

## Research Working Paper Series

# A Financial CGE Model of the Australian Economy

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# A Financial CGE Model of the Australian Economy

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## *Abstract*

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 financial sides of the economy.

Key words: financial CGE model.

JEL: C68, G11, G17, G21.

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## 1 Introduction

This paper develops a dynamic CGE model with financial sector detail. 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 **N**ational) and developing further a theory of the financial side of the economy described in Dixon et al. (2014). VU-Nat has evolved from the MONASH model described in Dixon and Rimmer (2002), with new theory and data 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 AT(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 FLOW(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 VAL(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, ROI(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  $s \in LA$ ,  $f \in FI$  and  $d \in AA$ , where the sets LA, FI and AA are defined as follows:

AA	The set of “asset agents”, comprising: Superannuation, Banks, the Central Bank, 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 Central Bank, 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 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 CGE model. Section 4 describes closure options, detailing the exogenous / endogenous status of key variables under closures in which the model’s financial theory is either activated or deactivated.

## 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:

$$AA(\text{Banks}, \text{Dep}, j, t) = AS(j, \text{DepBanks}, t)$$

$$AA(\text{CBank}, \text{Cur}, j, t) = AS(j, \text{CurCBank}, t)$$

$$FF(\text{PFnds}, \text{Equity}, j, t) = FFA(j, \text{EquityPFnds}, t)$$

$$FF(\text{PNFC}, \text{Bonds}, j, t) = FFA(j, \text{BondsPNFC}, t)$$

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:

$INST = \{\text{Bonds}, \text{Cash}, \text{DeposLoans}, \text{Equity}, \text{GldSDR}\}$

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

Table 1 and Table 2 provide the mappings between  $FININST$  and  $INST$  and  $FAGENTS$  and  $AGENT$ .

**Table 1: Set mapping - FININST to INST**

<b>FININST</b>	<b>Description</b>	<b>INST</b>
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**

<b>FAGENTS</b>	<b>Description</b>	<b>AGENT</b>
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 of modelling housing asset price bubbles in future work. 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 is 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 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:

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

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 (s);

$AT0_{(s,f,d)}$  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  $E\_a\_t\_ldom$ ,  $E\_ave\_ror\_d$  and  $E\_big\_budd$  (see Table 14). Equation  $E\_a\_t\_ldom$  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 re-valued start-of-year 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:

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

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

$\Phi$  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  $E\_a\_t\_lf$  and  $E\_big\_budf$  (see Table 14). Equation  $E\_a\_t\_lf$  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, equation  $E_a_t$  ensures that, with  $t-1$  levels values for start-of-year  $AT\_B_{(s,f,d)}$  and end-of-year  $AT1\_B_{(s,f,d)}$  asset values, and the current value of  $AT_{(s,f,d)}$ , the value for  $a_t_{(s,f,d)}$  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 agent (d)'s end-of-period holdings of financial instrument (f,s) and revalued start-of-period holdings of financial instrument (f,s) via:

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

Converted to percentage change form, this provides equation  $E_d\_flowd$  in Table 14.

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

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

The percentage change form of which is given by equation  $E_d\_shift4$  in Table 14.

### 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,  $v_{(s,f,d)}$ . In the main, the values for these terms are determined via exogenous shift variables with varying degrees of instrument and agent specificity via equation  $E_v$ . However there are a number of special cases in which valuation effects are determined independently of equation  $E_v$ :

1. revaluation of the equity of capital creating agents (see Section 3.13 below);
2. revaluation of the government's equity in the central bank (see Section 3.21 below);  
and
3. revaluation of the foreign assets held by domestic agents via exchange rate effects.

The impact of exchange rate movements on the domestic currency value of foreign asset holdings by domestic agents is measured by equation  $E_f\_v1$ . This equation introduces the lagged nominal exchange rate, which is defined by equation  $E\_phi\_1$ .

### 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 levels:

$$CAD = \text{NEWAACQ}_{\text{Foreigners}} - \sum_{f \in \text{FI}} \sum_{d \in \text{AALF}} \text{FLOW}_{\text{Foreigners},f,d}$$

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,  $\text{NEWAACQ}_{\text{Foreigners}}$ ) and the change in national foreign assets (acquisitions of foreign financial instruments by domestic agents,  $\sum_{f \in \text{FI}} \sum_{d \in \text{AALF}} \text{FLOW}_{\text{Foreigners},f,d}$ ). This is expressed in percentage change form in Table 14 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,  $d\_new\_assacq_{(\text{Foreigners})}$ . 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 ( $d\_flow_{(\text{Foreigners},j,d)}$ ) 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  $d\_new\_assacq_{(\text{Foreigners})}$ .

### 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:

$$\text{GOVDEF} = \sum_{f \in \text{FI}} \sum_{d \in \text{AA}} \text{FLOW}_{\text{Govt},f,d} - \text{NEWAACQ}_{\text{Govt}}$$

Where  $\text{GOVDEF}$  is the public sector borrowing requirement,  $\sum_{f \in \text{FI}} \sum_{d \in \text{AA}} \text{FLOW}_{\text{Govt},f,d}$  is gross new liabilities of the public sector, and  $\text{NEWAACQ}_{\text{Govt}}$  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 14.

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: (s ∈ LALF)

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

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

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 to this problem, converted to percentage change form, provides equations  $E\_big\_budl$  to  $E\_a\_t\_1$  in Table 14. 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  $E\_d\_flowd$ , 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 at the start of each year 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 needs 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.<sup>1</sup> 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 the 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 equation  $E\_f\_roipow$  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 on existing equity, 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 ( $roipoweq_{(s)}$ ) 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.

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<sup>1</sup> 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:

$$\begin{aligned} ROI\_EQ\_D_{(Inds)} = & 1 + \left[ \sum_{i \in NOD} V1CAP_{(i)} + (P2TOT\_INF - 1) \times \sum_{i \in NOD} VCAP_{(i)} \right. \\ & - \sum_{i \in NOD} [DEP_{(i)} \times VCAP_{(i)}] - \sum_{f \in NEQ} \sum_{d \in AA} [AT_{(Inds,f,dd)} \times VAL_{(Inds,f,dd)} \times (ROIL_{(Inds,f,dd)} - 1)] \Big] / \\ & \left[ \sum_{dd \in AA} AT_{(Inds,Equity,dd)} \times VAL_{(Inds,Equity,dd)} \right] \end{aligned}$$

where definitions for each of the variables are the same as those for the identically-named coefficients in Table 15. 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 (  $\sum_{i \in NOD} V1CAP_{(i)}$  ); plus,
- inflation in the asset value of physical capital (  $(P2TOT\_INF - 1) \times \sum_{i \in NOD} VCAP_{(i)}$  ); minus,
- the value of depreciation of physical capital (  $\sum_{i \in NOD} [DEP_{(i)} \times VCAP_{(i)}]$  ); minus,
- the sum of the value of non-equity claims on the gross operating surplus of industry (  $\sum_{f \in NEQ} \sum_{d \in AA} [AT_{(Inds,f,dd)} \times VAL_{(Inds,f,dd)} \times (ROIL_{(Inds,f,dd)} - 1)]$  ); divided by,
- the market value of the equity issued by industry (  $\sum_{dd \in AA} AT_{(Inds,Equity,dd)} \times VAL_{(Inds,Equity,dd)}$  ).

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 equation  $E\_f\_roipow\_ie$ . 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:

$$(1) \text{EROR}_{(i)} = f(\text{KGR}_{(i)}) \times \text{ROR}_{(i)}$$

where  $\text{EROR}_{(i)}$  is the expected rate of return on physical capital in sector (i),  $\text{KGR}_{(i)}$  is sector (i)'s capital growth rate,  $\text{ROR}_{(i)}$  is the rate of return on sector (i)'s physical capital, and  $f(\text{KGR}_{(i)})$  is a negative function of the capital growth rate with the logistic form described by KK in Figure 1.  $f(\text{KGR}_{(i)})$  is parameterised so that it has the value 1 when  $\text{KGR}_{(i)} = \text{KGR\_BASE}_{(i)}$ . Hence, when the capital growth rate is maintained at its level from the previous year ( $\text{KGR\_BASE}_{(i)}$ ), capital creators expect new investments will generate the prevailing rate of return ( $\text{ROR}_{(i)}$ ). Because  $f$  is negatively-sloped, if capital growth exceeds  $\text{KGR\_BASE}_{(i)}$ , then capital creators anticipate that new investment will generate lower rates of return than the current rate.  $\text{KGR\_MIN}_{(i)}$  and  $\text{KGR\_MAX}_{(i)}$  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:

$$(2) \text{EROR}_{(i)} = \text{WACC}_{(i)}$$

where  $\text{WACC}_{(i)}$  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 14 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  $\text{ave\_ror}_{s(s)}$  (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 <sup>(a)</sup>
$RISKWGT_{(CB,f)}$ ( $\forall f \in FI$ )	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 standard 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  $big\_bud\_nr_{(d)}$ , the percentage change in each agent's total asset holdings excluding cash and central bank deposits. Equation  $E\_ave\_ror\_nr$  calculates  $ave\_ror\_nr_{(d)}$ , 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 ( $f \in FI$ ) issued by agents other than the central bank ( $s \in LANCB$ ); and (ii) all non-cash and non-deposit instruments ( $f \in NOTCD$ ) issued by the central bank ( $s \in CBSET$ ). 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  $d\_new\_assacq_{(Banks)}$  and exogenising  $d\_bankprofit_{(Banks)}$ , and then enforcing equality of the asset and liability sides of bank balance sheets by endogenously determining  $d\_new\_liaacq_{(Banks)}$  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  $E_{d\_superpst}$  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 portfolio excluding the two types of financial instrument issued by superannuation, namely equity and deposits.<sup>2</sup> 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 paid 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.

