Mortgage Default, Financial Disintermediation and Macroprudential Policies

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22 July 2017

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Objective

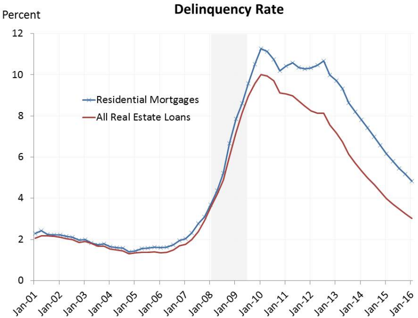
(I) Propose the model that can capture the key aspects of the recent global financial crisis, namely the spillover effects of shocks originating in the housing and financial sectors on the real economy

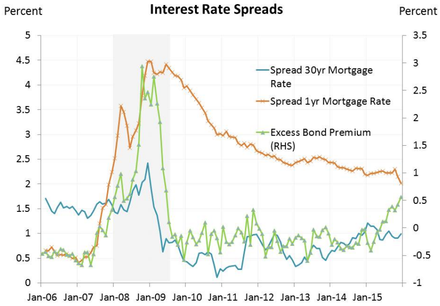
- The paper embeds endogenous mortgage default into a New Keynesian model that features housing and non-trivial banking sectors
- Two shocks: (1) shocks to the variance of idiosyncratic housing shock (housing risk shocks) and (2) shocks to the penalty on capital regulation, to explain heightened mortgage default risk and credit spreads

(II) Evaluate the effectiveness of three macroprudential measures in improving allocations and welfare

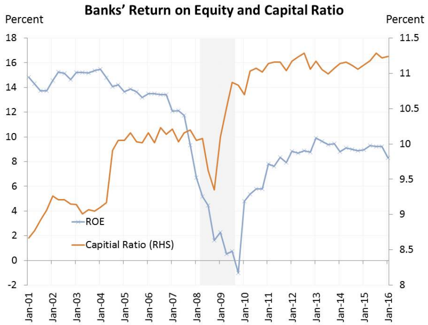
- The measures include caps on LTV ratio, countercyclical capital buffers and state-contingent LTV caps

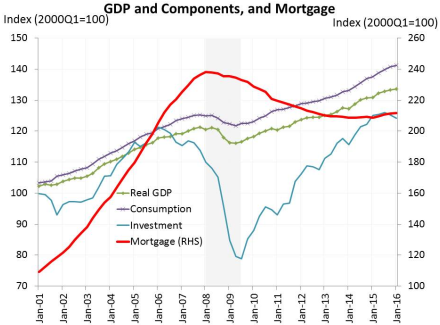
Facts


Delinquency Rate
Percent
12
10
8
6
4
2
0
Residential Mortgages
All Real Estate Loans
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16


Interest Rate Spreads
Percent
Percent
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
Spread 30yr Mortgage Rate
Spread 1yr Mortgage Rate
Excess Bond Premium (RHS)
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15

Facts (cont'd)


Banks' Return on Equity and Capital Ratio
Percent
Percent
ROE
Capitial Ratio (RHS)


GDP and Components, and Mortgage
Index (2000Q1=100)
Index (2000Q1=100)
Real GDP
Consumption
Investment
Mortgage (RHS)

Existing Literature

DSGE models with housing and borrowing constraint Kiyotaki and Moore (1997), Iacoviello (2005), Iacoviello and Neri (2010), Monacelli (2009) and Gerali et al. (2010)

DSGE models with mortgage default Forlati and Lambertini (2011), Quint and Rabanal (2014), Clerc et al. (2015) and Ferrante (2015)

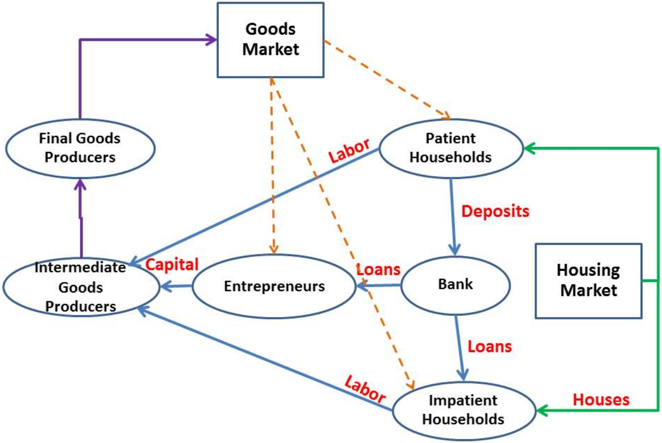
Mortgage default in other DGE models Campbell and Cocco (2015), Goodhart et al. (2011) and Goodhart et al. (2013)

