Monetary Policy, Heterogeneity and the Housing Channel

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- Does the effectiveness of policy depend on the **distribution of LTV**?
  - e.g. low-LTV (pre-2000) vs high-LTV(pre-Great Recession).

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- Do housing and mortgage markets contribute to the asymmetric effects of monetary policy?

How to answer?

- develop a **H**eterogenous **A**gents **N**ew **K**eynesian model with frictional housing market and long-term mortgages.

Transmission channels of monetary policy

Recent strand in the monetary policy literature focusing on mechanisms that complement the **intertemporal substitution channel:**

- Auclert et al. (2019), Beraja et al (2018), Cloyne et al (2018), Gornemann et al (2016), Greenwald (2016), Kaplan et al (2018), Luetticke (2018), Sterk and Tenreyro (2018), and many others.
- Key insight: Household portfolios and MPC heterogeneity are important for the conduct of monetary policy.

We focus on the role of **housing** and **mortgagedebt** in the transmission of monetary policy.

Why Housing and Mortgages?

For many households, **houses** are the single most important asset in their portfolio, tied to long-term nominal debt-**mortgages**.

Various indirect effects on aggregate demand:

- wealth effects due to endogenous movements in house prices
- liquidity effects on mortgage lending standards
- cash-flow effects (e.g., Flodén et al. 2017)
- redistribution channel (e.g., Auclert 2018)

Today

- A HANK model with a frictional housing market and long-term nominal debt
- Calibration and model's fit
  - Compare MPCs w.r.t LTVs between the data and the model.
- Monetary policy experiments
- Conclusion

MODEL

Model: Households

Continuum of ex-ante identical households with preferences for leisure, ND consumption and housing services:

$$U = E_0 \sum_{t=0}^{\infty} (\beta)^t u(c_t, s_t, l_t)$$

where:

$$u(c, s, l) = \frac{\left[(1 - \phi_h)\,(c_t)^{1-\gamma_h} + \phi_h s_t^{1-\gamma_h}\right]^{\frac{1-\sigma}{1-\gamma_h}}}{1 - \sigma} + g(1 - l_t).$$

and $\beta \in (0, 1)$ is the discount factor.

- Households' labor productivity $\{z_t\}_{t=0}^{\infty}$ is stochastic
- $z_t \in \mathcal{Z} = \{z_1, \cdots, z_N\}$ with transition probability characterized by $p(z'|z)$

Housing

Owner-occupied housing

- Houses come in a set of discrete sizes $h \in \mathcal{H}$
- A house of size h generates services $s = \omega h$.

Rental housing

- A linear, reversible technology converts one unit of the final good into A_h units of housing services, $\Rightarrow r_h = \frac{1}{A_h}$.
- Partial segmentation in housing market: can only obtain up to $\bar{a}$ housing services from rentals.

Search in the housing market

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- Room for the LTV distribution to affect prices and liquidity.
- Leverage an insight from the labor search literature (Menzio & Shi 2011):
  - Directed search (price posting) with various submarkets
  - Risk-neutral market makers [real estate brokers]
  - Admits "block-recursive" structure.

Directed Search in the Housing Market

- Real estate brokers intermediate all trades
- Owners of house size h who wish to sell choose:
  - List at price x_s
  - Meet broker w/prob: $p_s(\theta_s(x_s, h))$
  - Sells house conditional on match
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- Brokers:
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- Symmetric on the buyer side

Broker Problem and Block Recursivity

- Inter-broker price of p_h per unit of housing (trade freely)
- Broker profit maximization:

$$\kappa_s h \geq \overbrace{\alpha_s(\theta_s(x_s, h))}^{\text{prob of match}} \overbrace{(p_h h - x_s)}^{\text{broker revenue}}$$

with $\theta_s(x_s, h) \geq 0$

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- Free entry of brokers $\Rightarrow$ block recursivity, i.e. $\theta_s(x_s, h)$ depends only on p_h:

$$\theta_s(x_s, h) = \alpha_s^{-1}\left(\frac{\kappa_s h}{p_h h - x_s}\right)$$

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- Symmetry on the buyer side, p_h pins down $\theta_s(x_s, h), \theta_b(x_b, h)$.

Financial Instruments

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- **Mortgage borrowing** (m): long-term, adjustable rate nominal debt contract.
  - Mortgage amortized at rate $r_{mt} = \overbrace{(1+\phi)}^{\text{spread}} \overbrace{(1+r_t)(1+\pi_t)}^{\text{nominal risk-free rate}}$
  - Price schedule $q_m(r_{mt}, m, b', h, z)$ competitively determined and reflect all idiosyncratic default and refi risk.
  - Required to pay χ-share of the balance each period $\Rightarrow$ effective duration $1/\chi$
  - Option to **refinance** at an origination cost of ζ
  - Option to **default**: Forfeit house to the bank and incur utility cost ξ_f

Banks

- Banks finance themselves by bundling future stream of payments from originated mortgages into *mortgage-backed securities* (MBS_t).

$$\overbrace{q_t^{MBS_t} MBS_t}^{\text{Securities sold}} = \text{Funds dispersed to borrowers}$$

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- Assume LLN holds such that idiosyncratic risk perfectly diversified in MBS
- *Ex-post* losses or profits (due to unanticipated shocks) absorbed by government via GSEs (e.g. Fannie/Freddie)
- This assumption does not prevent the aggregate state and monetary policy from affecting contemporaneous pricing of mortgages, q_m.