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<sup>2</sup> 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 paid 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 effect changes in domestic interest rates. Equation  $E\_big\_bud\_nf$  defines  $big\_bud\_nf_{(d)}$ , 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,  $big\_bud\_for_{(d)}$ .

Equation  $E\_d\_f\_v\_cb$  describes balance condition of the central bank's balance sheet. With the financial theory deactivated, the shift variable  $d\_f\_v\_cb$  is determined endogenously. However, under the model's financial closure,  $d\_f\_v\_cb$  is determined exogenously via the endogenous determination of the valuation term on the government's equity stake in the central bank ( $v_{(CB,Equity,Govt)}$ ). This ensures that movements in the valuation terms on the central bank's asset holdings are translated into changes in the value of the government's equity in the central bank.

### 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  $\beta$ . We set  $\beta=1.025$ , to reflect initial inflation expectations of 2.5%. The parameter  $\gamma$  reflects the lowest rate of wage deflation that workers will tolerate when labour market conditions reach a dire state described by  $\phi$ . 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  $(\phi, \gamma)$  and  $(1, \beta)$ .

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:

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

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

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

The percentage change forms of equations (2), (3) and (4) are given by  $E\_fp3tot\_exp2$ ,  $E\_p3tr\_exp$ ,  $E\_p3tr\_pow$  in Table 14.

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,  $W_{(t)}^*$ . 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 16 describes the variables of the financial component of the CGE model, and a selection of those variables from the real side of the model that are relevant to advancing the description of the operation of the model's financial theory. 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 only, 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. We approach the development and exposition of the closure of the government sector under the “financial” closure in a row-by-row fashion below.

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

	<b>(A) Exogenous under “real” closure, Endogenous under “financial” closure.</b>	<b>(B) Endogenous under “real” closure, Exogenous under “financial” closure.</b>
(1)	$d\_new\_liaacq_{(Govt)}$	$d\_ff\_govt$
(2)	$d\_new\_assacq_{(Govt)}$	$shiftg$
(3)	$roipowl_{(Govt,f,d)}$	$liab\_shift_{(Govt,f,d)}$
(4)	$d\_mtb_{(Govt,f)}$	$liab\_sh\_d_{(Govt,f)}$
(5)	$liab\_shift_{Govt,f,d} (f \in FI, d \in AA)$	$f3\_roipowl_{Govt,f,d} (f \in FI, d \in AA)$
(6)	$f2\_roipowl_{Govt,f} (f \in FI)$	$d\_MTB_{Govt,f} (f \in FI)$
(7)	$f3\_roipowl_{Govt,DeposLoans,d} (d \in AA)$	$liab\_shift_{Govt,DeposLoans,d} (d \in AA)$
(8)	$d\_MTB_{Govt,DeposLoans}$	$f2\_roipowl_{Govt,DeposLoans}$

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 ( $d\_new\_liaacq_{(Govt)}$ ) with the public sector borrowing requirement and purchases of new financial assets by government. Acquisition of financial assets by government ( $d\_new\_assacq_{(Govt)}$ ) 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  $liab\_sh\_d_{(Govt,f)}$  and  $liab\_shift_{(Govt,f,d)} (f \in FI)$  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 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  $f2\_roipowl_{Govt,f}$ , 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  $f3\_roipowl_{Govt,f,d}$ , 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. We approach the development and exposition of the “financial” closure of the industry sector 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)	$d\_new\_liaacq_{(Inds)}$	$d\_shiftind$
(2)	$d\_new\_assacq_{(Inds)}$	$shiftind$
(3)	$roipowl_{(Inds,f,d)} (f \in FI, d \in AA)$	$liab\_shift_{(Inds,f,d)} (f \in FI, d \in AA)$
(4)	$d\_mtb_{(Inds,f)} (f \in FI)$	$liab\_sh\_d_{(Inds,f)} (f \in FI)$
(5)	$liab\_shift_{Inds,f,d} (f \in FI, d \in AA)$	$f3\_roipowl_{Inds,f,d} (f \in FI, d \in AA)$
(6)	$f2\_roipowl_{Inds,f} (f \in FI)$	$d\_MTB_{Inds,f} (f \in FI)$

(7)	$f3\_roipowl_{In ds, DeposLoans, d} \quad (d \in AA)$	$liab\_shift_{In ds, DeposLoans, d} \quad (d \in AA)$
(8)	$d\_MTB_{In ds, DeposLoans}$	$f2\_roipowl_{In ds, DeposLoans}$
(9)	$fff\_v_{(In ds, Equity)}$	$d\_f\_inds\_eq$
(10)	$f\_roipow_{(In ds, Equity, d)}$	$f4\_roipow_{(In ds, d)}$

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 ( $d\_new\_liaacq_{(In ds)}$ ) with nominal gross fixed capital formation and acquisition of financial assets by industry. Acquisition of financial assets by industry ( $d\_new\_assacq_{(In ds)}$ ) 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  $liab\_sh\_d_{(In ds, f)}$  and  $liab\_shift_{(In ds, f, d)}$  ( $f \in FI$ ) 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 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 ( $roipowl_{(In ds, f, d)}$ ). 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  $f2\_roipowl_{In ds, f}$ , 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  $f3\_roipowl_{In ds, f, d}$ , 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  $fff\_v_{(In ds, Equity)}$  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)	$d\_new\_liaacq_{(RH)}$	$d\_shiftRH$
(2)	$roipowl_{(RH,f,d)} (f \in FI, d \in AA)$	$liab\_shift_{(RH,f,d)} (f \in FI, d \in AA)$
(3)	$d\_mtb_{(RH,f)} (f \in FI)$	$liab\_sh\_d_{(RH,f)} (f \in FI)$
(4)	$liab\_shift_{RH,f,d} (f \in FI, d \in AA)$	$f3\_roipowl_{RH,f,d} (f \in FI, d \in AA)$
(5)	$f2\_roipowl_{RH,f} (f \in FI)$	$d\_MTB_{RH,f} (f \in FI)$
(6)	$f3\_roipowl_{RH,DeposLoans,d} (d \in AA)$	$liab\_shift_{RH,DeposLoans,d} (d \in AA)$
(7)	$d\_MTB_{RH,DeposLoans}$	$f2\_roipowl_{RH,DeposLoans}$
(8)	$fff\_v_{(RH,Equity)}$	$d\_f\_RH\_eq$
(10)	$f\_roipow_{(RH,Equity,d)}$	$f4\_roipow_{(RH,d)}$

Under the financial closure, liability accumulation by the reproducible housing sector ( $d\_new\_liaacq_{(RH)}$ ) 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  $liab\_sh\_d_{(RH,f)}$  and  $liab\_shift_{(RH,f,d)} (f \in FI)$  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 ( $roipowl_{(RH,f,d)}$ ). 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)	$f\_roipow_{(NRH,Equity,d)}$	$f4\_roipow_{(NRH,d)}$
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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 ( $roipowl_{(RH,f,d)}$ ). 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  $f2\_roipowl_{NRH,f}$ , 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  $f3\_roipowl_{NRH,f,d}$ , 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  $fff\_v_{(NRH,Equity)}$  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  $d\_shiftl4_{(CB)}$ ,  $a\_t\_1_{(Foreigners,f,CB)}$  ( $f \in FI$ ), and  $f\_cb\_assetl_{(s,f,CB)}$  ( $s \in DOMAGENT, f \in FI$ ) endogenous, and  $d\_new\_liaacq_{(CB)}$ ,  $f\_a\_t\_1_{(Foreigners,f,CB)}$  ( $f \in FI$ ) and  $f\_a\_t\_1_{(s,f,CB)}$  ( $s \in DOMAGENT, f \in FI$ ) 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)  $d\_shift14_{(CB)}$  is moved to the set of exogenous variables, and  $d\_new\_liaacq_{(CB)}$  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.<sup>3</sup> 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  $E\_f\_cb\_asset1$ .

Equation  $E\_d\_f\_v\_cb$  links the valuation term on the government’s equity in the central bank to movements in the valuation terms on the financial assets held by the central bank. The equation is activated via the exogenous determination of  $d\_f\_v\_cb$  and the endogenous determination of  $f\_v_{(CB,Equity,Govt)}$ .

#### 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

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<sup>3</sup> 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.

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 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)	$d\_new\_assacq_{(Foreigners)}$	$d\_ff\_phi$
(2)	$phi$	$d\_shift4_{(Foreigners)}$

#### 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 ( $d\_new\_liacq_{(Super)}$ ), 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.
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(1)	$d\_new\_liaacq_{(Super)}$	$sup\_con\_rate$
(2)	$d\_mtb_{(Super,f)} (f \in FI)$	$liab\_sh\_d_{(Super,f)} (f \in FI)$
(3)	$roipowl_{(Super,f,d)} (f \in FI, d \in AA)$	$liab\_shift_{(Super,f,d)} (f \in FI, d \in AA)$
(4)	$d\_new\_assacq_{(Super)}$	$fd\_super\_assac$
(5)	$d\_super\_sub$	$d\_superprofit$
(6)	$liab\_shift_{Super,f,d} (f \in FI, d \in AA)$	$f3\_roipowl_{Super,f,d} (f \in FI, d \in AA)$
(7)	$f2\_roipowl_{Super,f} (f \in FI)$	$d\_MTB_{Super,f} (f \in FI)$
(8)	$f3\_roipowl_{Super,DeposLoans,d} (d \in AA)$	$liab\_shift_{Super,DeposLoans,d} (d \in AA)$
(9)	$d\_MTB_{Super,DeposLoans}$	$f2\_roipowl_{Super,DeposLoans}$
(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 equations  $E\_a\_t\_1\_d2$  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 it 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 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 life-cycle 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.<sup>4</sup> Rows (6) and (7) begin by activating  $E\_a\_t\_I\_d$  and deactivating  $E\_a\_t\_I\_d2$  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  $E\_a\_t\_I\_d2$  and activating  $E\_a\_t\_I$  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 assignment of  $ff\_apc\_gnp$  to the set of exogenous variables, and the assignment 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  $E\_a\_t\_I\_dom$ . 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  $E\_a\_t\_I\_dom$ . Row (12), under

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<sup>4</sup> 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 capacity to offer different returns on liability instruments across asset agents is of more specific importance to other financial agents.

