeIns, NRH, RH.
EQUITY	Liability instrument Equity.	Equity
FI	Set of all financial instruments.	Bonds, Cash, DeposLoans, Equity, GldSDR
FINEQ	Non-equity liabilities.	Bonds, Cash, DeposLoans, GldSDR
FINDL	All financial instruments excluding deposits and loans	Bonds, Cash, Equity, GldSDR
IND	Set of all industries.	i1- i106.
INDP	Set of all industries plus established housing.	$IND \cup OLDAS$
KLA	Subset of liability agents comprising those that own physical capital.	Inds, RH, NRH.
LA	Set of all liability agents.	Banks, CB, Foreigners, Govt, Hlds, Inds, NonBankFinIn, Super, LifeIns, NRH, RH.
LANCB	Set of all liability agents excluding the central bank.	Banks, Foreigners, Govt, Hlds, Inds, NonBankFinIn, Super, LifeIns, NRH, RH.
LANSUPER	Set of all liability agents excluding Superannuation	Banks, CB, Foreigners, Govt, Hlds, Inds, NonBankFinIn, LifeIns, NRH, RH.
NOTCD	Assets other than cash and deposits.	Bonds, Equity, GldSDR
OLDAS	Established housing.	OldHouse
OD	Dwellings	Dwellings
NOD	Set of all industries, excluding Dwellings	IND - OD.

Table 15: Equations

Name	Equation	Range
Determination of end-of-year asset holdings by domestic agents		
E_a_t_1dom	$a\_t\_1_{(s,f,d)} = big\_bud_{(d)} + ELAS\_AS*\left[roipowa_{(s,f,d)} - ave\_ror\_d_{(d)}\right] + f\_a\_t\_1_{(s,f,d)}$	$(s \in LA)$ $(f \in FI)$ $(d \in AALF)$
Average rate of return received by domestic asset agents		
E_ave_ror_d	$BIGBUDGET_{(d)} \cdot ave\_ror\_d_{(d)} = \sum_s \sum_f AT1_{(s,f,d)} \cdot roipowa_{(s,f,d)}$	$(d \in AALF)$
Budget available for asset purchases by domestic agents		
E_big_budd	$BIGBUDGET_{(d)} \cdot big\_bud_{(d)} = \sum_s \sum_f [AT_{(s,f,d)} \cdot VAL_{(s,f,d)}] \cdot (a\_t_{(s,f,d)} + v_{(s,f,d)}) + 100 \cdot d\_new\_assacq_{(d)}$	$(d \in AALF)$
Determination of end-of-year asset holdings by foreign agents		
E_a_t_1f	$phi + a\_t\_1_{(s,j,\ Foreigners)} = big\_budf + ELAS\_AS*\left[roipowa_{(s,j,Foreigners)} - ave\_ror\_row\right]$	$(s \in LA)$ $(f \in FI)$
E_big_budf	$big\_budf = phi + big\_bud_{(Foreigners)}$	
Year-on-year tracking of start-of-year asset values		
E_a_t	$AT_{(s,f,d)} \cdot a\_t_{(s,f,d)} = 100 \cdot [AT1\_B_{(s,f,d)} - AT\_B_{(s,f,d)}] \cdot del\_unity$	$(s \in LA)$ $(f \in FI)$ $(d \in AALF)$
Acquisitions of financial assets		
E_d_flowd	$100 \cdot d\_flow_{(s,f,d)} = [AT1_{(s,f,d)}] \cdot a\_t\_1_{(s,f,d)} - [VAL_{(s,f,d)} \cdot AT_{(s,f,d)}] \cdot (a\_t_{(s,f,d)} + v_{(s,f,d)})$	$(s \in LA)$ $(f \in FI)$ $(d \in AA)$
E_d_shift4	$d\_new\_assacq_{(d)} = \sum_j \sum_f d\_flow_{(j,f,d)} + d\_shift4_{(d)}$	$(d \in AA)$
Revaluation effects		
E_v	$v_{(s,f,d)} = f\_v_{(s,f,d)} + ff\_v_{(d)} + fff\_v_{(s,f)} - VEXCH_{(s,f,d)} \cdot phi$	$(s \in LA)$ $(f \in FI)$ $(d \in AA)$

Asset acquisitions by foreigners linked to current account financing requirement		
E_d_ff_phi	$d\_new\_assacq_{(Foreigners)} - \sum_{d \in AA} \sum_{j \in FI} d\_flow_{(Foreigners,j,d)} = d\_CAD + d\_ff\_phi$	
Liability acquisition by government linked to public sector borrowing requirement		
E_ff_govt	$d\_new\_assacq_{(govt)} = \sum_{f \in FI} \sum_{j \in AA} d\_flow_{(govt,f,j)} - d\_gov\_def + d\_ff\_govt$	
E_shiftG	$100 \times [1/[NEW\_ASS\_ACQ_{(govt)}]] \times d\_new\_assacq_{(govt)} = w5tot + shiftG$	
	$roipowl_{(Govt,f,d)} = roiB\_DL\_G + f\_roipow\_g_{(f,d)}$	$(f \in B\_DL)$ $(d \in AA)$
Liability optimisation by domestic liability agents		
E_big_budl	$BIGBUDGETL_{(s)} \cdot big\_budl_{(s)} =$ $\sum_{f \in FI} \sum_{d \in AA} [AT_{(s,f,d)} \cdot VAL_{(s,f,d)}] \cdot (a\_t_{(s,f,d)} + v_{(s,f,d)}) + 100 \cdot d\_new\_liaacq_{(s)}$	$(s \in LALF)$
E_ave_ror_s	$ave\_ror\_s_{(s)} = \sum_{f \in FI} \sum_{d \in AA} (AT1_{(s,f,d)} / BIGBUDGETL_{(s)}) \cdot roipowl_{(s,f,d)}$	$(s \in LALF)$
E_d_new_liaacq	$d\_new\_liaacq_{(s)} = \sum_{f \in FI} \sum_{d \in AA} d\_flow_{(s,f,d)} + d\_shiftl4_{(s)}$	$(s \in LALF)$
E_a_t_1_d	$AT1\_D_{(s,f)} \cdot a\_t\_1\_d_{(s,f)} = \sum_{d \in AA} AT1_{(s,f,d)} \cdot a\_t\_1_{(s,f,d)} + d\_MTB_{(s,f)}$	$(s \in LALF)$ $(f \in FI)$
E_a_t_1_d2	$a\_t\_1\_d_{(s,f)} = big\_budl_{(s)} + (TAU-1) \cdot [roipowl\_d_{(s,f)} - ave\_ror\_s_{(s)}] + liab\_sh\_d_{(s,f)}$	$(s \in LALF)$ $(f \in FI)$
E_a_t_1	$a\_t\_1_{(s,f,d)} = a\_t\_1\_d_{(s,f)} + (TAU-1) \cdot [roipowl_{(s,f,d)} - roipowl\_d_{(s,f)}] + liab\_shift_{(s,f,d)}$	$(s \in LALF)$ $(f \in FI)$ $(d \in AA)$
E_roipowl4	$roipowl_{(s,f,d)} = f2\_roipowl_{(s,f)} + f3\_roipowl_{(s,f,d)} + f4\_roipowl_{(s)}$	$(s \in LALF)$ $(f \in FI)$ $(d \in AA)$
E_roipowl_d	$[\sum_{d \in AA} AT1_{(s,f,d)}] \cdot roipowl\_d_{(s,f)} = \sum_{d \in AA} AT1_{(s,f,d)} \cdot roipowl_{(s,f,d)}$	$(s \in LALF)$ $(f \in FI)$

Quantity of capital in the reproducible housing sector		
E_cap_trh	$QCAP\_RH \cdot cap\_trh = 100 \cdot [QINVEST\_B_{(Dwellngs)}] \cdot del\_unity + 100 \cdot d\_f\_cap\_trf$	
New liabilities issued by industry		
E_d_shiftind2	$d\_new\_liaacq_{(Inds)} = [0.01 \cdot V2IND] \cdot w2\_ind + \sum_{f \in FI} \sum_{s \in LA} d\_flow_{(s,f,Inds)} + d\_shiftind$	
E_w2_ind	$V2IND \cdot w2\_ind = V2TOT\_I \cdot w2tot\_i - \sum_{i \in IND} G\_VINVEST_{(i)} \cdot [x2tot_{(i)} + p2tot_{(i)} + gv2tot_{(i)}] + V6TOT \cdot [x6tot + p6tot] - \{V2TOT_{(Dwellings)} \cdot [x2tot_{(Dwellings)} + p2tot_{(Dwellings)}] - G\_VINVEST_{(Dwellings)} \cdot [x2tot_{(Dwellings)} + p2tot_{(Dwellings)} + gv2tot_{(Dwellings)}]\}$	
Asset acquisition by industry		
E_shiftind	$[100/NEW\_ASS\_ACQ_{(Inds)}] \times d\_new\_assacq_{(Inds)} = w0gdpinc + shiftind$	
Asset accumulation by households		
E_d_shiftH	$100 \cdot d\_new\_assacq_{(Hlds)} = HOUS\_DIS\_INC \cdot hdy - V3TOT \cdot w3tot + 100 \cdot \sum_{f \in FI} \sum_{d \in AA} d\_flow_{(Hlds,f,d)} + 100 \cdot d\_shiftH$	
Liability accumulation by the reproducible housing sector		
E_d_shiftRH	$d\_new\_liaacq_{(RH)} = 0.01 \cdot \{V2TOT_{(Dwelling)} \cdot [x2tot_{(Dwelling)} + p2tot_{(Dwelling)}] - G\_VINVEST_{(Dwelling)} \cdot [x2tot_{(Dwelling)} + p2tot_{(Dwelling)} + gv2tot_{(Dwelling)}]\} + \sum_{f \in FI} \sum_{s \in LA} d\_flow_{(s,f,RH)} + d\_shiftRH$	