Final Goods Production

A final good producer aggregates a continuum of intermediate goods indexed by $j \in [0,1]$ and with prices p_j:

$$Y_t = \left(\int_0^1 y_{jt}^{\frac{\epsilon-1}{\epsilon}} dj \right)^{\frac{\epsilon}{\epsilon-1}} .$$

Given a level of aggregate demand Y, cost minimization for the final goods producer implies that the demand for the intermediate good j is given by

$$y_{jt} = y(p_{jt}; P_t, Y_t) = \left(\frac{p_{jt}}{P_t} \right)^{-\epsilon} Y_t,$$

where P is the (equilibrium) price of the final good and can be expressed as

$$P_t = \left(\int_0^1 p_{jt}^{1-\epsilon} dj \right)^{\frac{1}{1-\epsilon}} .$$

Intermediate Goods Production

Production technology is linear in labor:

$$y_{jt} = Z_t n_{jt}$$

where Z_t is aggregate productivity.
Marginal costs given by

$$mc_{jt} = \frac{w_t}{Z_t}.$$

Price adjustment costs a la Rotemberg (1982):

$$\Theta\left(p_{jt}, p_{jt-1}; Y_t\right) = \frac{\theta}{2}\left(\frac{p_{jt}}{p_{jt-1}} - \overline{\Pi}\right)^2 Y_t$$

where $\overline{\Pi}$ is steady state inflation

Government

- Taxes labor income and provides nominal transfers, $\tilde{T}_t$.
- taxes all the intermediate firm profits, $P_t d_t$.
- Issues nominal bonds B_t^g.
- Exogenous expenditures G_t.
- Absorbs aggregate risk in mortgage market, T_t^{GSE}.
- Government budget constraint is given by:

$$B_{t+1}^g = (1 + i_t)B_t^g + P_t G_t + T_t^{GSE} - P_t d_t - \int \tilde{T}_t(w_t s_t l_t) d\Omega.$$

Monetary authority

Nominal interest rate given by Taylor rule:

$$(1 + i_{t+1}) = (1 + i) \left(\frac{1 + \pi_t}{1 + \overline{\pi}} \right)^{\phi_T} e^{\epsilon_t}$$

- ϵ_t follows an AR(1)
- Monetary-fiscal coordination: assume government adjusts T to keep government debt constant.
- Real rate follows from Fisher equation

$$(1 + i_t) = (1 + r_t)(1 + \pi_t)$$

Calibration and Model Fit

Calibration

- Calibrate the steady state of the model to US economy prior to 2003–2005.
- Some parameters set externally. Others chosen to hit some key moments.
- Emphasis on matching
  - housing moments related to sales, time on the market, etc.
  - joint distribution of housing wealth and mortgage debt.

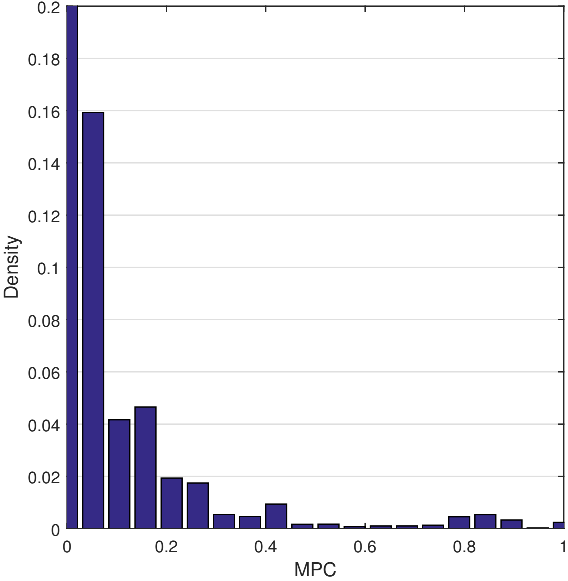
Fit to targeted moments

Moment	Model	Data
Home ownership rate	66%	63%
Median net worth (rel. to mean income)	0.79	1.06
Mean mortgage debt (rel. to median income)	2.10	1.87
Foreclosure rate (%)	0.4	0.4
Mean seller time on the market (weeks)	17.1	17.3
Mean REO time on the market (weeks)	29	52

LTV Distribution

Moment	Model	Data
Median mortgage debt	1.54	1.55
Fraction of homeowners with a mortgage	99%	82%
Median LTV	0.68	0.49
Percent with LTV>70%	44.7	28.5
Percent with LTV>80%	14.6	18.1
Percent with LTV>90%	9.6	9.4
Percent with LTV>95%	5.4	5.8

Distribution of MPCs



Relationship Between MPC and LTV

- Estimate MPC out of transitory income (Blundell, Pistaferri, Preston 2008).
  - Regress Δc_t on Δy_t, instrumenting with future income growth Δy_{t+1}.