Positive analysis on macroprudential regulation Angelini et al. (2014), Angelini et al. (2015), Bean et al. (2010), Kannan et al. (2012), Lambertini et al. (2013), Gelain et al. (2013) and Rubio and Carrasco-Gallego (2014)

Gap in the literature: None of the DSGE articles on macroprudential regulation above includes mortgage default. DSGE papers with mortgage default are yet to study the effectiveness of capital and LTV regulations.

Agents and Market Structure

This paper embeds mortgage default into the model of Gerali et al (2010) which features housing and non-trivial banking sectors.



Impatient Household

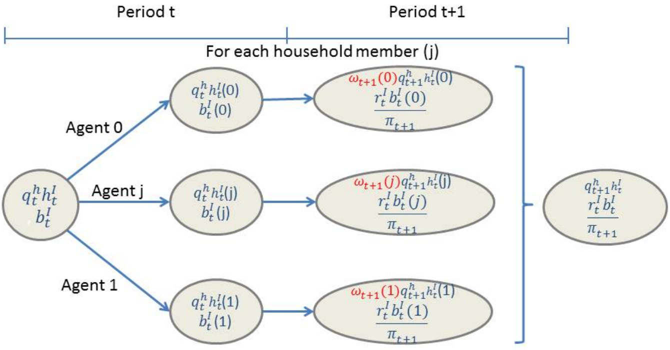
Impatient households maximise a lifetime utility function given by:

$$E_0 \sum_{t=0}^{\infty} \beta_t^I [(1-a_I) ln(c_t^I(i) - a_I c_{t-1}^I) + j ln(h_t^I(i)) - \frac{(l_t^{I,s}(i))^{\eta}}{\eta}]$$

subject to the following budget constraint

$$c_t^I(i) + q_t^h h_t^I(i) + (1 - F_t(\bar{\omega}_t(i))) \frac{r_{t-1}^I b_{t-1}^I(i)}{\pi_t} + \phi_h (\frac{h_t^I(i) - h_{t-1}^I(i)}{h_{t-1}^I(i)})^2 \frac{q_t^h h_{t-1}^I(i)}{2}$$
$$= b_t^I(i) + w_t^I l_t^{I,s}(i) + (1 - G_t(\bar{\omega}_t(i))) q_t^h h_{t-1}^I(i)$$

Impatient Household (cont'd)



$$\log \omega_{t+1} \sim N(\mu_{\omega,t+1}, \sigma_{\omega,t+1}^2)$$

Housing Risk Shocks: $\ln \sigma_{\omega,t+1} = \rho_\omega \ln \sigma_{\omega,t} + (1-\rho_\omega) \ln \sigma_\omega + \varepsilon_{\omega,t}$

Default decision

Household chooses the cut-off point $\bar{\omega}_{t+1}$ such that its members default on the contracts with $\omega_{t+1}(j)$ lower than $\bar{\omega}_{t+1}$

Total default: $F_{t+1}(\bar{\omega}_{t+1}) \frac{r_t^I b_t^I}{\pi_{t+1}}$

Houses seized by banks: $G_{t+1}(\bar{\omega}_{t+1}) q_{t+1}^h h_t^I$

Mortgage Default

Mortgage Default

The first order condition with respect to $\bar{\omega}_t$ yields:

$$\frac{r^l_{t-1} b^l_{t-1}}{\pi_t} = \bar{\omega}_t q^h_t h^l_{t-1}$$

Define the LTV ratio, $m^l_t = E_t[\frac{r^l_t b^l_t}{q^h_{t+1} h^l_t \pi_{t+1}}]$, we have;

$$\bar{\omega}_t = m^l_{t-1} \frac{E_{t-1}[q^h_t \pi_t]}{q^h_t \pi_t}$$

The probability of default ($F_t(\bar{\omega}_t(i))$) is driven by three factors:

1. the variance of idiosyncratic housing shock $\sigma_{\omega,t}$
2. the predetermined LTV ratio
3. a deviation of nominal house price from expectation

Banks and the Capital Regulation

Risk-neutral banks maximise the following objective function:

$$E_0 \sum_{t=0}^{\infty} \Lambda^P_{0,t}[\Pi^B_t + \phi^k_t \frac{(\frac{k^B_t}{k})^{1-\sigma_B} - 1}{1-\sigma_B}]$$

where

$$\Pi^B_t = (1 - F_t(\bar{\omega}_t))\frac{r^l_{t-1} b^l_{t-1}}{\pi_t} + (1-\theta)G_t(\bar{\omega}_t)q^h_t h^l_{t-1} + \frac{r^E_{t-1} b^E_{t-1}}{\pi_t} - \frac{r_{t-1} d^P_{t-1}}{\pi_t}$$

$$k^\gamma_t = \frac{e^B_t}{rwa_t} = \frac{e^B_t}{rw^l_t b^l_t + rw^E_t b^E_t}$$

$$e^B_t = (1-\delta_B)\frac{e^B_{t-1}}{\pi_t} + (1-\gamma_B)(\Pi^B_t - \frac{e^B_{t-1}}{\pi_t})$$

subject to

$$b^l_t + b^E_t \leq d^P_t + e^B_t$$

Interest Rate Spreads

Interest Rate Spreads

$$\phi_t^k(\frac{k_t^B}{k})^{-\sigma_B}\frac{rw_t^l}{rwa_t} = \beta_P E_t[\frac{\lambda_{t+1}^P}{\lambda_t^P}\frac{(1-F_{t+1}(\bar{\omega}_{t+1}) + (1-\theta)\frac{G_{t+1}(\bar{\omega}_{t+1})}{m_t^l})r_t^l - r_t}{\pi_{t+1}}]$$

$$\phi_t^k(\frac{k_t^B}{k})^{-\sigma_B}\frac{rw_t^E}{rwa_t} = \beta_P E_t[\frac{\lambda_{t+1}^P}{\lambda_t^P}\frac{r_t^E - r_t}{\pi_{t+1}}]$$

Banks price into loans interest rates:

1. anticipated losses from default
2. disutility from loans origination associated with capital regulation penalty

Risk premium shocks $\ln\phi_t^k = \rho_k \ln\phi_{t-1}^k \ln\phi^k + \epsilon_{k,t}$

Calibration

Parameter value

Var	Description	Value	Var	Description	Value
β_P	PH's discount rate	0.991	σ_ω^2	Variance of idio. housing shocks	0.167
β_I	IH's discount rate	0.984	Θ	Cost of state verification	0.160
β_E	Entrepreneur's discount rate	0.980	rec	Recovery rate	0.500
j	Housing weight	0.200	m^E	Business loans LTV caps	0.200
η	Labor supply aversion	2.000	k	Regulatory capital requirement	0.800
δ	Capital depreciation rate	0.025	rw^E	Risk weight on business loan	1.000
μ	Share of capital income	0.330	Υ	Sensitivity of risk weight	7.473
α	PH's wage share	0.640	ϕ^k	Capital regulation penalty	0.044
A	Steady-state productivity level	1.000	σ_B	Capital regulation penalty	6.000
$\frac{\epsilon}{\epsilon-1}$	Mark up in the goods market	1.100	δ_B	Dividend payout rate	0.135
θ	Probability fixed price	0.750	γ_B	Dividend payout rate	0.010
H	Fixed supply of houses	33.27	a_P	Habit coefficient	0.500
ϕ_h	Housing adjustment cost	0.330	a_I	Habit coefficient	0.500
r_R	Taylor-rule coefficient	0.800	a_E	Habit coefficient	0.500
r_Y	Taylor-rule coefficient	0.125	k_i	Investment adjustment cost	0.200
r_π	Taylor-rule coefficient	0.500	$\epsilon_{k,1}$	Capital utilisation cost	0.0452
ρ	Persistence of shocks	0.900	$\epsilon_{k,2}$	Capital utilisation cost	0.0452