Revaluation of the equity of industry, reproducible housing, and non-reproducible housing		
E_ff_v_inds_eq	$\sum_{i \in NOD} \text{VCAP}_{(i)} \cdot (\text{p2tot}_{(i)} + \text{cap\_t}_{(i)}) + \sum_{s \in LA} \sum_{s \in FI} \text{AT}_{(s,f,Inds)} \cdot \text{VAL}_{(s,f,Inds)} \cdot (\text{a\_t}_{(s,f,Inds)} + \text{v}_{(s,f,Inds)})$ $= \sum_{f \in FI} \sum_{d \in AA} \text{AT}_{(Inds,f,d)} \cdot \text{VAL}_{(Inds,f,d)} \cdot (\text{a\_t}_{(Inds,f,d)} + \text{v}_{(Inds,f,d)}) + 100 \cdot \text{d\_f\_inds\_eq}$	
E_ff_v_RH_eq	$\text{VCAP\_RH} \cdot (\text{p2tot}_{(Dwellings)} + \text{cap\_trh}) =$ $\sum_{f \in FI} \sum_{d \in AA} \text{AT}_{(RH,f,d)} \cdot \text{VAL}_{(RH,f,d)} \cdot [\text{a\_t}_{(RH,f,d)} + \text{v}_{(RH,f,d)}] + 100 \cdot \text{d\_f\_RH\_eq}$	
E_ff_v_NRH_eq	$\text{VCAP\_NRH} \cdot \text{p2tot}_{(Oldhouse)} =$ $\sum_{f \in FI} \sum_{d \in AA} \text{AT}_{(NRH,f,d)} \cdot \text{VAL}_{(NRH,f,d)} \cdot [\text{a\_t}_{(NRH,f,d)} + \text{v}_{(NRH,f,d)}] + 100 \cdot \text{d\_f\_NRH\_eq}$	
Relationship between rates of return from asset and liability sides		
E_f_roipow	$\text{roipowa}_{(s,f,d)} = \text{roipowl}_{(s,f,d)} + \text{f\_roipow}_{(s,f,d)}$	$(s \in LA)$ $(f \in FI)$ $(d \in AA)$
Expected rate of return on equity as a function of realised and offered rates of return		
E_f4_roipow	$\text{roipowa}_{(s,Equity,d)} = \text{ALFA} \cdot \text{roipoweqc}_{(s)} + [1\text{-ALFA}] \cdot \text{roipowl}_{(s,Equity,d)} + \text{f4\_roipow}_{(s,d)}$	$(s \in KLA)$ $(d \in AA)$
Power of the rate of return on industry equity		

E_f_roipow_ie	$[\mathrm{ROI\_EQ\_D}_{(\mathrm{Inds})}/\{\mathrm{ROI\_EQ\_D}_{(\mathrm{Inds})}\text{-}1\}] \times$ $\{\mathrm{roipoweqc}_{(\mathrm{Inds})} - \mathrm{f\_roipow\_ie}\} =$ $[1/[\sum_{i\in NOD} \mathrm{V1CAP}_{(i)} + (\mathrm{P2TOT\_INF}\text{-}1)\times \sum_{i\in NOD} \mathrm{VCAP}_{(i)}$ $- \sum_{i\in NOD} [\mathrm{DEP}_{(i)} \times \mathrm{VCAP}_{(i)}]$ $- \sum_{f\in NEQ} \sum_{dd\in AA} [\mathrm{AT}_{(\mathrm{Inds,f,dd})} \times \mathrm{VAL}_{(\mathrm{Inds,f,dd})} \times (\mathrm{ROIL}_{(\mathrm{Inds,f,dd})}\text{-}1)]\ \ ]]\times$ $[\sum_{i\in NOD} \mathrm{V1CAP}_{(i)} \times (\mathrm{x1cap}_{(i)} + \mathrm{p1cap}_{(i)})$ $+[\mathrm{P2TOT\_INF}\times \sum_{i\in NOD} \mathrm{VCAP}_{(i)}] \times \mathrm{p2totinf}$ $+[\mathrm{P2TOT\_INF}\text{-}1]\times \sum_{i\in NOD} \mathrm{VCAP}_{(i)} \times (\mathrm{x1cap}_{(i)} + \mathrm{p2tot}_{(i)})$ $- \sum_{i\in NOD} [\mathrm{DEP}_{(i)} \times \mathrm{VCAP}_{(i)}]\times(\mathrm{x1cap}_{(i)} + \mathrm{p2tot}_{(i)})$ $- \sum_{f\in NEQ} \sum_{dd\in AA} [\mathrm{AT}_{(\mathrm{Inds,f,dd})} \times \mathrm{VAL}_{(\mathrm{Inds,f,dd})} \times \mathrm{ROIL}_{(\mathrm{Inds,f,dd})}]\times \mathrm{roipowl}_{(\mathrm{Inds,f,dd})}$ $- \sum_{f\in NEQ} \sum_{dd\in AA} [\mathrm{AT}_{(\mathrm{Inds,f,dd})} \times \mathrm{VAL}_{(\mathrm{Inds,f,dd})} \times (\mathrm{ROIL}_{(\mathrm{Inds,f,dd})}\text{-}1)]\times$ $(\mathrm{a\_t}_{(\mathrm{Inds,f,dd})} + \mathrm{v}_{(\mathrm{Inds,f,dd})})]\ -$ $[1/[\sum_{dd\in AA} \mathrm{AT}_{(\mathrm{Inds,Equity,dd})} \times \mathrm{VAL}_{(\mathrm{Inds,Equity,dd})}]] \times$ $[\sum_{d\in AA} [\mathrm{AT}_{(\mathrm{Inds,Equity,dd})} \times \mathrm{VAL}_{(\mathrm{Inds,Equity,dd})}]\times(\mathrm{a\_t}_{(\mathrm{Inds,Equity,dd})} + \mathrm{v}_{(\mathrm{Inds,Equity,dd})})]$	
Power of the rate of return on reproducible housing equity		

E_f_roipow_rhe	$[ROI\_EQ\_D_{(RH)}/(ROI\_EQ\_D_{(RH)}-1)] \times$ $\{roipoweqc_{(RH)} - f\_roipow\_rhe\} =$ $[1/[\ V1CAP\_RH + (P2TOT\_INF\_RH-1) \times VCAP\_RH$ $- \sum_{f \in NEQ} \sum_{dd \in AA} [AT_{(RH,f,dd)} \times VAL_{(RH,f,dd)} \times (ROIL_{(RH,f,dd)}-1)]\ ]] \times$ $[V1CAP\_RH \times (cap\_trh + p1cap_{(Dwelling)}) +$ $P2TOT\_INF\_RH \times VCAP\_RH \times p2tinf\_rh +$ $[\{P2TOT\_INF\_RH-1\} \times VCAP\_RH] \times (cap\_trh + p2tot_{(Dwelling)})$ $- \sum_{f \in NEQ} \sum_{dd \in AA} [AT_{(RH,f,dd)} \times VAL_{(RH,f,dd)} \times ROIL_{(RH,f,dd)}] \times roipowl_{(RH,f,dd)}$ $- \sum_{f \in NEQ} \sum_{dd \in AA} [AT_{(RH,f,dd)} \times VAL_{(RH,f,dd)} \times$ $(ROIL_{(RH,f,dd)}-1)] \times (a\_t_{(RH,f,dd)} + v_{(RH,f,dd)})\ ]\ -$ $[1/[\sum_{dd \in AA} AT_{(RH,Equity,dd)} \times VAL_{(RH,Equity,dd)})] \times$ $[\sum_{dd \in AA} [AT_{(RH,Equity,dd)} \times VAL_{(RH,Equity,dd)}] \times (a\_t_{(RH,Equity,dd)} + v_{(RH,Equity,dd)})]$	
Power of the rate of return on non-reproducible housing equity		