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  $E_{a\_t\_Idom}$  for households. With Superannuation removed from the standard asset optimisation framework described by equation  $E_{a\_t\_Idom}$ , 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.

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 wage bill 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 (i.e. superannuation equity held by households).
- (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)	$d\_new\_assacq_{(Banks)}$	$d\_bankprofit$
(2)	$d\_new\_liaacq_{(Banks)}$	$d\_f\_liaacq\_bank$
(3)	$d\_mtb_{(Banks,f)} (f \in FI)$	$liab\_sh\_d_{(Banks,f)} (f \in FI)$
(4)	$roipowl_{(Banks,f,d)} (f \in FI, d \in AA)$	$liab\_shift_{(Banks,f,d)} (f \in FI, d \in AA)$
(5)	$liab\_sh\_d_{(Banks,Equity)}$	$p\_ratio\_t1$
(6)	$liab\_sh\_d_{(Banks,f)} (f \in FINEQ)$	$f\_bank\_eq_{(f)} (f \in FINEQ)$
(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  $E\_a\_t\_I\_d2$  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 ( $E\_a\_t\_I\_dom$ ), 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 ( $roipowl_{(Banks,f,d)}$ ). 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  $E\_a\_t\_I\_d$  and deactivating  $E\_a\_t\_I\_d2$  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  $f2\_roipowl_{Banks,f}$ , 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  $E\_a\_t\_I\_d2$  and activating  $E\_a\_t\_I$  for the financial instrument “Deposits and loans” issued by commercial banks as a liability, and thereby, via the endogenous determination of  $f3\_roipowl_{Banks,f,d}$ , 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 NBFIs 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)	$d\_new\_assacq_{(LifeIns)}$	$d\_lifeprofit$
(2)	$d\_new\_assacq_{(NonBankFinIn)}$	$d\_nbprofit$
(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)	$d\_MTB_{NonBankFinIn,DeposLoans}$	$f2\_roipowl_{NonBankFinIn,DeposLoans}$

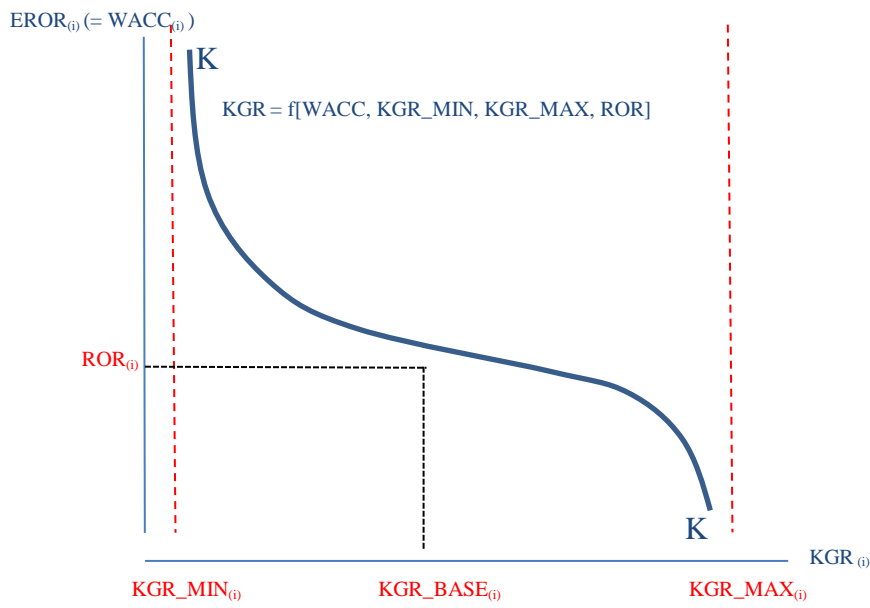
Beginning with rows (1) - (4) of Table 11, under the “financial” closure the endogenous status of  $d\_new\_assacq_{(LifeIns)}$ ,  $d\_new\_assacq_{(NonBankFinIn)}$ ,  $d\_new\_liaacq_{(LifeIns)}$ , and  $d\_new\_liaacq_{(NonBankFinIn)}$  is supported by the exogenous status of  $d\_lifeprofit$ ,  $d\_nbprofit$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

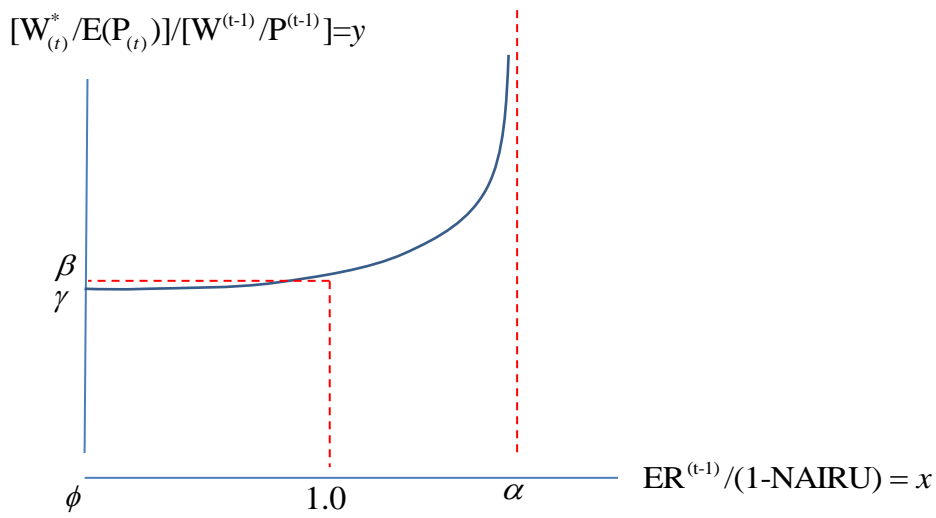
exogenously under the “finance” closure, thereby activating those elements of equations  $E\_a\_t\_1\_d2$  and  $E\_a\_t\_1$  relating to life insurance and NBFIs. This establishes conventional optimising behaviour on the part of life insurance and NBFIs as liability agents.

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.

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



**Figure 2: Asymmetric wage adjustment**



**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) NBF	(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) NBF	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: Set names and definitions**

<b>Set name</b>	<b>Description</b>	<b>Elements</b>
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 14: Equations**

<b>Name</b>	<b>Equation</b>	<b>Range</b>
<b><i>Determination of end-of-year asset holdings by domestic agents</i></b>		
E_a_t_1dom	$a_{t-1(s,f,d)} = \text{big\_bud}_{(d)} + \text{ELAS\_AS} * [\text{roipowa}_{(s,f,d)} - \text{ave\_ror\_d}_{(d)}] + f_{a\_t-1(s,f,d)}$	(s ∈ LA) (f ∈ FI) (d ∈ AALF)
<b><i>Average rate of return received by domestic asset agents</i></b>		
E_ave_ror_d	$\text{BIGBUDGET}_{(d)} \cdot \text{ave\_ror\_d}_{(d)} = \sum_s \sum_f \text{AT1}_{(s,f,d)} \cdot \text{roipowa}_{(s,f,d)}$	(d ∈ AALF)
<b><i>Budget available for asset purchases by domestic agents</i></b>		
E_big_budd	$\text{BIGBUDGET}_{(d)} \cdot \text{big\_bud}_{(d)} = \sum_s \sum_f [\text{AT}_{(s,f,d)} \cdot \text{VAL}_{(s,f,d)}] \cdot (a_{t(s,f,d)} + v_{(s,f,d)}) + 100 \cdot d_{\text{new\_assacq}}_{(d)}$	(d ∈ AALF)
<b><i>Determination of end-of-year asset holdings by foreign agents</i></b>		
E_a_t_1f	$\text{phi} + a_{t-1(s,j, \text{Foreigners})} = \text{big\_budf} + \text{ELAS\_AS} * [\text{roipowa}_{(s,j, \text{Foreigners})} - \text{ave\_ror\_row}]$	(s ∈ LA) (f ∈ FI)
E_big_budf	$\text{big\_budf} = \text{phi} + \text{big\_bud}_{(\text{Foreigners})}$	
<b><i>Year-on-year tracking of start-of-year asset values</i></b>		
E_a_t	$\text{AT}_{(s,f,d)} \cdot a_{t(s,f,d)} = 100 \cdot [\text{AT1\_B}_{(s,f,d)} - \text{AT\_B}_{(s,f,d)}] \cdot \text{del\_unity}$	(s ∈ LA) (f ∈ FI) (d ∈ AALF)
<b><i>Acquisitions of financial assets</i></b>		
E_d_flowd	$100 \cdot d_{\text{flow}}_{(s,f,d)} = [\text{AT1}_{(s,f,d)}] \cdot a_{t-1(s,f,d)} - [\text{VAL}_{(s,f,d)} \cdot \text{AT}_{(s,f,d)}] \cdot (a_{t(s,f,d)} + v_{(s,f,d)})$	(s ∈ LA) (f ∈ FI) (d ∈ AA)
E_d_shift4	$d_{\text{new\_assacq}}_{(d)} = \sum_j \sum_f d_{\text{flow}}_{(j,f,d)} + d_{\text{shift4}}_{(d)}$	(d ∈ AA)
<b><i>Revaluation effects</i></b>		
E_v	$v_{(s,f,d)} = f_{v(s,f,d)} + ff_{v(d)} + fff_{v(s,f)}$	(s ∈ LA) (f ∈ FI) (d ∈ AA)