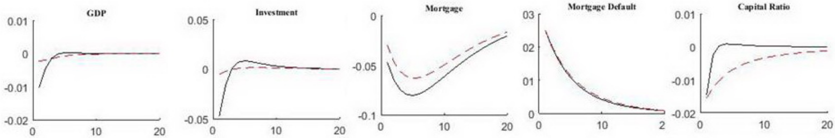
Calibration (cont'd)

Important Rates and Ratios at the Steady State

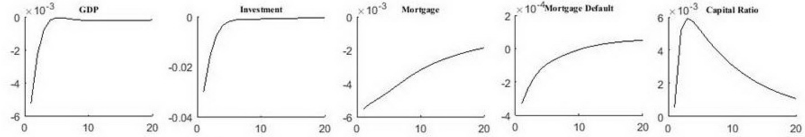
Variable	Description	Value
$F(\omega)$	Mortgage default probability	2.007%
m^I	Loan-to-value ratio	70.00%
r	Deposit interest rate (p.a.)	3.673%
r^I	Mortgage interest rate (p.a.)	6.800%
r^E	Business Loans interest rate (p.a.)	7.736%
k^B	Capital adequacy ratio	8.000%
rw^I	Risk weight on mortgages	0.350
$\frac{b^I}{b^I+b^E}$	Proportion of mortgages	57.26%
$\frac{c^P}{Y}$	Patient household consumption to output	52.96%
$\frac{c^I}{Y}$	Impatient household consumption to output	19.24%
$\frac{c^E}{Y}$	Entrepreneur consumption to output	10.95%
$\frac{i}{Y}$	Investment to output	16.59%

Simulation Results

An adverse housing risk shock

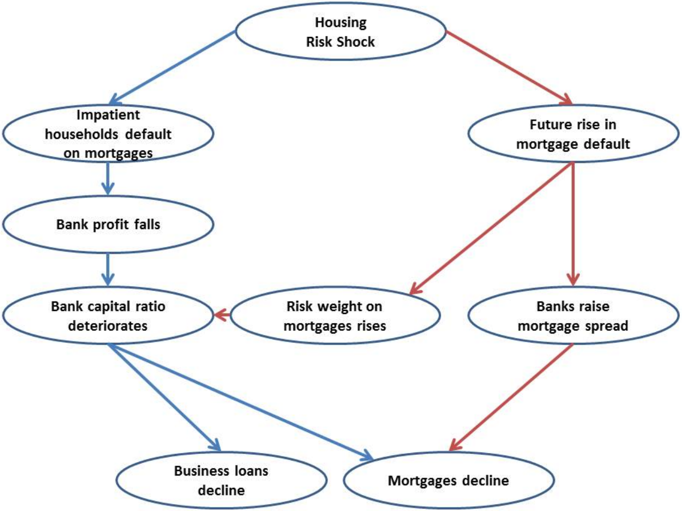


An adverse risk premium shock



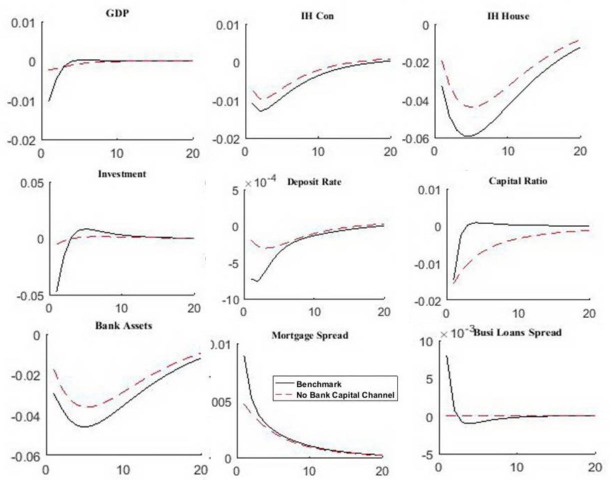
- A large adverse housing risk shock results in higher mortgage default that in turn raises the mortgage spreads. It also generates losses to banks, which subsequently constrains their lending activity.
- A shock to the capital regulation penalty raises mortgage and business loans interest rates, which has negative effects on aggregate demand.