E_f_roipow_nrhe	$[ROI\_EQ\_D_{(NRH)}/(ROI\_EQ\_D_{(NRH)}-1)]\times$ $\{roipoweqc_{(NRH)} - f\_roipow\_nrhe\} =$ $[1/[\ V1CAP\_NRH + (P2T\_INF\_NRH-1)\times VCAP\_NRH$ $-\sum_{f\in NEQ}\sum_{dd\in AA}[AT_{(NRH,f,dd)}\times VAL_{(NRH,f,dd)}\times(ROIL_{(NRH,f,dd)}-1)]\ ]]\times$ $[V1CAP\_NRH\times p1cap_{(house)} +$ $P2T\_INF\_NRH\times VCAP\_NRH\times p2tinf\_nrh +$ $[\{P2T\_INF\_NRH-1\}\times VCAP\_NRH]\times p2tot_{(house)}$ $-\sum_{f\in NEQ}\sum_{dd\in AA}[AT_{(NRH,f,dd)}\times VAL_{(NRH,f,dd)}\times ROIL_{(NRH,f,dd)}]\times roipowl_{(NRH,f,dd)}$ $-\sum_{f\in NEQ}\sum_{dd\in AA}[AT_{(NRH,f,dd)}\times VAL_{(NRH,f,dd)}\times(ROIL_{(NRH,f,dd)}-1)]$ $\times(a\_t_{(NRH,f,dd)} + v_{(NRH,f,dd)})\ ] -$ $[1/[\sum_{dd\in AA} AT_{(NRH,Equity,dd)}\times VAL_{(NRH,Equity,dd)}\ ]]\times$ $[\sum_{dd\in AA}[AT_{(NRH,Equity,dd)}\times VAL_{(NRH,Equity,dd)}]\times$ $(a\_t_{(NRH,Equity,dd)} + v_{(NRH,Equity,dd)})]$	
Connecting physical capital formation with the cost of financial capital		
E_d_wacc	$d\_WACC_{(s)} = 0.01\times AVE\_ROI_{(s)}\times ave\_ror\_s_{(s)}$	$(s\in LALF)$
E_fd_WACC	$d\_rwacc_{(i)} = d\_WACC_{(i)} + fd\_WACC_{(i)}$	$(i\in KLA)$
Linking the weighted average cost of capital with the expected rate of return.		
E_d_eriror	$d\_eriror_{(i)} = d\_rwacc_{(i)} + d\_f\_rwacc_{(i)}$	$(i\in INDP)$
Expected rate of return related to capital growth rate and current rate of return		

E_del_k_gr	$d\_eriror_{(i)} = d\_neriror_{(i)} - (1/COEFF\_SL_{(i)}) \times$ $[\ 1/(K\_GR_{(i)} - K\_GR\_MIN_{(i)}) +$ $1/(K\_GR\_MAX_{(i)} - K\_GR_{(i)})\ ] \times del\_k\_gr_{(i)} - d\_feriror_{(i)}$	$(i \in INDP)$
Risk-weighted bank assets		
E_p_ra_bank1	$RA\_BANK1 \times p\_ra\_bank1 = \sum_{s \in LA} \sum_{f \in FI} [RISKWGT_{(s,f)} \times AT1_{(s,f,Banks)}] \times (p\_riskwgt_{(s,f)} + a\_t\_1_{(s,f,Banks)})$	
Value of bank equity		
E_p_eq_bank1	$EQ\_BANK1 \times p\_eq\_bank1 = \sum_{d \in AA} AT1_{(Banks,Equity,d)} \times a\_t\_1_{(Banks,Equity,d)}$	
Ratio of bank equity to risk-weighted bank assets		
E_p_ratio_t1	$p\_ratio\_t1 = p\_eq\_bank1 - p\_ra\_bank1$	
Non-equity financing needs of commercial banks		
E_big_budl_neq	$BIGBUDNEQ_{(s)} \times big\_budl\_neq_{(s)} =$ $BIGBUDGETL_{(s)} \times big\_budl_{(s)} - \sum_{d \in AA} AT1_{(s,Equity,d)} \times a\_t\_1_{(s,Equity,d)}$	$(s \in LALF)$
Average cost of non-equity finance		
E_ave_ror_sne	$ave\_ror\_sne_{(s)} = \sum_{d \in AA} \sum_{f \in FINEQ} [AT1_{(s,f,d)} / BIGBUDNEQ_{(s)}] \times roipowl_{(s,f,d)}$	$(s \in LALF)$
Liability optimisation over non-equity financing instruments		
E_f_bank_eq	$a\_t\_1\_d_{(Banks,f)} = big\_budl\_neq_{(Banks)} +$ $(TAU-1) \times [roipowl\_d_{(Banks,f)} - ave\_ror\_sne_{(Banks)}] + f\_bank\_eq_{(f)}$	$(f \in FINEQ)$

Bank holdings of cash and reserves with the central bank		
E_p_bankresr	$BANKRESR \times p\_bankresr =$ $AT1_{(CB,Cash,Banks)} \times a\_t\_1_{(CB,Cash,Banks)} +$ $AT1_{(CB,DeposLoans,Banks)} \times a\_t\_1_{(CB,DeposLoans,Banks)}$	
Household deposits with banks		
E_p_bankdepo	$p\_bankdepo = a\_t\_1_{(Banks,DeposLoans,Hlds)}$	
Ratio of bank reserves to bank deposits		
E_p_resratio	$p\_resratio = p\_bankresr - p\_bankdepo$	
Bank assets excluding cash and deposits with the central bank		
E_big_bud_nr	$BIGBUDNR_{(d)} \times big\_bud\_nr_{(d)} = BIGBUDGET_{(d)} \times big\_bud_{(d)} -$ $AT1_{(CB,Cash,d)} \times a\_t\_1_{(CB,Cash,d)} - AT1_{(CB,DeposLoans,d)} \times a\_t\_1_{(CB,DeposLoans,d)}$	$(d \in AA)$
Average rate of return earned on non-reserve assets		
E_ave_ror_nr	$ave\_ror\_nr_{(d)} =$ $\sum_{s \in LANCB} \sum_{f \in FI} (AT1_{(s,f,d)} / [BIGBUDNR_{(d)} + TINY]) \times roipowa_{(s,f,d)} +$ $\sum_{f \in NOTCASHDEP} (AT1_{(CB,f,d)} / [BIGBUDNR_{(d)} + TINY]) \times roipowa_{(CB,f,d)}$	$(d \in AA)$
Non-reserve assets held by banks		
E_f_bankres1	$a\_t\_1_{(s,f,Banks)} = big\_bud\_nr_{(Banks)} +$ $ELAS\_AS \times [roipowa_{(s,f,Banks)} - ave\_ror\_nr_{(Banks)}] + f\_bankres1_{(s,f)}$	$(s \in LANCB)\ (f \in FI)$

E_f_bankres2	$a\_t\_1_{(s,f,Banks)} = big\_bud\_nr_{(Banks)} + ELAS\_AS \times [roipowa_{(s,f,Banks)} - ave\_ror\_nr_{(Banks)}] + f\_bankres2_{(s,f)}$	$(s \in CBSET)$ $(f \in NOTCD)$
Ratio of bank cash holdings to bank deposits with central bank		
E_r_cash_cbdep	$r\_cash\_cbdep = a\_t\_1_{(CB,Cash,Banks)} - a\_t\_1_{(CB,DeposLoans,Banks)}$	
Commercial bank financial costs and revenues		
E_d_bankrev	$100 \times d\_bankrev = \sum_{s \in LA} \sum_{f \in FI} \left[AT1_{(s,f,Banks)} \times (ROIA_{(s,f,Banks)} - 1) \right] \times a\_t\_1_{(s,f,Banks)} + \sum_{s \in LA} \sum_{f \in F} \left[ROIA_{(s,f,Banks)} \times AT1_{(s,f,Banks)} \right] \times roipowA_{(s,f,Banks)}$	
E_d_bankcst	$100 \times d\_bankcst = \sum_{f \in FI} \sum_{d \in AA} \left[AT1_{(Banks,f,d)} \times (ROIL_{(Banks,f,d)} - 1) \right] \times a\_t\_1_{(Banks,f,d)} + \sum_{f \in FI} \sum_{d \in AA} \left[AT1_{(Banks,f,d)} \times ROIL_{(Banks,f,d)} \right] \times roipowL_{(Banks,f,d)}$	
E_d_bankprofit	$d\_bankprofit = d\_bankrev - d\_bankcst$	
Bank balance sheet		
E_d_f_liaacq_bank	$d\_new\_liaacq_{(Banks)} = d\_new\_assacq_{(Banks)} + d\_f\_liaacq\_bank$	
New liability acquisition by the superannuation sector		
E_sup_con_rate	$[100/NEW\_LIA\_ACQ_{(Super)}] \cdot d\_new\_liaacq_{(Super)} = w1lab\_oi + sup\_con\_rate$	
Asset acquisition by the superannuation sector		
E_fd_super_assac	$d\_new\_assacq_{(Super)} = d\_new\_liaacq_{(Super)} + fd\_super\_assac$	