<b>Exchange rate induced movements in valuation terms on domestic holdings of foreign assets</b>		
E_f_v1	$v_{(\text{foreigners},f,d)} = \text{phi}_1 - \text{phi} + f\_v1_{(f,d)}$	(f ∈ FI) (d ∈ AA)
<b>Lagged value of the exchange rate</b>		
E_phi_1	$\text{LEV\_PHI\_L} \times \text{phi}_1 = 100 \times [\text{LEV\_PHI\_B} - \text{LEV\_PHI\_L\_B}] \times \text{del\_unity}$	-
<b>Asset acquisitions by foreigners linked to current account financing requirement</b>		
E_d_ff_phi	$d\_new\_assacq_{(\text{Foreigners})} - \sum_{d \in AA} \sum_{j \in FI} d\_flow_{(\text{Foreigners},j,d)} = d\_CAD + d\_ff\_phi$	
<b>Liability acquisition by government linked to public sector borrowing requirement</b>		
E_ff_govt	$d\_new\_assacq_{(\text{govt})} = \sum_{f \in FI} \sum_{j \in AA} d\_flow_{(\text{govt},f,j)} - d\_gov\_def + d\_ff\_govt$	
E_shiftG	$100 \times [1 / [\text{NEW\_ASS\_ACQ}_{(\text{govt})}]] \times d\_new\_assacq_{(\text{govt})} = w5tot + \text{shiftG}$	
	$\text{roipowl}_{(\text{Govt},f,d)} = \text{roiB\_DL\_G} + f\_roipow\_g_{(f,d)}$	(f ∈ B_DL) (d ∈ AA)
<b>Liability optimisation by domestic liability agents</b>		
E_big_budl	$\text{BIGBUDGETL}_{(s)} \cdot \text{big\_budl}_{(s)} = \sum_{f \in FI} \sum_{d \in AA} [\text{AT}_{(s,f,d)} \cdot \text{VAL}_{(s,f,d)}] \cdot (a\_t_{(s,f,d)} + v_{(s,f,d)}) + 100 \cdot d\_new\_liaacq_{(s)}$	(s ∈ LALF)
E_ave_ror_s	$\text{ave\_ror\_s}_{(s)} = \sum_{f \in FI} \sum_{d \in AA} (\text{AT1}_{(s,f,d)} / \text{BIGBUDGETL}_{(s)}) \cdot \text{roipowl}_{(s,f,d)}$	(s ∈ LALF)
E_d_new_liaacq	$d\_new\_liaacq_{(s)} = \sum_{f \in FI} \sum_{d \in AA} d\_flow_{(s,f,d)} + d\_shift14_{(s)}$	(s ∈ LALF)
E_a_t_1_d	$\text{AT1\_D}_{(s,f)} \cdot a\_t_1\_d_{(s,f)} = \sum_{d \in AA} \text{AT1}_{(s,f,d)} \cdot a\_t_1_{(s,f,d)} + d\_MTB_{(s,f)}$	(s ∈ LALF) (f ∈ FI)
E_a_t_1_d2	$a\_t_1\_d_{(s,f)} = \text{big\_budl}_{(s)} + (\text{TAU}-1) \cdot [\text{roipowl\_d}_{(s,f)} - \text{ave\_ror\_s}_{(s)}] + \text{liab\_sh\_d}_{(s,f)}$	(s ∈ LALF) (f ∈ FI)
E_a_t_1	$a\_t_1_{(s,f,d)} = a\_t_1\_d_{(s,f)} + (\text{TAU}-1) \cdot [\text{roipowl}_{(s,f,d)} - \text{roipowl\_d}_{(s,f)}] + \text{liab\_shift}_{(s,f,d)}$	(s ∈ LALF) (f ∈ FI)

		(d ∈ AA)
E_roipowl4	$roipowl_{(s,f,d)} = f2\_roipowl_{(s,f)} + f3\_roipowl_{(s,f,d)} + f4\_roipowl_{(s)}$	(s ∈ LALF) (f ∈ FI) (d ∈ 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 ∈ LALF) (f ∈ FI)
<b>Quantity of capital in the reproducible housing sector</b>		
E_cap_trh	$QCAP\_RH \cdot cap\_trh = 100 \cdot [QINVEST\_B_{(Dwellings)}] \cdot del\_unity + 100 \cdot d\_f\_cap\_trf$	
<b>New liabilities issued by industry</b>		
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	$V2IND \cdot w2\_ind = V2TOT\_I \cdot w2tot\_i -$ $\sum_{i \in IND} G\_VINVEST_{(i)} \cdot [x2tot_{(i)} + p2tot_{(i)} + gv2tot_{(i)}] +$ $V6TOT \cdot [x6tot + p6tot] - \{ V2TOT_{(Dwellings)} \cdot [x2tot_{(Dwellings)} +$ $p2tot_{(Dwellings)}] - G\_VINVEST_{(Dwellings)} \cdot [x2tot_{(Dwellings)} +$ $p2tot_{(Dwellings)} + gv2tot_{(Dwellings)}] \}$	
<b>Asset acquisition by industry</b>		
E_shiftind	$[100/NEW\_ASS\_ACQ_{(Inds)}] \times d\_new\_assacq_{(Inds)} = w0gdpinc + shiftind$	
<b>Asset accumulation by households</b>		
E_d_shiftH	$100 \cdot d\_new\_assacq_{(Hlds)} = HOUS\_DIS\_INC \cdot hdy -$ $V3TOT \cdot w3tot + 100 \cdot \sum_{f \in FI} \sum_{d \in AA} d\_flow_{(Hlds,f,d)} + 100 \cdot d\_shiftH$	
<b>Liability accumulation by the reproducible housing sector</b>		

E_d_shiftRH	$d\_new\_liaacq_{(RH)} =$ $0.01 \cdot \{ V2TOT_{(Dwelling)} \cdot [x2tot_{(Dwelling)} + p2tot_{(Dwelling)}] -$ $G\_VINVEST_{(Dwelling)} \cdot [x2tot_{(Dwelling)} + p2tot_{(Dwelling)} + gv2tot_{(Dwelling)}] \}$ $+ \sum_{f \in FI} \sum_{s \in LA} d\_flow_{(s,f,RH)} + d\_shiftRH$	
<b>Revaluation of the equity of industry, reproducible housing, and non-reproducible housing</b>		
E_ff_v_indeq	$\sum_{i \in NOD} VCAP_{(i)} \cdot (p2tot_{(i)} + cap\_t_{(i)}) + \sum_{s \in LA} \sum_{f \in FI} AT_{(s,f,Inds)} \cdot VAL_{(s,f,Inds)} \cdot (a\_t_{(s,f,Inds)} + v_{(s,f,Inds)})$ $= \sum_{f \in FI} \sum_{d \in AA} AT_{(Inds,f,d)} \cdot VAL_{(Inds,f,d)} \cdot (a\_t_{(Inds,f,d)} + v_{(Inds,f,d)}) + 100 \cdot d\_f\_indeq$	
E_ff_v_RH_eq	$VCAP\_RH \cdot (p2tot_{(Dwellings)} + cap\_trh) =$ $\sum_{f \in FI} \sum_{d \in AA} AT_{(RH,f,d)} \cdot VAL_{(RH,f,d)} \cdot [a\_t_{(RH,f,d)} + v_{(RH,f,d)}] + 100 \cdot d\_f\_RH\_eq$	
E_ff_v_NRH_eq	$VCAP\_NRH \cdot p2tot_{(Oldhouse)} =$ $\sum_{f \in FI} \sum_{d \in AA} AT_{(NRH,f,d)} \cdot VAL_{(NRH,f,d)} \cdot [a\_t_{(NRH,f,d)} + v_{(NRH,f,d)}] + 100 \cdot d\_f\_NRH\_eq$	
<b>Relationship between rates of return from asset and liability sides</b>		
E_f_roipow	$roipowa_{(s,f,d)} = roipowl_{(s,f,d)} + f\_roipow_{(s,f,d)}$	(s ∈ LA) (f ∈ FI) (d ∈ AA)
<b>Expected rate of return on equity as a function of realised and offered rates of return</b>		
E_f4_roipow	$roipowa_{(s,Equity,d)} = ALFA \cdot roipoweqc_{(s)} + [1-ALFA] \cdot roipowl_{(s,Equity,d)} + f4\_roipow_{(s,d)}$	(s ∈ KLA) (d ∈ AA)
<b>Power of the rate of return on industry equity</b>		

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

$E_{f\_roipow\_rhe}$	$ \begin{aligned} & [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)}) ] \end{aligned} $	
<b><i>Power of the rate of return on non-reproducible housing equity</i></b>		