Transmission of Housing Risk Shocks



The Importance of the Bank Capital Channel

The Effects of Housing Risk Shocks



Is the evolution of house prices important?

- The interactions between mortgage default, house prices and credit supply conditions could be a potential financial accelerator that lies behind a significant economic downturn
  - Falling house prices raise default probability.
  - The value of seized collateral also affected
  - On the loan demand side, low housing accumulation and house prices imply limited collateral.
  - Reduced mortgage extension puts further pressure on house prices.
- However, the role of house prices in the model is limited
- Capital regulation and housing adjustment costs are shown to be an important propagator of shocks.
- Why the latter?
  - High housing adjustment costs constrain non-durable consumption.
  - With low housing adjustment costs, loan-to-value ratio declines to a larger extent, but helps lower default risk and strengthen banks' balance sheet.

Macroprudential regulations

- **Caps on loan-to-value ratio**

$$r_t^l b_t^l \leq \hat{m}^l q_t^h h_t^l$$

- **Countercyclical capital buffers**

$$\bar{k}_t = \rho_{\bar{k}} \bar{k}_{t-1} + (1 - \rho_{\bar{k}})[\bar{k} - \Phi_k(\frac{b_t^l + b_t^E}{GDP_t} - \frac{b^l + b^E}{GDP})]$$

- **State-contingent LTV ratio**

$$\hat{m}_t^l = \rho_m \hat{m}_{t-1}^l + (1 - \rho_m)[\hat{m}^l - \Phi_m(\frac{b_t^l}{GDP_t} - \frac{b^l}{GDP})]$$

Caps on loan-to-value ratio

- Imposing LTV caps benefits mortgage borrowers in the steady state. The banking system also becomes safer.
- Models without mortgage default yield contrasting results (see e.g. Gelain et al, 2013)

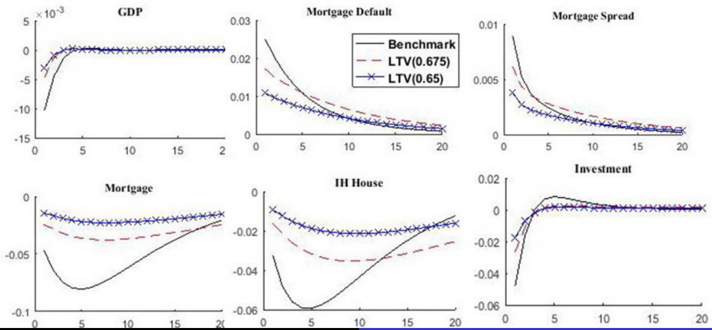
Steady State Effects from Imposing LTV Caps

	$\hat{m}^l$	$F(\bar{\omega})$	r^l	b^l	c^l	GDP
Benchmark	70%	2.01%	1.70%	-	-	-
Case1	67%	1.03%	1.42%	$+6.52\%$	$+0.95\%$	-0.05%
Case2	65%	0.63%	1.30%	$+8.06\%$	$+1.52\%$	-0.08%
Case3	60%	0.15%	1.17%	$+5.31\%$	$+2.71\%$	-0.16%
Case4	55%	0.02%	1.13%	-3.121%	$+3.66\%$	-0.22%

Caps on loan-to-value ratio (cont'd)

- LTV caps are effective in limiting a surge in mortgage default in the face of housing risk shocks, benefiting mortgage extension and aggregate demand.
- The level of the caps needs to be sufficiently stringent for impatient households to reap the welfare benefits.
- In terms of risk premium shocks, LTV caps help limit a plunge in mortgages. But, this comes at the expense of entrepreneurs.

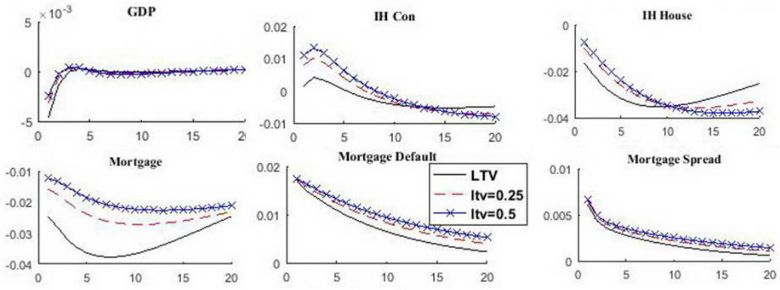
The effects of Housing Risk Shocks



State-contingent LTV ratio

- When the economy faces housing risk shocks, the measure helps relax impatient households borrowing constraint. However, it exacerbates default and eventually reduces their welfare.
- This disagrees with the literature most of which supports state-contingent LTV ratios. For example, see Lambertini et al. (2013) and Rubio and Carrasco-Gallego (2014).