Assets under management of the superannuation sector		
E_p_superassets	$SUPERASSETS \times p\_superassets = \sum_{s \in LA} \sum_{f \in FI} [AT_{(s,f,Super)} \times VAL_{(s,f,Super)}] \times (a\_t_{(s,f,Super)} + v_{(s,f,Super)})$	
Average return on superannuation assets		
E_p_roipow_supa	$[ROIPOW\_SUPER \times SUPERASSETS] \times (p\_roipow\_supa + p\_superassets) =$ $\sum_{s \in LA} \sum_{f \in FI} [AT_{(s,f,Super)} \times VAL_{(s,f,Super)} \times ROIA_{(s,f,Super)}] \times (a\_t_{(s,f,Super)} + v_{(s,f,Super)} + roipowa_{(s,f,Super)})$	
Change in expected superannuation revenue		
E_d_superrev	$100 \times d\_superrev =$ $\sum_{s,LA} \sum_{f,FI} AT1_{(s,f,Super)} \times (ROIA_{(s,f,Super)} - 1) \times a\_t\_1_{(s,f,Super)} +$ $\sum_{s \in LA} \sum_{f \in FI} ROIA_{(s,f,Super)} \times AT1_{(s,f,Super)} \times roipowA_{(s,f,Super)}$	
Change in expected superannuation costs		
E_d_supercst	$100 \times d\_supercst =$ $\sum_{f,FI} \sum_{d,AA} AT1_{(Super,f,d)} \times (ROIL_{(Super,f,d)} - 1) \times a\_t\_1_{(Super,f,d)} +$ $\sum_{f \in FI} \sum_{d \in AA} AT1_{(Super,f,d)} \times ROIL_{(Super,f,d)} \times roipowL_{(Super,f,d)}$	
Superannuation net financial revenue		
E_d_superprofit	d_superprofit = d_superrev + d_super_sub - d_supercst	
End-of-period portfolio excluding super-issued deposits and equity		
E_big_bud_ns	$BIGBUDNS_{(d)} \times big\_bud\_ns_{(d)} = BIGBUDGET_{(d)} \times big\_bud_{(d)} -$ $AT1_{(Super,Equity,d)} \times a\_t\_1_{(Super,Equity,d)} - AT1_{(Super,DeposLoans,d)} \times a\_t\_1_{(Super,DeposLoans,d)}$	$(d \in AA)$

Average rate of return on non-superannuation assets		
E_ave_ror_ns	$\text{ave\_ror\_ns}_{(d)} = \sum_{s\in LANSUPER}\sum_{f\in FI}(\text{AT1}_{(s,f,d)}/\text{BIGBUDNS}_{(d)})\times \text{roipowa}_{(s,f,d)} + \sum_{f\in NOTDEPEQTY}(\text{AT1}_{(Super,f,d)}/\text{BIGBUDNS}_{(d)})\times \text{roipowa}_{(Super,f,d)}$	$(d \in AA)$
Non-super assets held by households		
E_f_Super1	$\text{a\_t\_1}_{(s,f,Households)} = \text{big\_bud\_ns}_{(Households)} + \text{ELAS\_AS}\times[\text{roipowa}_{(s,f,Households)} - \text{ave\_ror\_ns}_{(Households)}] + \text{f\_Super1}_{(s,f)}$	$(s \in LANSUPER)$ $(f \in FI)$
Residual (i.e. not debt or equity) liabilities issued by super (all zero)		
E_f_Super2	$\text{a\_t\_1}_{(s,f,Super)} = \text{big\_bud\_ns}_{(Households)} + \text{ELAS\_AS}\times[\text{roipowa}_{(s,f,Households)} - \text{ave\_ror\_ns}_{(Households)}] + \text{f\_Super2}_{(s,f)}$	$(s \in SUPERSET)$ $(f \in NOTDEPEQTY)$
Ratio of household holdings of two types of super liabilities: deposits/loans & equity		
E_r_dep_equity	$\text{r\_dep\_equity} = \text{a\_t\_1}_{(Super,DeposLoans,Households)} - \text{a\_t\_1}_{(Super,Equity,Households)}$	
Relationship between the savings rate and the superannuation contribution rate		
E_ff_apc_gnp	$\text{apc\_gnp} + \text{ff\_apc\_gnp} = -[100\times(1\text{-SCROWD})\times(\text{V1LAB\_OI\_I} / \text{V3TOT\_I})]\times \text{d\_sup\_con\_rate}$	
Change in expected NBFI revenue		

E_d_nbfirev	$100 \times \text{d\_nbfirev} =$ $\sum_{s,LA}\sum_{f,FI}\left[AT1_{(s,f,NonBankFinIn)} \times (ROIA_{(s,f,NonBankFinIn)}\text{-}1)\right] \times a\_t\_1_{(s,f,NonBankFinIn)} +$ $\sum_{s,LA}\sum_{f,FI}\left[ROIA_{(s,f,NonBankFinIn)} \times AT1_{(s,f,NonBankFinIn)}\right] \times roipowA_{(s,f,NonBankFinIn)}$	
Change in expected NBFI costs		
E_d_nbficst	$100 \times \text{d\_nbficst} =$ $\sum_{f \in FI}\sum_{d \in AA} AT1_{(NonBankFinIn,f,d)} \times (ROIL_{(NonBankFinIn,f,d)}\text{-}1) \times a\_t\_1_{(NonBankFinIn,f,d)} +$ $\sum_{f \in FI}\sum_{d \in AA} AT1_{(NonBankFinIn,f,d)} \times ROIL_{(NonBankFinIn,f,d)} \times roipowL_{(NonBankFinIn,f,d)}$	
Change in expected NBFI profit		
E_d_nbfiprofit	d_nbfiprofit = d_nbfirev - d_nbficst	
NBFI new liability acquisition linked to new asset acquisition		
E_f_liaacq_nbfi	$d\_new\_liaacq_{(NonBankFinIn)} = d\_new\_assacq_{(NonBankFinIn)} + d\_f\_liaacq\_nbfi$	
Change in expected life insurance revenue		
E_d_liferev	$100 \times \text{d\_liferev} =$ $\sum_{s,LA}\sum_{f,FI}\left[AT1_{(s,f,LifeIns)} \times (ROIA_{(s,f,LifeIns)}\text{-}1)\right] \times a\_t\_1_{(s,f,LifeIns)} +$ $\sum_{s,LA}\sum_{f,FI}\left[ROIA_{(s,f,LifeIns)} \times AT1_{(s,f,LifeIns)}\right] \times roipowA_{(s,f,LifeIns)}$	
Change in expected life insurance costs		

E_d_lifecst	$100 \times \text{d\_lifecst} =$ $\sum_{f\in FI}\sum_{d\in AA} AT1_{(LifeIns,f,d)} \times (ROIL_{(LifeIns,f,d)} - 1) \times a\_t\_1_{(LifeIns,f,d)} +$ $\sum_{f\in FI}\sum_{d\in AA} AT1_{(LifeIns,f,d)} \times ROIL_{(LifeIns,f,d)} \times roipowL_{(LifeIns,f,d)}$	
Change in life insurance profit		
E_d_lifeprofit	$\text{d\_lifeprofit} = \text{d\_liferev} - \text{d\_lifecst}$	
New liability acquisition by life insurance linked to new asset acquisition		
E_f_liaacq_life	$\text{d\_new\_liaacq}_{(LifeIns)} = \text{d\_new\_assacq}_{(LifeIns)} + \text{d\_f\_liaacq\_life}$	
End of period portfolio, excluding foreign assets		
E_big_bud_nf	$BIGBUDNF_{(d)} \times big\_bud\_nf_{(d)} =$ $BIGBUDGET_{(d)} \times big\_bud_{(d)} - \sum_{f\in FI} AT1_{(Foreigners,f,d)} \times a\_t\_1_{(Foreigners,f,d)}$	$(d \in AA)$
Average rate of return earned on domestic assets		
E_ave_ror_nf	$BIGBUDNF_{(d)} \times ave\_ror\_nf_{(d)} = \sum_{s\in DOMAGENT}\sum_{f\in FI} AT1_{(s,f,d)} \times roipowa_{(s,f,d)}$	$(d \in AA)$
Asset optimising over non-foreign assets		
E_f_cb_asset1	$a\_t\_1_{(s,f,d)} = big\_bud\_nf_{(d)} + ELAS\_AS \times [roipowa_{(s,f,d)} - ave\_ror\_nf_{(d)}] + f\_cb\_asset1_{(s,f,d)}$	$(s \in DOMAGENT)$ $(f \in FI)$ $(d \in AA)$
End-of-period portfolio, foreign assets only		