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

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 ∈ INDP)
<b>Risk-weighted bank assets</b>		
E_p_ra_bank1	$RA\_BANK1 \times p\_ra\_bank1 =$ $\sum_{s \in LA} \sum_{f \in FI} [RISKWGT_{(s,f)} \times AT1_{(s,f,Banks)}] \times (p\_riskwgt_{(s,f)} + a\_t\_1_{(s,f,Banks)})$	
<b>Value of bank equity</b>		
E_p_eq_bank1	$EQ\_BANK1 \times p\_eq\_bank1 = \sum_{d \in AA} AT1_{(Banks,Equity,d)} \times a\_t\_1_{(Banks,Equity,d)}$	
<b>Ratio of bank equity to risk-weighted bank assets</b>		
E_p_ratio_t1	$p\_ratio\_t1 = p\_eq\_bank1 - p\_ra\_bank1$	
<b>Non-equity financing needs of commercial banks</b>		
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 ∈ LALF)
<b>Average cost of non-equity finance</b>		
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 ∈ LALF)
<b>Liability optimisation over non-equity financing instruments</b>		
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 ∈ FINEQ)

<b>Bank holdings of cash and reserves with the central bank</b>		
E_p_bankresr	$\text{BANKRESR} \times \text{p\_bankresr} =$ $\text{AT1}_{(\text{CB,Cash,Banks})} \times \text{a\_t\_1}_{(\text{CB,Cash,Banks})} +$ $\text{AT1}_{(\text{CB,DeposLoans,Banks})} \times \text{a\_t\_1}_{(\text{CB,DeposLoans,Banks})}$	
<b>Household deposits with banks</b>		
E_p_bankdepo	$\text{p\_bankdepo} = \text{a\_t\_1}_{(\text{Banks,DeposLoans,Hlds})}$	
<b>Ratio of bank reserves to bank deposits</b>		
E_p_resratio	$\text{p\_resratio} = \text{p\_bankresr} - \text{p\_bankdepo}$	
<b>Bank assets excluding cash and deposits with the central bank</b>		
E_big_bud_nr	$\text{BIGBUDNR}_{(d)} \times \text{big\_bud\_nr}_{(d)} = \text{BIGBUDGET}_{(d)} \times \text{big\_bud}_{(d)} -$ $\text{AT1}_{(\text{CB,Cash,d})} \times \text{a\_t\_1}_{(\text{CB,Cash,d})} - \text{AT1}_{(\text{CB,DeposLoans,d})} \times \text{a\_t\_1}_{(\text{CB,DeposLoans,d})}$	(d ∈ AA)
<b>Average rate of return earned on non-reserve assets</b>		
E_ave_ror_nr	$\text{ave\_ror\_nr}_{(d)} =$ $\sum_{s \in \text{LANCB}} \sum_{f \in \text{FI}} (\text{AT1}_{(s,f,d)} / [\text{BIGBUDNR}_{(d)} + \text{TINY}]) \times \text{roipowa}_{(s,f,d)} +$ $\sum_{f \in \text{NOTCASHDEP}} (\text{AT1}_{(\text{CB},f,d)} / [\text{BIGBUDNR}_{(d)} + \text{TINY}]) \times \text{roipowa}_{(\text{CB},f,d)}$	(d ∈ AA)
<b>Non-reserve assets held by banks</b>		
E_f_bankres1	$\text{a\_t\_1}_{(s,f,\text{Banks})} = \text{big\_bud\_nr}_{(\text{Banks})} +$ $\text{ELAS\_AS} \times [\text{roipowa}_{(s,f,\text{Banks})} - \text{ave\_ror\_nr}_{(\text{Banks})}] + \text{f\_bankres1}_{(s,f)}$	(s ∈ LANCB) (f ∈ 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 ∈ CBSET) (f ∈ NOTCD)
<b>Ratio of bank cash holdings to bank deposits with central bank</b>		
E_r_cash_cbdep	$r\_cash\_cbdep = a_{t-1}(CB,Cash,Banks) - a_{t-1}(CB,DeposLoans,Banks)$	
<b>Commercial bank financial costs and revenues</b>		
E_d_bankrev	$100 \times d\_bankrev =$ $\sum_{s \in LA} \sum_{f \in FI} [AT1_{(s,f,Banks)} \times (ROIA_{(s,f,Banks)} - 1)] \times a_{t-1}(s,f,Banks) +$ $\sum_{s \in LA} \sum_{f \in F} [ROIA_{(s,f,Banks)} \times AT1_{(s,f,Banks)}] \times roipowA_{(s,f,Banks)}$	
E_d_bankcst	$100 \times d\_bankcst =$ $\sum_{f \in FI} \sum_{d \in AA} [AT1_{(Banks,f,d)} \times (ROIL_{(Banks,f,d)} - 1)] \times a_{t-1}(Banks,f,d) +$ $\sum_{f \in FI} \sum_{d \in AA} [AT1_{(Banks,f,d)} \times ROIL_{(Banks,f,d)}] \times roipowL_{(Banks,f,d)}$	
E_d_bankprofit	$d\_bankprofit = d\_bankrev - d\_bankcst$	
<b>Bank balance sheet</b>		
E_d_f_liaacq_bank	$d\_new\_liaacq_{(Banks)} = d\_new\_assacq_{(Banks)} + d\_f\_liaacq\_bank$	
<b>New liability acquisition by the superannuation sector</b>		
E_sup_con_rate	$[100/NEW\_LIA\_ACQ_{(Super)}] \cdot d\_new\_liaacq_{(Super)} = wllab\_oi + sup\_con\_rate$	
<b>Asset acquisition by the superannuation sector</b>		
E_fd_super_assa c	$d\_new\_assacq_{(Super)} = d\_new\_liaacq_{(Super)} + fd\_super\_assac$	

<b>Assets under management of the superannuation sector</b>		
E_p_superassets	$\text{SUPERASSETS} \times \text{p\_superassets} = \sum_{s \in \text{LA}} \sum_{f \in \text{FI}} [\text{AT}_{(s,f,\text{Super})} \times \text{VAL}_{(s,f,\text{Super})}] \times (\text{a\_t}_{(s,f,\text{Super})} + \text{v}_{(s,f,\text{Super})})$	
<b>Average return on superannuation assets</b>		
E_p_roipow_sup a	$[\text{ROIPOW\_SUPER} \times \text{SUPERASSETS}] \times (\text{p\_roipow\_supa} + \text{p\_superassets}) = \sum_{s \in \text{LA}} \sum_{f \in \text{FI}} [\text{AT}_{(s,f,\text{Super})} \times \text{VAL}_{(s,f,\text{Super})} \times \text{ROIA}_{(s,f,\text{Super})}] \times (\text{a\_t}_{(s,f,\text{Super})} + \text{v}_{(s,f,\text{Super})} + \text{roipowa}_{(s,f,\text{Super})})$	
<b>Change in expected superannuation revenue</b>		
E_d_superrev	$100 \times \text{d\_superrev} = \sum_{s, \text{LA}} \sum_{f, \text{FI}} \text{AT1}_{(s,f,\text{Super})} \times (\text{ROIA}_{(s,f,\text{Super})} - 1) \times \text{a\_t\_1}_{(s,f,\text{Super})} + \sum_{s \in \text{LA}} \sum_{f \in \text{FI}} \text{ROIA}_{(s,f,\text{Super})} \times \text{AT1}_{(s,f,\text{Super})} \times \text{roipowA}_{(s,f,\text{Super})}$	
<b>Change in expected superannuation costs</b>		
E_d_supercst	$100 \times \text{d\_supercst} = \sum_{f, \text{FI}} \sum_{d, \text{AA}} \text{AT1}_{(\text{Super},f,d)} \times (\text{ROIL}_{(\text{Super},f,d)} - 1) \times \text{a\_t\_1}_{(\text{Super},f,d)} + \sum_{f \in \text{FI}} \sum_{d \in \text{AA}} \text{AT1}_{(\text{Super},f,d)} \times \text{ROIL}_{(\text{Super},f,d)} \times \text{roipowL}_{(\text{Super},f,d)}$	
<b>Superannuation net financial revenue</b>		
E_d_superprofit	$\text{d\_superprofit} = \text{d\_superrev} + \text{d\_super\_sub} - \text{d\_supercst}$	
<b>End-of-period portfolio excluding super-issued deposits and equity</b>		
E_big_bud_ns	$\text{BIGBUDNS}_{(d)} \times \text{big\_bud\_ns}_{(d)} = \text{BIGBUDGET}_{(d)} \times \text{big\_bud}_{(d)} - \text{AT1}_{(\text{Super},\text{Equity},d)} \times \text{a\_t\_1}_{(\text{Super},\text{Equity},d)} - \text{AT1}_{(\text{Super},\text{DeposLoans},d)} \times \text{a\_t\_1}_{(\text{Super},\text{DeposLoans},d)}$	(d ∈ AA)