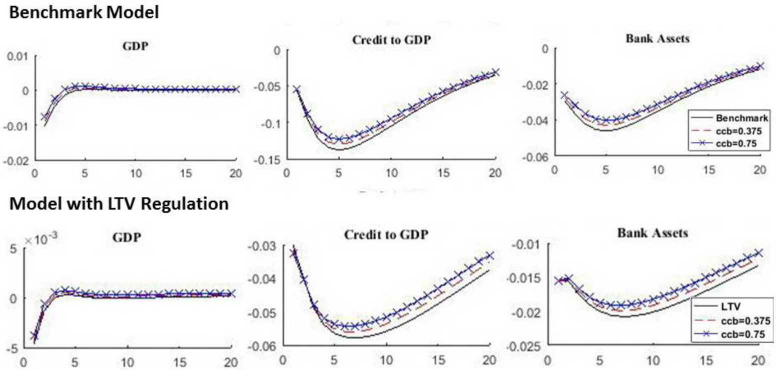
The effects of Housing Risk Shocks



Countercyclical capital buffers

- Result1: The measure improves allocations and the welfare of both impatient households and entrepreneurs.
- Result2: In the face of housing risk shocks, the buffers yield large macroeconomic stabilisation benefits when LTV caps are not available.

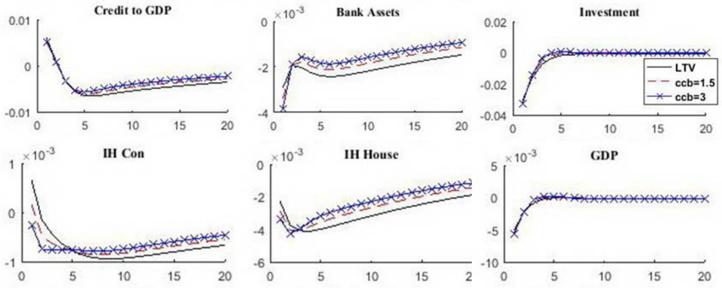
The effects of Housing Risk Shocks



Countercyclical capital buffers (cont'd)

- Result3: Policymakers need to be aware of a false (or delayed) signal when the economy faces risk premium shocks

The effects of Risk Premium Shocks (in the Model with LTV regulation)



Summary

- This paper embeds endogenous mortgage default into a New Keynesian model that features housing and non-trivial banking sectors.
- Two shocks: (1) shocks to the variance of idiosyncratic housing shock (housing risk shocks) and (2) shocks to the penalty on capital regulation (risk premium shocks) to capture key aspects of the recent global financial crisis
- Main contributions: evaluating the effectiveness of three macroprudential measures in the model with mortgage default $\rightarrow$ some new results particularly on the steady state effect of LTV and the use of state-contingent LTV regulation

Patient Households

Patient households maximise a given lifetime utility function:

$$E_0 \sum_{t=0}^{\infty} \beta_t^P [(1 - a_P) ln(c_t^P(i) - a_P c_{t-1}^P) + j ln(h_t^P(i)) - \frac{(l_t^{P,s}(i))^\eta}{\eta}]$$

subject to the following budget constraint

$$c_t^P(i) + q_t^h h_t^P(i) + d_t^P(i) + \phi_h (\frac{h_t^P(i) - h_{t-1}^P(i)}{h_{t-1}^P(i)})^2 \frac{q_t^h h_{t-1}^P(i)}{2}$$
$$= \frac{r_{t-1} d_{t-1}^P(i)}{\pi_t} + w_t^P l_t^{P,s}(i) + div_t(i) + F_t(i) + t_t^P(i)$$