E_big_bud_for	$BIGBUDFOR_{(d)} \times big\_bud\_for_{(d)} = BIGBUDGET_{(d)} \times big\_bud_{(d)} - \sum_{s \in DOMAGENT} \sum_{f \in FI} AT1_{(s,f,d)} \times a\_t\_1_{(s,f,d)}$	$(d \in AALF)$
Average rate of return on foreign assets		
E_ave_ror_for	$BIGBUDFOR_{(d)} \times ave\_ror\_for_{(d)} = \sum_{f \in FI} AT1_{(Foreigners,f,d)} \times roipowa_{(Foreigners,f,d)}$	$(d \in AALF)$
Optimising over foreign assets		
E_f_cb_asset2	$a\_t\_1_{(Foreigners,f,d)} = big\_bud\_for_{(d)} + ELAS\_AS \times [roipowa_{(Foreigners,f,d)} - ave\_ror\_for_{(d)}] + f\_cb\_asset2_{(f,d)}$	$(f \in FI)$ $(d \in AALF)$
Relationship between expected wage growth and lagged unemployment		
E_fp1lab_oi4	$(p1lab\_oi\_targ - p3tot\_exp) - (p1lab\_oi\_l - p3tot\_l) = WAGE\_ELAS2 \times emprate\_l + fp1lab\_oi4$	
Expected rate of CPI inflation set equal to trend value of CPI inflation		
E_fp3tot_exp2	$p3tot\_exp = p3tot\_l + p3tr\_pow\_exp + fp3tot\_exp2$	
Expected power of the rate of CPI inflation set equal to trend value of power of rate of inflation		
E_p3tr_pow_exp	$p3tr\_pow\_exp = p3tr\_pow$	
Power of the trend rate of CPI inflation		
E_p3tr_pow	$TREND\_P3 \times p3tr\_pow = [TREND\_ADJ2 \times TREND\_P3\_L] \times p3tr\_pow\_l + [[1-TREND\_ADJ2] \times INF3POW\_L] \times p3inf\_pow\_l$	
Lagged value of the percentage change in the trend value of CPI growth		

E_dp3tr_pow_l	$TREND\_P3\_L \times p3tr\_pow\_l =$ $100 \times [TREND\_P3\_B - TREND\_P3\_L\_B] \times del\_unity +$ $100 \times dp3tr\_pow\_l$	
Lagged value of the percentage change in the power of CPI growth		
E_dp3inf_pow_l	$INF3POW\_L \times p3inf\_pow\_l =$ $100 \times [INF3POW\_B - INF3POW\_L\_B] \times del\_unity$ $+ 100 \times dp3inf\_pow\_l$	
Relationship between actual and target wage growth		
E_d_f_w_pow	$LEV\_NWPOW \times (p1lab\_oi - p1lab\_oi\_l) =$ $\left[WGRADJ \times [WAGETARG / LEV\_WAGE\_L]\right] \times$ $\{p1lab\_oi\_targ - p1lab\_oi\_l\} +$ $\left[[1-WGRADJ] \times LEV\_NWPOW\_L\right] \times w\_pow\_l +$ $100 \times d\_f\_w\_pow$	
Lagged value of the percentage change in the power of nominal wage growth		
E_d_w_pow_l	$LEV\_NWPOW\_L \times w\_pow\_l =$ $100 \times (LEV\_NWPOW\_B - LEV\_NWPOW\_LB) \times del\_unity +$ $100 \times d\_w\_pow\_l$	

Table 16: Coefficients and parameters

Name	Range	Description
ALFA	-	Weight on realised returns on equity in establishing expected returns on equity on the part of asset agents.
$AT_{(s,f,d)}$	$(s \in LA)$ $(f \in FI)$ $(d \in AA)$	Start-of-year holdings by agent (d) of asset type (f) issued by agent (s).
$AT\_B_{(s,f,d)}$	$(s \in LA)$ $(f \in FI)$ $(d \in AA)$	Initial value for the start-of-year holdings by agent (d) of asset type (f) issued by agent (s).
$AT1\_D_{(s,f)}$	$(s \in LALF)$ $(f \in FI)$	End-of-year liabilities of type (f) issued by agent (s).
$AT1_{(s,f,d)}$	$(s \in LA)$ $(f \in FI)$ $(d \in AA)$	End-of-year holdings by agent (d) of asset type (f) issued by agent (s).
$AT1\_B_{(s,f,d)}$	$(s \in LA)$ $(f \in FI)$ $(d \in AA)$	Initial value for the end-of-year holdings by agent (d) of asset type (f) issued by agent (s).
$AVE\_ROI_{(s)}$	$(s \in LALF)$	Average power of the rate of return on the liabilities of agent (s).
BANKRESR	-	Value of bank holdings of cash and deposits with the central bank.
$BIGBUDFOR_{(d)}$	$(d \in AALF)$	Value of agent (d)'s holdings of foreign financial assets.
$BIGBUDGET_{(d)}$	$(d \in AA)$	Aggregate end-of-year asset holdings by agent (d).
$BIGBUDGETL_{(s)}$	$(s \in LALF)$	Aggregate end-of-year liabilities of agent (s).
$BIGBUDNEQ_{(s)}$	$(s \in LALF)$	Equity-exclusive value of the liabilities of agent (s).
$BIGBUDNF_{(d)}$	$(d \in AA)$	That part of asset agent (d)'s financial assets relating to domestic financial assets only.
$BIGBUDNR_{(d)}$	$(d \in AA)$	Level of end-of-year asset holdings excluding cash and deposits with the central bank.
$BIGBUDNS_{(d)}$	$(d \in AA)$	End of period portfolio, excluding Super-issued deposits & equity.
$COEFF\_SL_{(i)}$	$(i \in INDP)$	Coefficient governing the elasticity of investment to rates of return.
$DEP_{(i)}$	$(i \in IND)$	Rate of depreciation of physical capital, industry (i).
ELAS_AS	-	Elasticity of portfolio shares to relative rates of return.
EQ_BANK1	-	Value of bank equity, end of year.
$G\_VINVEST_{(i)}$	$(i \in IND)$	Value of public investment in industry (i).
HOUS_DIS_INC	-	Household disposable income.
INF3POW_L	-	Lagged level of the power of CPI inflation.
INF3POW_B	-	Level of the power of the growth in the CPI, base.
INF3POW_L_B	-	Lagged level of the power of the growth in CPI, base.
$K\_GR_{(i)}$	$(i \in INDP)$	Level of the capital growth rate.
$K\_GR\_MIN_{(i)}$	$(i \in INDP)$	Lowest possible rate of physical capital growth for sector (i).
$K\_GR\_MAX_{(i)}$	$(i \in INDP)$	Highest possible rate of physical capital growth for sector (i).

LEV_NWPOW	-	Level of the power (1+the rate rate) of the growth in nominal wages.
LEV_NWPOW_B		Level of the power of the growth in nominal wages, base t-1.
LEV_NWPOW_L	-	Lagged level of the power of nominal wage growth.
LEV_NWPOW_LB		Lagged level of power of the growth in nominal wages, base
LEV_WAGE_L	-	Lagged level of the wage, that is its level in *t*-1.
P2TOT_INF	-	Anticipated rate of inflation for industry capital.
P2T_INF_NRH	-	Anticipated rate of inflation for non-reproducible housing.
P2TOT_INF_RH		Anticipate rate of inflation for reproducible housing capital.
QCAP_RH		Quantity of capital in the reproducible housing sector.
$QINVEST\_B_{(i)}$	$(i \in IND)$	Quantity of investment in year t-1 in industry *i*.
RA_BANK1	-	Value of risk-weighted bank assets, end of year.
$RISKWGT_{(s,f)}$	$(s \in LA)$ $(f \in FI)$	Bank risk weight attaching to financial instrument (f) issued by liability agent (s).
$ROI\_EQ\_D_{(s)}$	$(s \in KLA)$	Power of the realised rate of return on the equity of industry, reproducible housing, and non-reproducible housing.
$ROIA_{(s,f,d)}$	$(s \in LA)$ $(f \in FI)$ $(d \in AA)$	Power of the rate of interest as seen by asset holders.
$ROIL_{(s,f,d)}$	$(s \in LA)$ $(f \in FI)$ $(d \in AA)$	Power of the rate of interest as seen by liability holders.
SCROWD	-	Share of superannuation contributions representing displaced savings.
TAU		Transformation elasticity between liabilities.
TREND_ADJ2	-	Proportion of P3INF_TREND(t-1) carrying to period (t).
TREND_P3	-	Power of the trend growth in the CPI (e.g. 1.025).
TREND_P3_B	-	Base value of power of trend growth in the CPI
TREND_P3_L	-	Lagged value of trend power of the growth rate in the CPI.
TREND_P3_L_B	-	Lagged value of power of trend growth in the CPI, base
$VEXCH_{(s,f,d)}$	$(s \in LA)$ $(f \in FI)$ $(d \in AA)$	Dummy variable, =1 for $VEXCH_{(Foreigners,f,d)}$ $\forall$ f,d, but otherwise =0.
$V1CAP_{(i)}$	$(i \in IND)$	Value of the returns to capital of industry (i).
V1CAP_NRH		Value of returns to capital of the non-reproducible housing.
V1CAP_RH		Value of returns to capital of reproducible housing.
$VCAP_{(i)}$	$(i \in IND)$	Value of the physical capital stock of industry (i).
VCAP_NRH	-	Value of the physical capital stock of non-reproducible housing.
VCAP_RH		Value of the physical stock of reproducible housing.
V1LAB_OI_I		Value of payments to labour, initial.
V2IND		Value of private investment (excluding investment in dwellings) plus net inventory accumulation.
$V2TOT_{(i)}$	$(i \in IND)$	Value of investment (private and public) in industry *i*.
V2TOT_I		Value of aggregate economy-wide investment.
V3TOT		Nominal private consumption.