<b><i>Average rate of return on non-superannuation assets</i></b>		
E_ave_ror_ns	$\text{ave\_ror\_ns}_{(d)} =$ $\sum_{s \in \text{LANSUPER}} \sum_{f \in \text{FI}} (\text{AT1}_{(s,f,d)} / \text{BIGBUDNS}_{(d)}) \times \text{roipowa}_{(s,f,d)} +$ $\sum_{f \in \text{NOTDEPEQTY}} (\text{AT1}_{(\text{Super},f,d)} / \text{BIGBUDNS}_{(d)}) \times \text{roipowa}_{(\text{Super},f,d)}$	(d ∈ AA)
<b><i>Non-super assets held by households</i></b>		
E_f_Super1	$\text{a\_t\_1}_{(s,f,\text{Households})} = \text{big\_bud\_ns}_{(\text{Households})} +$ $\text{ELAS\_AS} \times [\text{roipowa}_{(s,f,\text{Households})} - \text{ave\_ror\_ns}_{(\text{Households})}] + \text{f\_Super1}_{(s,f)}$	(s ∈ LANSUPER) (f ∈ FI)
<b><i>Residual (i.e. not debt or equity) liabilities issued by super (all zero)</i></b>		
E_f_Super2	$\text{a\_t\_1}_{(s,f,\text{Super})} = \text{big\_bud\_ns}_{(\text{Households})} +$ $\text{ELAS\_AS} \times [\text{roipowa}_{(s,f,\text{Households})} - \text{ave\_ror\_ns}_{(\text{Households})}] + \text{f\_Super2}_{(s,f)}$	(s ∈ SUPERSET) (f ∈ NOTDEPEQTY)
<b><i>Ratio of household holdings of two types of super liabilities: deposits/loans &amp; equity</i></b>		
E_r_dep_equity	$\text{r\_dep\_equity} = \text{a\_t\_1}_{(\text{Super},\text{DeposLoans},\text{Households})} - \text{a\_t\_1}_{(\text{Super},\text{Equity},\text{Households})}$	
<b><i>Relationship between the savings rate and the superannuation contribution rate</i></b>		
E_ff_apc_gnp	$\text{apc\_gnp} + \text{ff\_apc\_gnp} =$ $- [100 \times (1 - \text{SCROWD}) \times (\text{V1LAB\_OI\_I} / \text{V3TOT\_D})] \times \text{d\_sup\_con\_rate}$	
<b><i>Change in expected NBF1 revenue</i></b>		

E_d_nbfirev	$100 \times d\_nbfirev =$ $\sum_{s,LA} \sum_{f,FI} \left[ AT1_{(s,f,NonBankFinIn)} \times (ROIA_{(s,f,NonBankFinIn)} - 1) \right] \times a\_t\_1_{(s,f,NonBankFinIn)} +$ $\sum_{s,LA} \sum_{f,FI} \left[ ROIA_{(s,f,NonBankFinIn)} \times AT1_{(s,f,NonBankFinIn)} \right] \times roipowA_{(s,f,NonBankFinIn)}$	
<b><i>Change in expected NBF1 costs</i></b>		
E_d_nbficst	$100 \times d\_nbficst =$ $\sum_{f \in FI} \sum_{d \in AA} AT1_{(NonBankFinIn,f,d)} \times (ROIL_{(NonBankFinIn,f,d)} - 1) \times a\_t\_1_{(NonBankFinIn,f,d)} +$ $\sum_{f \in FI} \sum_{d \in AA} AT1_{(NonBankFinIn,f,d)} \times ROIL_{(NonBankFinIn,f,d)} \times roipowL_{(NonBankFinIn,f,d)}$	
<b><i>Change in expected NBF1 profit</i></b>		
E_d_nbfiprofit	$d\_nbfiprofit = d\_nbfirev - d\_nbficst$	
<b><i>NBF1 new liability acquisition linked to new asset acquisition</i></b>		
E_f_liaacq_nbfi	$d\_new\_liaacq_{(NonBankFinIn)} = d\_new\_assacq_{(NonBankFinIn)} + d\_f\_liaacq\_nbfi$	
<b><i>Change in expected life insurance revenue</i></b>		
E_d_liferev	$100 \times d\_liferev =$ $\sum_{s,LA} \sum_{f,FI} \left[ AT1_{(s,f,LifeIns)} \times (ROIA_{(s,f,LifeIns)} - 1) \right] \times a\_t\_1_{(s,f,LifeIns)} +$ $\sum_{s,LA} \sum_{f,FI} \left[ ROIA_{(s,f,LifeIns)} \times AT1_{(s,f,LifeIns)} \right] \times roipowA_{(s,f,LifeIns)}$	
<b><i>Change in expected life insurance costs</i></b>		

E_d_lifecst	$100 \times d\_lifecst =$ $\sum_{f \in FI} \sum_{d \in AA} AT1_{(LifeIns,f,d)} \times (ROIL_{(LifeIns,f,d)} - 1) \times a\_t\_1_{(LifeIns,f,d)} +$ $\sum_{f \in FI} \sum_{d \in AA} AT1_{(LifeIns,f,d)} \times ROIL_{(LifeIns,f,d)} \times roipowL_{(LifeIns,f,d)}$	
<b><i>Change in life insurance profit</i></b>		
E_d_lifeprofit	$d\_lifeprofit = d\_liferev - d\_lifecst$	
<b><i>New liability acquisition by life insurance linked to new asset acquisition</i></b>		
E_f_liaacq_life	$d\_new\_liaacq_{(LifeIns)} = d\_new\_assacq_{(LifeIns)} + d\_f\_liaacq\_life$	
<b><i>End of period portfolio, excluding foreign assets</i></b>		
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 ∈ AA)
<b><i>Average rate of return earned on domestic assets</i></b>		
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 ∈ AA)
<b><i>Asset optimising over non-foreign assets</i></b>		
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 ∈ DOMAGENT) (f ∈ FI) (d ∈ AA)
<b><i>End-of-period portfolio, foreign assets only</i></b>		
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 ∈ AALF)

<b><i>Average rate of return on foreign assets</i></b>		
E_ave_ror_for	$\text{BIGBUDFOR}_{(d)} \times \text{ave\_ror\_for}_{(d)} = \sum_{f \in FI} \text{AT1}_{(\text{Foreigners},f,d)} \times \text{roipowa}_{(\text{Foreigners},f,d)}$	(d ∈ AALF)
<b><i>Optimising over foreign assets</i></b>		
E_f_cb_asset2	$\text{a\_t\_1}_{(\text{Foreigners},f,d)} = \text{big\_bud\_for}_{(d)} + \text{ELAS\_AS} \times [\text{roipowa}_{(\text{Foreigners},f,d)} - \text{ave\_ror\_for}_{(d)}] + \text{f\_cb\_asset2}_{(f,d)}$	(f ∈ FI) (d ∈ AALF)
<b><i>Relationship between expected wage growth and lagged unemployment</i></b>		
E_fp1lab_oi4	$(\text{p1lab\_oi\_targ} - \text{p3tot\_exp}) - (\text{p1lab\_oi\_1} - \text{p3tot\_1}) = \text{WAGE\_ELAS2} \times \text{emprate\_1} + \text{fp1lab\_oi4}$	
<b><i>Expected rate of CPI inflation set equal to trend value of CPI inflation</i></b>		
E_fp3tot_exp2	$\text{p3tot\_exp} = \text{p3tot\_1} + \text{p3tr\_pow\_exp} + \text{fp3tot\_exp2}$	
<b><i>Expected power of the rate of CPI inflation set equal to trend value of power of rate of inflation</i></b>		
E_p3tr_pow_exp	$\text{p3tr\_pow\_exp} = \text{p3tr\_pow}$	
<b><i>Power of the trend rate of CPI inflation</i></b>		
E_p3tr_pow	$\text{TREND\_P3} \times \text{p3tr\_pow} = [\text{TREND\_ADJ2} \times \text{TREND\_P3\_L}] \times \text{p3tr\_pow\_1} + [[1 - \text{TREND\_ADJ2}] \times \text{INF3POW\_L}] \times \text{p3inf\_pow\_1}$	
<b><i>Lagged value of the percentage change in the trend value of CPI growth</i></b>		
E_dp3tr_pow_1	$\text{TREND\_P3\_L} \times \text{p3tr\_pow\_1} = 100 \times [\text{TREND\_P3\_B} - \text{TREND\_P3\_L\_B}] \times \text{del\_unity} + 100 \times \text{dp3tr\_pow\_1}$	

<b>Lagged value of the percentage change in the power of CPI growth</b>		
E_dp3inf_pow_l	$\text{INF3POW\_L} \times \text{p3inf\_pow\_l} =$ $100 \times [\text{INF3POW\_B} - \text{INF3POW\_L\_B}] \times \text{del\_unity}$ $+ 100 \times \text{dp3inf\_pow\_l}$	
<b>Relationship between actual and target wage growth</b>		
E_d_f_w_pow	$\text{LEV\_NWPOW} \times (\text{p1lab\_oi} - \text{p1lab\_oi\_l}) =$ $[\text{WGRADJ} \times [\text{WAGETARG} / \text{LEV\_WAGE\_L}]] \times$ $\{\text{p1lab\_oi\_targ} - \text{p1lab\_oi\_l}\} +$ $[[1 - \text{WGRADJ}] \times \text{LEV\_NWPOW\_L}] \times \text{w\_pow\_l} +$ $100 \times \text{d\_f\_w\_pow}$	
<b>Lagged value of the percentage change in the power of nominal wage growth</b>		
E_d_w_pow_l	$\text{LEV\_NWPOW\_L} \times \text{w\_pow\_l} =$ $100 \times (\text{LEV\_NWPOW\_B} - \text{LEV\_NWPOW\_LB}) \times \text{del\_unity} +$ $100 \times \text{d\_w\_pow\_l}$	
<b>Revaluation of government equity in the central bank</b>		
E_d_v_cb	$\sum_{s \in LA} \sum_{f \in FI} \text{AT1}_{(s,f,CB)} \times \text{a\_t\_l}_{(s,f,CB)} = \sum_{f \in FI} \sum_{d \in AA} \text{AT1}_{(CB,f,d)} \times \text{a\_t\_l}_{(CB,f,d)} + 100 \times \text{d\_f\_v\_cb}$	-