where $t_t^P(i) = rec \Theta G_t(\bar{\omega}_t) q_t^h h_{t-1}^I$

Entrepreneurs

Entrepreneurs possess the economy's physical capital and rent it to intermediate goods producers. Collateral is required to acquire business loans:

$$r_t^E b_t^E(i) \leq m^E E_t[(1-\delta)q_{t+1}^k k_t \pi_{t+1}]$$

The representative entrepreneur maximises a lifetime utility function given by:

$$E_0 \sum_{t=0}^{\infty} \beta_t^E [(1-a_E)ln(c_t^E(i) - a_E c_{t-1}^E)]$$

subject to the above borrowing constraint and the following flow of fund constraint:

$$c_t^E(i) + \frac{r_{t-1}^E b_{t-1}^E(i)}{\pi_t} + q_t^k(k_t(i) - (1-\tau)k_{t-1}(i)) + \Psi(u_t(i))k_{t-1}(i) = r_t^k u_t(i) k_{t-1}(i) + b_t^E(i)$$

where $\Psi(u_t(i)) = \epsilon_{k,1}(u_t(i)-1) + \frac{\epsilon_{k,2}}{2}(u_t(i)-1)^2$

Capital Producers

Capital producers purchase undepreciated capital at price q_t^k from firms and consumption goods i_t from goods market. They combine both components into new capital k_t using the following production function:

$$k_t = (1-\tau)k_{t-1} + i_t(1 - \frac{k_i}{2}(\frac{i_t}{i_{t-1}} - 1)^2)$$

Each capital producer maximises profits subject to the production function above. This yields the following capital price equation:

$$1 = q_t^k(1 - \frac{k_i}{2}(\frac{i_t}{i_{t-1}} - 1)^2 - k_i(\frac{i_t}{i_{t-1}} - 1)\frac{i_t}{i_{t-1}}) + E_t[\Lambda_{t,t+1}^E q_{t+1}^k k_i(\frac{i_{t+1}}{i_t} - 1)(\frac{i_{t+1}}{i_t})^2]$$

Final and Intermediate Good Producers

Demand (from final good producers) for each intermediate good:

$$Y_t(j) = (\frac{P_t(j)}{P_t})^{-\epsilon} Y_t$$

where $P_t = (\int_0^1 P_t^{1-\epsilon}(j)dj)^{\frac{1}{1-\epsilon}}$

Production function:

$$Y_t(j) = A_t(k_{t-1}(j))^{\mu}(l_t^{P,d}(j))^{\alpha(1-\mu)}(l_t^{I,d}(j))^{(1-\alpha)(1-\mu)}$$

Intermediate good producers, who get a chance to reoptimise their price, choose the optimal price taking into account the fact that it remains the same in later periods. New Keynesian Phillips Curve:

$$\hat{\pi}_t = \beta_P \hat{\pi}_{t+1} + \frac{(1-\theta)(1-\beta_P\theta)}{\theta}\hat{mc}_t$$

$$\hat{mc}_t = \mu \hat{r}_t^k + \alpha(1-\mu)\hat{w}_t^P + (1-\alpha)(1-\mu)\hat{w}_t^I - \hat{A}_t$$

The Central Bank

The Central Bank controls deposit interest rates according to the following rule:

$$\frac{r_t}{r} = (\frac{r_{t-1}}{r})^{r_R}((\frac{\pi_t}{\pi})^{r_\pi}(\frac{GDP_t}{GDP_{t-1}})^{r_Y})^{1-r_R}$$

where

$$GDP_t = c_t^P + c_t^I + c_t^E + k_t - (1-\delta)k_{t-1}$$

Note that $k_t - (1-\delta)k_{t-1}$ does not equal to i_t

Aggregation and Market Clearing Conditions:

Good Market:

$$Y_t = c_t^P + c_t^I + c_t^E + i_t + \Psi(u_t) + \phi_h() + (1 - rec)\Theta G_t(\bar{\omega}_t) q_t^h h_{t-1}^I$$

$$A_t(u_t k_{t-1})^{\mu}(l_t^P)^{\alpha(1-\mu)}(l_t^I)^{(1-\alpha)(1-\mu)} = Y_t \int_0^1 (\frac{P_t(j)}{P_t})^{-\epsilon} dj$$

Housing Market:

$$h_t^P + h_t^I = H$$