V3TOT_I		Nominal private consumption, initial.
V6TOT		Value of aggregate inventory accumulation.
$VAL_{(s,f,d)}$	$(s \in LA)$ $(f \in FI)$ $(d \in AA)$	Power of the valuation term applying to holdings by agent (d) of financial instrument (f) issued by agent (s).
$VCAP_{(i)}$	$(i \in IND)$	Value of industry (i)'s capital stock at the start of the year.
VCAP_RH	-	Value of the capital stock of the reproducible housing sector.
VCAP_NRH	-	Value of the capital stock of the non-reproducible housing sector.
$VEXCH_{(s,f,d)}$	$(s \in LA)$ $(f \in FI)$ $(d \in AA)$	Dummy variable for transmitting currency-induced valuation effects to domestic holding of foreign assets. Equal to 0 for f,d where $(s \in AALF)$, equal to 1 for all f,d for s = foreigners.
WAGE_ELAS2	-	Elasticity of the desired growth in the real wage in year (t) to the employment rate in year (t-1).
WAGETARG	-	Level of the target value of the nominal wage (via wage growth/employment rate curve).
WGRADJ	-	Governs adjustment of nominal wage to target.

Table 17: Variables (percentage change unless otherwise indicated)

Name	Range	Description	Closure(*)	
			Real CGE	**Financial CGE**
$a\_t_{(s,f,d)}$	$(s \in LA)$ $(f \in FI)$ $(d \in AA)$	Start-of-year holdings by agent (d) of asset type (f) issued by agent (s).	N	N
$a\_t\_1_{(s,f,d)}$	$(s \in LA)$ $(f \in FI)$ $(d \in AA)$	End-of-year holdings by agent (d) of asset type (f) issued by agent (s).	N	X: $a\_t\_1_{(Foreigners,f,CB)}$ $(f \in FI)$, rest endogenous. See Section 4.6.
$a\_t\_1\_d_{(s,f)}$	$(s \in LALF)$ $(f \in FI)$	End-of-year liabilities of type (f) issued by agent (s).	N	N
apc_gnp	-	Average propensity to consume.	X	N (See Section 4.9)
$ave\_ror\_nf_{(d)}$	$(d \in AA)$	Power of the weighted average rate of return earned by asset agent (d) on its domestic financial assets.	N	N
$ave\_ror\_nr_{(d)}$	$(d \in AA)$	Average rate of return on assets other than cash and central bank deposits.	N	N
$ave\_ror\_ns_{(d)}$	$(d \in AA)$	Average rate of return on asset agent (d)'s assets excluding instruments issued by Superannuation.	N	N
$ave\_ror\_d_{(d)}$	$(d \in AALF)$	Average rate of return received by agent (d).	N	N
$ave\_ror\_for_{(d)}$	$(d \in AALF)$	Percentage change in the power of the weighted average rate of return on agent (d)'s holdings of foreign financial assets.	N	N
ave_ror_row	$(s \in LA)$	Average rate of return available to foreigners in the rest of the world.	X	X
$ave\_ror\_s_{(s)}$	$(s \in LALF)$	Average rate of interest / return paid by liability agent (s).	N	N
$ave\_ror\_sne_{(s)}$	$(s \in LALF)$	Average rate of return on non-equity financial instruments issued by liability agent (s).	N	N
$big\_bud_{(d)}$	$(d \in AA)$	\$A value of end-of-year portfolio value.	N	N
$big\_bud\_for_{(d)}$	$(d \in AALF)$	Value of agent (d)'s holdings of foreign financial assets.	N	N

$big\_bud\_nf_{(d)}$	$(d \in AA)$	Asset agent (d)'s total holdings of domestic financial assets	N	N
$big\_bud\_nr_{(d)}$	$(d \in AA)$	End-of-period assets excluding cash holdings and deposits with the central bank.	N	N
$big\_bud\_ns_{(d)}$	$(d \in AA)$	End of period portfolio, excluding Superannuation-issued assets.	N	N
$big\_budl_{(s)}$	$(s \in LALF)$	$A value of end-of-year liabilities of agent (s).	N	N
$big\_budl\_neq_{(s)}$	$(s \in LALF)$	Percentage change in the equity-exclusive value of the liabilities of agent (s).	N	N
big_budf		Foreigners' budget for asset purchases, expressed in foreign currency terms.	X	X
$cap\_t_{(i)}$	$(i \in IND)$	Industry *i*'s start of year capital stock.	N	N
cap_trh	-	Quantity of capital in the reproducible housing sector.	X	N
$del\_k\_gr_{(i)}$	$(i \in INDP)$	Change in the capital growth rate.	N	N
dp3tr_pow_l	-	When exogenous, activates equation *E_dp3tr_pow_l*.	X	X
dp3inf_pow_l	-	When exogenous, activates equation *E_dp3inf_pow_l*.	X	X
d_bankcst	-	Change in bank financing costs.	N	
d_bankprofit	-	Change in difference between bank financial revenue and bank financial costs.	N	X (See Section 4.10)
d_bankrev		Change in bank revenue from holdings of financial instruments.	N	N
d_CAD	-	Change in the $A value of the current account deficit.	N	N
$d\_eriror_{(i)}$	$(i \in INDP)$	Expected rate of return.	N	N
d_f_cap_trf	-	When exogenous, activates equation *E_cap_trh*.	N	X
d_f_inds_eq	-	When exogenous, activates equation *E_ff_v_inds_eq*.	N	X (See Section 4.3)
d_f_liaacq_bank	-	When exogenous, links new bank liabilities to bank asset acquisition.	N	X (See Section 4.10)
d_f_liaacq_nbfi		When exogenous, links new liabilities of non-bank financial institutions to asset acquisitions of non-bank financial institutions.	N	X (See Section 4.11)

d_f_liaacq_life		When exogenous, links new liabilities of life insurance institutions to asset acquisitions of life insurance institutions.	N	X (See Section 4.11)
d_f_NRH_eq	-	When exogenous, activates equation E_ff_v_NRH_eq.	N	X (See Section 4.5)
d_f_RH_eq	-	When exogenous, activates equation E_ff_v_RH_eq.	N	X (see Section 4.4)
$d\_f\_rwacc_{(i)}$	$(i \in INDP)$	When exogenous, sets change in expected rate of return equal to change in weighted average cost of capital.	X	X
d_ff_govt	-	When exogenous, activates equation E_ff_govt.	N	X (See Section 4.2)
d_ff_phi	-	When exogenous, activates *E_d_ff_phi*.	N	X (See Section 4.8)
$d\_flow_{(s,f,d)}$	$(s \in LA)$ $(f \in FI)$ $(d \in AA)$	Change in the value of net acquisitions by agent (d) of financial instrument (f) issued by agent (s).	N	N
$d\_feriror_{(i)}$	$(i \in INDP)$	Shift in position of schedule relating expected rate of return to current rate of return and rate of capital growth.	X	N
d_gov_def	-	Change in the government deficit.	N	N
d_lifeprofit	-	Change in the difference between life insurance financial revenues and financial costs.	N	X (See Section 4.11).
d_liferev	-	Change in financial revenue received by life insurance as an asset agent.	N	N
d_lifecst	-	Change in financial costs paid by life insurance as a liability agent.	N	N
$d\_MTB_{(s,f)}$	$(s \in LALF)$ $(f \in FI)$	When exogenous, allows for two-stage liability optimisation.	X	N (s = Govt, $f \in FINDL$, see Section 4.2). N (s = Inds, $f \in FINDL$, see Section 4.3). N (s = RH, $f \in FINDL$, see Section 4.4). N (s = NRH, $f \in FINDL$, see Section 4.5).