**Table 15: 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 ∈ LA) (f ∈ FI) (d ∈ AA)	Start-of-year holdings by agent (d) of asset type (f) issued by agent (s).
$AT\_B_{(s,f,d)}$	(s ∈ LA) (f ∈ FI) (d ∈ 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 ∈ LALF) (f ∈ FI)	End-of-year liabilities of type (f) issued by agent (s).
$AT1_{(s,f,d)}$	(s ∈ LA) (f ∈ FI) (d ∈ AA)	End-of-year holdings by agent (d) of asset type (f) issued by agent (s).
$AT1\_B_{(s,f,d)}$	(s ∈ LA) (f ∈ FI) (d ∈ AA)	Initial value for the end-of-year holdings by agent (d) of asset type (f) issued by agent (s).
$AVE\_ROI_{(s)}$	(s ∈ 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 ∈ AALF)	Value of agent (d)'s holdings of foreign financial assets.
$BIGBUDGET_{(d)}$	(d ∈ AA)	Aggregate end-of-year asset holdings by agent (d).
$BIGBUDGETL_{(s)}$	(s ∈ LALF)	Aggregate end-of-year liabilities of agent (s).
$BIGBUDNEQ_{(s)}$	(s ∈ LALF)	Equity-exclusive value of the liabilities of agent (s).
$BIGBUDNF_{(d)}$	(d ∈ AA)	That part of asset agent (d)'s financial assets relating to domestic financial assets only.
$BIGBUDNR_{(d)}$	(d ∈ AA)	Level of end-of-year asset holdings excluding cash and deposits with the central bank.
$BIGBUDNS_{(d)}$	(d ∈ AA)	End of period portfolio, excluding Super-issued deposits & equity.
$COEFF\_SL_{(i)}$	(i ∈ INDP)	Coefficient governing the elasticity of investment to rates of return.
$DEP_{(i)}$	(i ∈ 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 ∈ 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 ∈ INDP)	Level of the capital growth rate.
$K\_GR\_MIN_{(i)}$	(i ∈ INDP)	Lowest possible rate of physical capital growth for sector (i).
$K\_GR\_MAX_{(i)}$	(i ∈ 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 $t-1$ .
LEV_PHI_L	-	Lagged level of the nominal exchange rate.
LEV_PHI_B	-	Level of the nominal exchange rate, base.
LEV_PHI_L_B	-	Lagged level of the nominal exchange rate, base.
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 <sub>(i)</sub>	( $i \in \text{IND}$ )	Quantity of investment in year t-1 in industry $i$ .
RA_BANK1	-	Value of risk-weighted bank assets, end of year.
RISKWGT <sub>(s,f)</sub>	( $s \in \text{LA}$ ) ( $f \in \text{FI}$ )	Bank risk weight attaching to financial instrument (f) issued by liability agent (s).
ROI_EQ_D <sub>(s)</sub>	( $s \in \text{KLA}$ )	Power of the realised rate of return on the equity of industry, reproducible housing, and non-reproducible housing.
ROIA <sub>(s,f,d)</sub>	( $s \in \text{LA}$ ) ( $f \in \text{FI}$ ) ( $d \in \text{AA}$ )	Power of the rate of interest as seen by asset holders.
ROIL <sub>(s,f,d)</sub>	( $s \in \text{LA}$ ) ( $f \in \text{FI}$ ) ( $d \in \text{AA}$ )	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 <sub>(s,f,d)</sub>	( $s \in \text{LA}$ ) ( $f \in \text{FI}$ ) ( $d \in \text{AA}$ )	Dummy variable, =1 for $VEXCH_{(\text{Foreigners},f,d)} \forall f,d$ , but otherwise =0.
V1CAP <sub>(i)</sub>	( $i \in \text{IND}$ )	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 <sub>(i)</sub>	( $i \in \text{IND}$ )	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 <sub>(i)</sub>	( $i \in \text{IND}$ )	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 <sub>(s,f,d)</sub>	(s ∈ LA) (f ∈ FI) (d ∈ AA)	Power of the valuation term applying to holdings by agent (d) of financial instrument (f) issued by agent (s).
VCAP <sub>(i)</sub>	(i ∈ 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.
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 16: Variables (percentage change unless otherwise indicated)**

Name	Range	Description	Closure <sup>(36)</sup>	
			Real CGE	Financial CGE
$a_{t(s,f,d)}$	(s ∈ LA) (f ∈ FI) (d ∈ 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 ∈ LA) (f ∈ FI) (d ∈ AA)	End-of-year holdings by agent (d) of asset type (f) issued by agent (s).	N	X: $a_{t_1(\text{Foreigners},f, \text{CB})}$ (f ∈ FI), rest endogenous. See Section 4.6.
$a_{t_1_d(s,f)}$	(s ∈ LALF) (f ∈ 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 <sub>(d)</sub>	(d ∈ AA)	Power of the weighted average rate of return earned by asset agent (d) on its domestic financial assets.	N	N
ave_ror_nr <sub>(d)</sub>	(d ∈ AA)	Average rate of return on assets other than cash and central bank deposits.	N	N
ave_ror_ns <sub>(d)</sub>	(d ∈ AA)	Average rate of return on asset agent (d)'s assets excluding instruments issued by Superannuation.	N	N
ave_ror_d <sub>(d)</sub>	(d ∈ AALF)	Average rate of return received by agent (d).	N	N
ave_ror_for <sub>(d)</sub>	(d ∈ 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 ∈ LA)	Average rate of return available to foreigners in the rest of the world.	X	X
ave_ror_s <sub>(s)</sub>	(s ∈ LALF)	Average rate of interest / return paid by liability agent (s).	N	N
ave_ror_sne <sub>(s)</sub>	(s ∈ LALF)	Average rate of return on non-equity financial instruments issued by liability agent (s).	N	N
big_bud <sub>(d)</sub>	(d ∈ AA)	\$A value of end-of-year portfolio value.	N	N
big_bud_for <sub>(d)</sub>	(d ∈ AALF)	Value of agent (d)'s holdings of foreign financial assets.	N	N

big_bud_nf <sub>(d)</sub>	(d ∈ AA)	Asset agent (d)'s total holdings of domestic financial assets	N	N
big_bud_nr <sub>(d)</sub>	(d ∈ AA)	End-of-period assets excluding cash holdings and deposits with the central bank.	N	N
big_bud_ns <sub>(d)</sub>	(d ∈ AA)	End of period portfolio, excluding Superannuation-issued assets.	N	N
big_budl <sub>(s)</sub>	(s ∈ LALF)	\$A value of end-of-year liabilities of agent (s).	N	N
big_budl_neq <sub>(s)</sub>	(s ∈ 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 <sub>(i)</sub>	(i ∈ IND)	Industry <i>i</i> 's start of year capital stock.	N	N
cap_trh	-	Quantity of capital in the reproducible housing sector.	X	N
del_k_gr <sub>(i)</sub>	(i ∈ 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 <sub>(i)</sub>	(i ∈ INDP)	Expected rate of return.	N	N
d_f_cap_trf	-	When exogenous, activates equation $E_{cap\_trf}$ .	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 <sub>(i)</sub>	(i ∈ 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 <sub>(s,f,d)</sub>	(s ∈ LA) (f ∈ FI) (d ∈ AA)	Change in the value of net acquisitions by agent (d) of financial instrument (f) issued by agent (s).	N	N
d_f_v_cb	-	When exogenous, activates equation $E_{d\_f\_v\_cb}$ .	N	X (See Section 4.6).
d_feriror <sub>(i)</sub>	(i ∈ 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 <sub>(s,f)</sub>	(s ∈ LALF) (f ∈ FI)	When exogenous, allows for two-stage liability optimisation.	X	N (s = Govt, f ∈ FINDL, see Section 4.2).  N (s = Inds, f ∈ FINDL, see Section 4.3).  N (s = RH, f ∈ FINDL, see Section 4.4).  N (s = NRH, f ∈ FINDL, see

				<p>Section 4.5).</p> <p>N (s = Super, f ∈ FINDL, see Section 4.9).</p> <p>N (s = Banks, f ∈ FINDL, see Section 4.10).</p> <p>N (s = LifeIns, f ∈ FINDL, see Section 4.11).</p> <p>N (s = NonBankFinIn, f ∈ FINDL, see Section 4.11).</p>
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 <sub>(d)</sub>	(d ∈ AA)	Change in total asset acquisitions by agent (d).	X	<p>N ( d = Govt, see Section 4.2)</p> <p>N ( d = Inds, see Section 4.3)</p> <p>X (d=CB, see Section 4.6)</p> <p>N (d=Super, see Section 4.9)</p> <p>X (d=RH, NRH)</p> <p>N (d=LifeIns, See Section 4.11).</p>

				<p>N (d=NonBankFinIn, See Section 4.11).</p> <p>N (d=Hlds, See Section 4.7).</p> <p>N (d=foreigners, See Section 4.8).</p>
$d\_new\_liaacq_{(s)}$	$(s \in LALF)$	Change in liability acquisition by agent (s).	X	<p>N (s = Govt, see Section 4.2)</p> <p>N (s = Inds, see Section 4.3)</p> <p>N (s = RH, see Section 4.4)</p> <p>X (s = NRH, Hlds)</p> <p>N (s = Banks)</p> <p>N (s = NonBankFinIn, see Section 4.11)</p> <p>N (s = Life insurance, see Section 4.11)</p> <p>N (s = Super, see Section 4.9)</p> <p>N (s = CB) (See Section 4.6)</p>
$d\_neriror_{(i)}$	$(i \in INDP)$	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 <sub>(d)</sub>	(d ∈ AA)	Exogenous shift variable. When exogenous, activates equation $E\_d\_shift4$ .	N	X (d=foreigners, see Section 4.8)  N ( $d \in \text{DOMAGENT}$ ).
d_shiftl4 <sub>(s)</sub>	(s ∈ 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_superbst	-	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 <sub>(s)</sub>	(s ∈ LALF)	Change in liability agent (s)'s weighted average cost of capital.	N	N
d_w_pow_1	-	When exogenous, activates $E\_d\_w\_pow\_1$ .	X	X
f2_roipow1 <sub>(s,f)</sub>	(s ∈ LALF) (f ∈ FI)	(s,f)-specific shift variable on Equation $E\_roipow14$ .	X	N (s=Govt, f ∈ FINDL, rest exogenous, see Section 4.2).  N (s=Ind, f ∈ FINDL, rest exogenous, see Section 4.3).  N (s=RH, f ∈ FINDL, rest exogenous, see Section 4.4).