				N (s = Super, $f \in$ FINDL, see Section 4.9). N (s = Banks, $f \in$ FINDL, see Section 4.10). N (s = LifeIns, $f \in$ FINDL, see Section 4.11). N (s = NonBankFinIn, $f \in$ FINDL, see Section 4.11).
d_nbfiprofit	-	Change in the difference between NBFI financial revenues and financial costs.	N	X (See Section 4.11).
d_nbfirev	-	Change in financial revenue received by NBFI as an asset agent.	N	N
d_nbficst	-	Change in financial costs paid by NBFI as a liability agent.	N	N
$d\_new\_assacq_{(d)}$	$(d \in AA)$	Change in total asset acquisitions by agent (d).	X	N (d = Govt, see Section 4.2) N (d = Inds, see Section 4.3) X (d=CB, see Section 4.6) N (d=Super, see Section 4.9) X (d=RH, NRH) N (d=LifeIns, See Section 4.11).

				N (d=NonBankFinIn, See Section 4.11). N (d=Hlds, See Section 4.7). N (d=foreigners, See Section 4.8).
$d\_new\_liaacq_{(s)}$	$(s \in LALF)$	Change in liability acquisition by agent (s).	X	N (s = Govt, see Section 4.2) N (s = Inds, see Section 4.3) N (s = RH, see Section 4.4) X (s = NRH, Hlds) N (s = Banks) N (s = NonBankFinIn, see Section 4.11) N (s = Life insurance, see Section 4.11) N (s = Super, see Section 4.9) N (s = CB) (See Section 4.6)
$d\_neriror_{(i)}$	$(i \in INDP)$	Change in the rate of return on physical capital.	N	N
$d\_rwacc_{(i)}$	$(i \in KLA)$	Weighted average cost of physical capital.	X	N
d_shiftH	-	When exogenous, activates equation *E_d_shiftH.*	N	X (see Section 4.7).
d_shiftind		When exogenous, activates equation *E_d_shiftind2.*	N	X (see Section 4.3)

$d\_shift4_{(d)}$	$(d \in AA)$	Exogenous shift variable. When exogenous, activates equation *E_d_shift4*.	N	X (d=foreigners, see Section 4.8) N ($d \in DOMAGENT$).
$d\_shiftl4_{(s)}$	$(s \in LALF)$	Checks consistency of aggregate new liability issuance and individual flows of financial liabilities. Should be zero.	N	X (s = CB) (See Section 4.6) N (s dne CB)
d_shiftRH	-	When exogenous, activates equation E_d_shiftRH	N	X (see Section 4.4)
d_supercst	-	Change in expected financial costs of the superannuation sector.	N	N
d_superprofit	-	Change in expected difference between financial revenues and financial costs of the superannuation sector.	N	X (see Section 4.9)
d_superrev	-	Change in the expected financial revenue of the superannuation sector.	N	N
d_super_sub	-	Change in government subsidisation of the superannuation sector.	X	X or N (See Section 4.9)
del_unity		Homotopy variable. With a shock value of 1, this ensures that year *t* values for stock variables reflect year *t*-1 values for relevant stock and flow variables.	X	X
$d\_WACC_{(s)}$	$(s \in LALF)$	Change in liability agent (s)'s weighted average cost of capital.	N	N
d_w_pow_l	-	When exogenous, activates *E_d_w_pow_l*.	X	X
$f2\_roipowl_{(s,f)}$	$(s \in LALF)$ $(f \in FI)$	(s,f)-specific shift variable on Equation *E_roipowl4*.	X	N (s=Govt, $f \in FINDL$, rest exogenous, see Section 4.2). N (s=Ind, $f \in FINDL$, rest exogenous, see Section 4.3). N (s=RH, $f \in FINDL$, rest exogenous, see Section 4.4). N (s=NRH, $f \in FINDL$, rest

				exogenous, see Section 4.5). N (s=Super, $f \in FINDL$, rest exogenous, see Section 4.9). N (s=Banks, $f \in FINDL$, rest exogenous, see Section 4.10). N (s=LifeIns, $f \in FINDL$, rest exogenous, see Section 4.11). N (s=NonBankFinIn, $f \in FINDL$, rest exogenous, see Section 4.11).
$f3\_roipowl_{(s,f,d)}$	($s \in LALF$) ($f \in FI$) ($d \in AA$)	(s,f,d)-specific shift variable on *Equation E_ropowl4*.	N	X (s=Govt, $f \in FINDL$, $d \in AA$, rest endogenous, see Section 4.2). X (s=Inds, $f \in FINDL$, $d \in AA$, rest endogenous, see Section 4.3). X (s=RH, $f \in FINDL$, $d \in AA$, rest endogenous, see Section 4.4). X (s=NRH, $f \in FINDL$, $d \in AA$, rest endogenous, see Section 4.5).

				X (s=Super, $f \in FINDL$, $d \in AA$, rest endogenous, see Section 4.9) X (s=Banks, $f \in FINDL$, $d \in AA$, rest endogenous, see Section 4.10). X (s=LifeIns, $f \in FINDL$, $d \in AA$, rest endogenous, see Section 4.11). X (s=NonBankFinIn, $f \in FINDL$, $d \in AA$, rest endogenous, see Section 4.11).
$f4\_roipowl_{(s)}$	$(s \in LALF)$	(s)-specific shift variable on Equation *E_roipowl4*.	X	X
$f4\_roipow_{(s,d)}$	$(s \in KAGENTS)$ $(d \in AA)$	When exogenous, activates equation *E_f4_roipow*.	N	X ($s \in KAGENTS$, see Sections 4.3, 4.4 and 4.5).
$f\_a\_t\_1_{(s,f,d)}$	$(s \in LA)$ $(f \in FI)$ $(d \in AALF)$	Shift variable for activating / deactivating equation *E_a_t_1dom*.	X	N: $f\_a\_t\_1_{(s,f,CB)}$ $(s \in LA)$ $(f \in FI)$, See Section 4.6. N: $f\_a\_t\_1_{(s,f,Banks)}$ $(s \in LA)$ $(f \in FI)$, See Section 4.10. Rest exogenous.
$f\_bank\_eq_{(f)}$	$(f \in FINEQ)$	When exogenous, activates equation *E_f_bank_eq*.	N	X (See Section 4.10).
$f\_bankres1_{(s,f)}$	$(s \in LANCB)$	When exogenous, activates equation *E_f_bankres1*.	N	X (See Section 4.10).

	$(f \in FI)$			
$f\_bankres2_{(s,f)}$	$(s \in CBSET)$ $(f \in NOTCD)$	When exogenous, activates equation *E_f_bankres2*.	N	X (See Section 4.10).
$f\_cb\_asset1_{(s,f,d)}$	$(s \in DOMAGENT)$ $(f \in FI)$ $(d \in AA)$	When exogenous, activates equation *E_f_cb_asset1*, imposing constrained asset optimising over the domestic component of agent (d)'s financial assets.	N	X (d=CB, $s \in DOMAGENT$, $f \in FI$, See Section 4.6).
$f\_cb\_asset2_{(f,d)}$	$(f \in FI)$ $(d \in AA)$	When exogenous, activates equation *E_f_cb_asset2*, imposing constrained asset optimisation over the foreign component of agent (d)'s financial assets.	N	N
$f\_roipow_{(s,f,d)}$	$(s \in LA)$ $(f \in FI)$ $(d \in AA)$	Ratio of rate of return on instrument *f* for asset and liability positions.	X	N ($s \in KAGENTS$, see Sections 4.3, 4.4 and 4.5).
$f\_roipow\_g_{(f,d)}$	$(f \in B\_DL)$ $(d \in AA)$	When exogenous, activates equation *E_roipow_g1*.	N	N
f_roipow_ie	-	When exogenous, activates equation *E_f_roipow_ie*.	X	X
f_roipow_rhe	-	When exogenous, activates equation *E_f_roipow_rhe.*	X	X
f_roipow_nrhe	-	When exogenous, activates equation *E_f_roipow_nrhe*.	X	X
fd_super_assac	-	When exogenous, activates equation *E_fd_super_assac.*	N	X (See Section 4.9)
$fd\_WACC_{(i)}$	$(i \in KLA)$	When exogenous, links changes in investment to changes in the weighted average cost of capital via the inverse-logistic function.	N	X
ff_apc_gnp	-	Shifter on equation *E_ff_apc_gnp*.	N	X (See Section 4.9)
fp1lab_oi4	-	When exogenous, activates equation E_fp1lab_oi4	N	X
fp3tot_exp2	-	When exogenous, activates equation E_fp3tot_exp2	N	X
$f\_v_{(s,f,d)}$	$(s \in LA)$ $(f \in FI)$ $(d \in AA)$	(s,f,d)-specific shifter on valuation terms in equation *E_v*.	X	X
$ff\_v_{(d)}$	$(d \in AA)$	Shifter on asset-agent-specific valuation terms in equation *E_v*.	X	X

$fff\_v_{(s,f)}$	($s \in LA$) ($f \in FI$)	(s,f)-specific shifter on valuation terms in equation *E_v*.	X	N (s=Inds,f=Equity), rest exogenous (see Section 4.3). N (s=RH,f=Equity), rest exogenous (see Section 4.4). N (s=NRH,f=Equity), rest exogenous (see Section 4.5).
$gv2tot_{(i)}$	($i \in IND$)	Government share of investment in industry (i).	X	X
hdy	-	Household disposable income.	N	N
$liab\_sh\_d_{(s,f)}$	($s \in LALF$) ($f \in FI$)	When exogenous, activates two-stage liability optimisation in which financial agents first optimise across financial instruments, before optimising across asset agents holding those instruments.	N	X (s=Inds, $f \in FI$) (see Section 4.3). X (s=RH, $f \in FI$) (See Section 4.4). X (s=NRH, $f \in FI$) (See Section 4.5). X (s=Super, $f \in FI$, see Section 4.9). N (s=Banks, $f \in FI$, see Section 4.10).
$liab\_shift_{(s,f,d)}$	($s \in LA$) ($f \in FI$) ($d \in AA$)	When exogenous, activates liability optimisation.	N	X (s=Govt, f=DeposLoans, $d \in AA$), rest endogenous (See Section 4.2). X (s=Inds, f=DeposLoans, $d \in AA$), rest endogenous (See Section 4.3).

				X (s=RH, f=DeposLoans, d $\in$ AA), rest endogenous (See Section 4.4). X (s=NRH, f=DeposLoans, d $\in$ AA), rest endogenous (See Section 4.5). X (s=Super, f =DeposLoans, d $\in$ AA), rest endogenous (See Section 4.9). X (s=Banks, f=DeposLoans, d $\in$ AA), rest endogenous (See Section 4.10). X (s=LifeIns, f=DeposLoans, d $\in$ AA), rest endogenous (See 4.11). X (s=NonBankFinIn, f=DeposLoans, d $\in$ AA), rest endogenous (See 4.11).
p_bankdepo	-	Deposits (by households) with banks.	N	N
p_bankresr	-	Percentage change in bank holdings of cash and deposits with the central bank.	N	N
p_resratio		Ratio of bank reserves to bank deposits.	N	X (See Section 4.10).
$p1cap_{(i)}$	(i $\in$ IND)	Rental price of industry (i) capital.	N	N

p1lab_oi_targ	-	Desired growth in the nominal wage	N	N
p1lab_oi_l	-	Lagged rate of growth in the nominal wage	N	N
p2tinf_nrh	-	Value of the rate of inflation in the price of non-reproducible housing.	X	X
p2tinf_rh	-	Anticipated rate of inflation in the price of reproducible housing.	X	X
$p2tot_{(i)}$	$(i \in INDP)$	Per-unit cost of capital in industry (i).	N	N
p2totinf		Anticipated rate of inflation for industry capital.	X	X
p3inf_pow_l		Percentage change in the power of the growth rate in the CPI, year (t-1).	N	N
p3tot_exp	-	Expected rate of consumer price inflation	N	N
p3tot_l	-	Lagged rate of growth in the consumer price index	N	N
p3tr_pow_exp	-	Percentage change in the power of the expected trend rate of CPI inflation.	N	N
p3tr_pow	-	Percentage change in the power of the trend rate of CPI inflation.	N	N
p3tr_pow_l	-	Lagged value of the percentage change in the power of the trend growth in the CPI.	N	N
p6tot		Price index for economy-wide inventory accumulation.	N	N
phi		Nominal exchange rate, $Foreign / $local.	X	N (See Section 4.8).
p_eq_bank1	-	Percentage change in end-of-year bank equity.	N	N
p_ra_bank1	-	Percentage change in the risk-weighted value of commercial bank end-of-year assets.	N	N
p_ratio_t1	-	When exogenous, links bank equity requirements to risk-weighted assets.	N	X (See Section 4.10).
$p\_riskwgt_{(s,f)}$	$(s \in LA)$ $(f \in FI)$	Percentage change in the value of the risk weight attached to commercial bank holdings of financial instrument (f) issued by liability agent (s).	X	X
roiB_DL_G	-	Common power for rate of interest on government bonds and loans to government.	X	X

$roipowa_{(s,f,d)}$	$(s \in LA)$ $(f \in FI)$ $(d \in AALF)$	Power of the rate of interest / return on financial instrument (f) issued by agent (s) held by agent (d).		
$roipoweqc_{(s)}$	$(s \in KLA)$	Power of the realised return on equity issued by capital agent (s)	N	N
$roipowl_{(s,f,d)}$	$(s \in LA)$ $(f \in FI)$ $(d \in AA)$	Power of the rate of interest / return paid to agent (d) on financial instrument (f) issued by agent (s).	X	N (s=Govt, $\forall$ f,d)(See Section 4.2) N (s=Inds, f $\in$ FI, d $\in$ AA) (See Section 4.3) N (s=RH, f $\in$ FI, d $\in$ AA) (See Section 4.4) N (s=NRH, f $\in$ FI, d $\in$ AA) (See Section 4.5) N (s=Super, $\forall$ f,d) (See Section 4.9).
$roipowl\_d_{(s,f)}$	$(s \in LALF)$ $(f \in FI)$	Average power of the rate of interest / return paid by liability agent (s) on instrument (f).	N	N
r_cash_cbdep	-	Ratio of bank cash holdings to bank central bank deposits.	N	X (See Section 4.10)
shiftG	-	When exogenous, activates equation *E_shiftG*.	N	X (see Section 4.2)
shiftind	-	When exogenous, activates equation *E_shiftind*.	N	X (see Section 4.3)
sup_con_rate		When exogenous, activates equation *E_sup_con_rate*.	N	X (See Section 4.9)
$v_{(s,f,d)}$	$(s \in LA)$ $(f \in FI)$ $(d \in AA)$	Power of the revaluation term applying to financial instrument (f) issued by agent (s) and held by agent (d).	N	N
w0gdpinc	-	Nominal GDP at market prices.	N	N
w2_ind		Value of investment plus inventories excluding government	N	N

		investment and private investment in ownership of dwellings.		
w2tot_i		Nominal economy-wide gross fixed capital formation.	N	N
w3tot	-	Nominal private consumption spending	N	N
w5tot	-	Nominal public consumption spending.	N	N
w_pow_l	-	Percentage change in the power of the growth rate in the nominal wage, year (t-1).	N	N
$x1cap_{(i)}$	$(i \in IND)$	Physical capital stock of industry (i).	N	N
$x2tot_{(i)}$	$(i \in IND)$	Real gross fixed capital formation in industry (i).	N	N
x6tot		Real inventory accumulation.	N	N
* “N” denotes en<u>n</u>dogenous; “X” denotes e<u>x</u>ogenous.				

REFERENCES

Australian Bureau of Statistics (2014, Australian National Accounts: Finance and Wealth, Cat No. 5232.0. Canberra, Australia: Australian Bureau of Statistics.

Australian Bureau of Statistics (2014), *Australian National Accounts: Finance and Wealth*, Catalogue No. 5232.0, Australian Bureau of Statistics, Canberra.

Australian Prudential Regulatory Authority. (2013, January), Prudential Standard APS 112 - Capital Adequacy: Standardised Approach to Credit Risk. Retrieved April 2015, from http://www.apra.gov.au/adi/PrudentialFramework/Documents/121109_APS_112.pdf

Connolly, E. (2007), The Effect of the Australian Superannuation Guarantee on Household Saving Behaviour. Reserve Bank of Australia Research Discussion Paper, 2007-08, Economic Analysis Department, Reserve Bank of Australia.

Connolly, E. (2007), The Effect of the Australian Superannuation Guarantee on Household Saving Behaviour. Reserve Bank of Australia Research Discussion Paper(2007-08), Economic Analysis Department, Reserve Bank of Australia.

Dixon, P. B., & Rimmer, M. T. (2002), *Dynamic General Equilibrium Modelling for Forecasting and Policy: A Practical Guide and Documentation of MONASH*. North Holland Publishing Company.

Gruen, D., & Soding, L. (2011, July 1), Compulsory superannuation and national savings. Address to the Melbourne Institute/The Australian 2011 Economic and Social Outlook Conference. Melbourne.

Harrison, W. J., & Pearson, K. R. (1996), Computing Solutions for Large General Equilibrium Models Using GEMPACK. *Computational Economics*, 83-127.

Horridge, M., Meeraus, A, Pearson, K., and Rutherford T. (2013) “Software platforms: GAMS and GEMPACK”, chapter 20, , in P.B. Dixon and D.W. Jorgenson (editors) *Handbook of Computable General Equilibrium Modeling*, Elsevier, Amsterdam, pp. 1331-82.

J.M. Dixon, P.B. Dixon, J.A. Giesecke and M.T. Rimmer (2014) “Quantifying ‘Dog Days’”, *Economic Papers* (forthcoming).

Zealand, R. B. (2007), Capital adequacy ratios for banks - simplified explanation and example of calculation. Retrieved February 2015, from file:///H:/AAATravelDisk/Administration/Library/References/Finance/capital_adequacy_calculation.pdf.