				<p>N (s=NRH, f ∈ FINDL , rest exogenous, see Section 4.5).</p> <p>N (s=Super, f ∈ FINDL , rest exogenous, see Section 4.9).</p> <p>N (s=Banks, f ∈ FINDL , rest exogenous, see Section 4.10).</p> <p>N (s=LifeIns, f ∈ FINDL , rest exogenous, see Section 4.11).</p> <p>N (s=NonBankFinIn, f ∈ FINDL , rest exogenous, see Section 4.11).</p>
f3_ropow1 <sub>(s,f,d)</sub>	(s ∈ LALF) (f ∈ FI) (d ∈ AA)	(s,f,d)-specific shift variable on <i>Equation E_ropow14</i> .	N	<p>X (s=Govt, f ∈ FINDL , d ∈ AA , rest endogenous, see Section 4.2).</p> <p>X (s=Inds, f ∈ FINDL , d ∈ AA , rest endogenous, see Section 4.3).</p> <p>X (s=RH, f ∈ FINDL , d ∈ AA , rest endogenous, see Section 4.4).</p> <p>X (s=NRH, f ∈ FINDL , d ∈ AA , rest endogenous, see Section 4.5).</p>

				<p>X (s=Super, f ∈ FINDL , d ∈ AA , rest endogenous, see Section 4.9)</p> <p>X (s=Banks, f ∈ FINDL , d ∈ AA , rest endogenous, see Section 4.10).</p> <p>X (s=LifeIns, f ∈ FINDL , d ∈ AA , rest endogenous, see Section 4.11).</p> <p>X (s=NonBankFinIn, f ∈ FINDL , d ∈ AA , rest endogenous, see Section 4.11).</p>
f4_roipow <sub>(s)</sub>	(s ∈ LALF)	(s)-specific shift variable on Equation $E_{roipow4}$ .	X	X
f4_roipow <sub>(s,d)</sub>	(s ∈ KAGENTS) (d ∈ AA)	When exogenous, activates equation $E_{f4\_roipow}$ .	N	X (s ∈ KAGENTS, see Sections 4.3, 4.4 and 4.5).
f_a_t_1 <sub>(s,f,d)</sub>	(s ∈ LA) (f ∈ FI) (d ∈ AALF)	Shift variable for activating / deactivating equation $E_{a\_t\_1dom}$ .	X	<p>N: f_a_t_1<sub>(s,f,CB)</sub> (s ∈ LA) (f ∈ FI), See Section 4.6.</p> <p>N: f_a_t_1<sub>(s,f,Banks)</sub> (s ∈ LA) (f ∈ FI), See Section 4.10.</p> <p>Rest exogenous.</p>
f_bank_eq <sub>(f)</sub>	(f ∈ FINEQ)	When exogenous, activates equation $E_{f\_bank\_eq}$ .	N	X (See Section 4.10).

f_bankres1 <sub>(s,f)</sub>	(s ∈ LANCB) (f ∈ FI)	When exogenous, activates equation $E_{f\_bankres1}$ .	N	X (See Section 4.10).
f_bankres2 <sub>(s,f)</sub>	(s ∈ CBSET) (f ∈ NOTCD)	When exogenous, activates equation $E_{f\_bankres2}$ .	N	X (See Section 4.10).
f_cb_asset1 <sub>(s,f,d)</sub>	(s ∈ DOMAGENT) (f ∈ FI) (d ∈ 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 ∈ DOMAGENT, f ∈ FI, See Section 4.6).
f_cb_asset2 <sub>(f,d)</sub>	(f ∈ FI) (d ∈ 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 <sub>(s,f,d)</sub>	(s ∈ LA) (f ∈ FI) (d ∈ AA)	Ratio of rate of return on instrument $f$ for asset and liability positions.	X	N (s ∈ KAGENTS, see Sections 4.3, 4.4 and 4.5).
f_roipow_g <sub>(f,d)</sub>	(f ∈ B_DL) (d ∈ 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 <sub>(i)</sub>	(i ∈ 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 <sub>(s,f,d)</sub>	(s ∈ LA) (f ∈ FI) (d ∈ AA)	(s,f,d)-specific shifter on valuation terms in equation $E_v$ .	X	N (s=CB, f=Equity,d=Govt, See Section 4.6). X (rest exogenous).
ff_v <sub>(d)</sub>	(d ∈ AA)	Shifter on asset-agent-specific valuation terms in equation $E_v$ .	X	X

$fff_v_{(s,f)}$	(s ∈ LA) (f ∈ 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).
$f_v1_{(f,d)}$	(f ∈ FI) (d ∈ AA)	When exogenous, activates equation $E_f_v1$	N	X (see Section 4.6).
$gv2tot_{(i)}$	(i ∈ IND)	Government share of investment in industry (i).	X	X
hdy	-	Household disposable income.	N	N
$liab\_sh\_d_{(s,f)}$	(s ∈ LALF) (f ∈ 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 ∈ FI) (see Section 4.3).  X (s=RH, f ∈ FI) (See Section 4.4).  X (s=NRH, f ∈ FI) (See Section 4.5).  X (s=Super, f ∈ FI, see Section 4.9).  N (s=Banks, f ∈ FI, see Section 4.10).
$liab\_shift_{(s,f,d)}$	(s ∈ LA) (f ∈ FI) (d ∈ AA)	When exogenous, activates liability optimisation.	N	X (s=Govt, f=DeposLoans, d ∈ AA), rest endogenous (See Section 4.2).

				<p>X (s=Inds, f=DeposLoans, d ∈ AA), rest endogenous (See Section 4.3).</p> <p>X (s=RH, f=DeposLoans, d ∈ AA), rest endogenous (See Section 4.4).</p> <p>X (s=NRH, f=DeposLoans, d ∈ AA), rest endogenous (See Section 4.5).</p> <p>X (s=Super, f =DeposLoans, d ∈ AA), rest endogenous (See Section 4.9).</p> <p>X (s=Banks, f=DeposLoans, d ∈ AA), rest endogenous (See Section 4.10).</p> <p>X (s=LifeIns, f=DeposLoans, d ∈ AA), rest endogenous (See 4.11).</p> <p>X (s=NonBankFinIn, f=DeposLoans, d ∈ AA), rest endogenous (See 4.11).</p>
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 <sub>(i)</sub>	(i ∈ 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 <sub>(i)</sub>	(i ∈ 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).
phi_l	-	Nominal exchange rate, \$Foreign / \$local, lagged.	N	N
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 <sub>(s,f)</sub>	(s ∈ LA) (f ∈ FI)	Percentage change in the value of the risk weight attached to commercial bank holdings of financial instrument (f) issued	X	X

		by liability agent (s).		
roiB_DL_G	-	Common power for rate of interest on government bonds and loans to government.	X	X
roipowa <sub>(s,f,d)</sub>	(s ∈ LA) (f ∈ FI) (d ∈ AALF)	Power of the rate of interest / return on financial instrument (f) issued by agent (s) held by agent (d).		
roipoweqc <sub>(s)</sub>	(s ∈ KLA)	Power of the realised return on equity issued by capital agent (s)	N	N
roipowl <sub>(s,f,d)</sub>	(s ∈ LA) (f ∈ FI) (d ∈ AA)	Power of the rate of interest / return paid to agent (d) on financial instrument (f) issued by agent (s).	X	N (s=Govt, ∀ f,d)(See Section 4.2)  N (s=Inds, f ∈ FI, d ∈ AA) (See Section 4.3)  N (s=RH, f ∈ FI, d ∈ AA) (See Section 4.4)  N (s=NRH, f ∈ FI, d ∈ AA) (See Section 4.5)  N (s=Super, ∀ f,d) (See Section 4.9).
roipowl_d <sub>(s,f)</sub>	(s ∈ LALF) (f ∈ 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 <sub>(s,f,d)</sub>	(s ∈ LA) (f ∈ FI)	Power of the revaluation term applying to financial instrument (f) issued by agent (s) and held by agent (d).	N	N

	(d ∈ AA)			
w0gdpinc	-	Nominal GDP at market prices.	N	N
w2_ind		Value of investment plus inventories excluding government investment and private investment in ownership of dwellings.	N	N
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_1	-	Percentage change in the power of the growth rate in the nominal wage, year (t-1).	N	N
x1cap <sub>(i)</sub>	(i ∈ IND)	Physical capital stock of industry (i).	N	N
x2tot <sub>(i)</sub>	(i ∈ IND)	Real gross fixed capital formation in industry (i).	N	N
x6tot		Real inventory accumulation.	N	N
* “N” denotes <u>endogenous</u> ; “X” denotes <u>exogenous</u> .				

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