- MPC of homeowners by LTV:

	All	Model
High LTV(≥ 0.85)	0.27	
	(0.01)	
Low LTV(< 0.85)	0.19	
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	All	Model
High LTV(≥ 0.85)	0.27	0.17
	(0.01)	
Low LTV(< 0.85)	0.19	0.07
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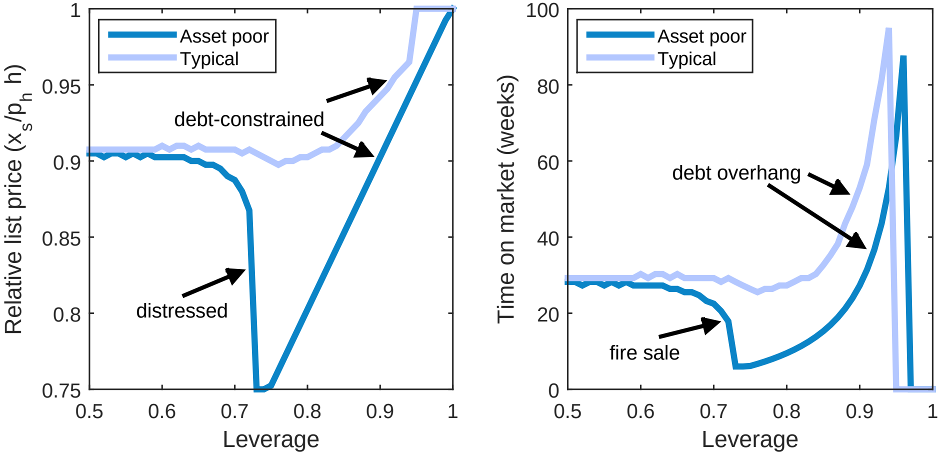
- Model rationalizes large differences in MPC w.r.t. LTV.

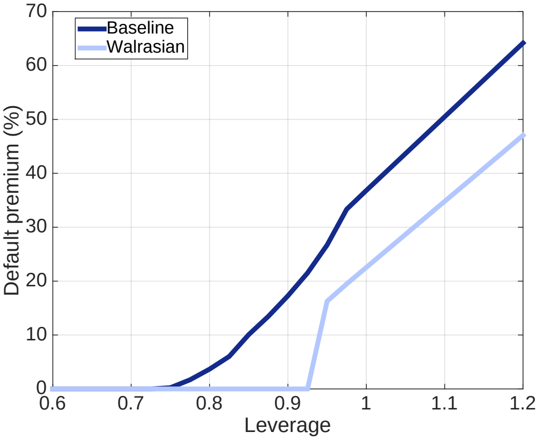
Steady State Behavior

Price Posting Behavior



- Distressed homeowners list their house at low prices (fire sale).
- Typical homeowners increase their selling price as LTV increases.

Frictions and Default Premia



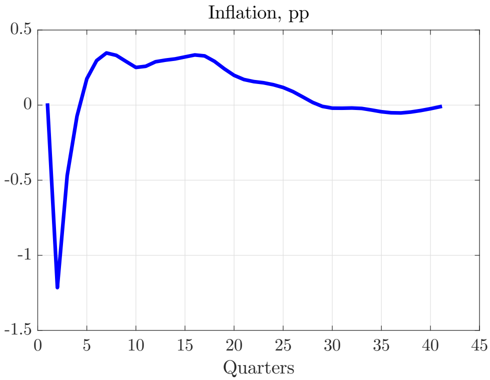
- In a Walrasian model, negative equity is necessary for default.
    - In our model homeowners with positive equity default in eqm.

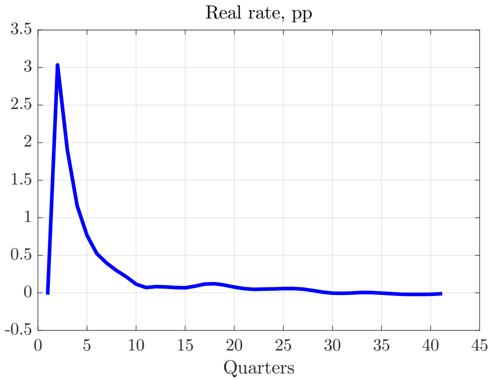
Policy Experiments

Monetary policy shocks

- Economy is initially in steady state in period $t = 0$.
- In $t = 1$, monetary authority introduces a persistent rate hike.
  - $\epsilon_t = \rho_\epsilon \epsilon_{t-1} + \eta_t$, $\rho_\epsilon = 0.60$, $\epsilon_0 = 0$, $\eta_1 =$100bp.
- Solve for the economy's response to this shock (perfect foresight) .

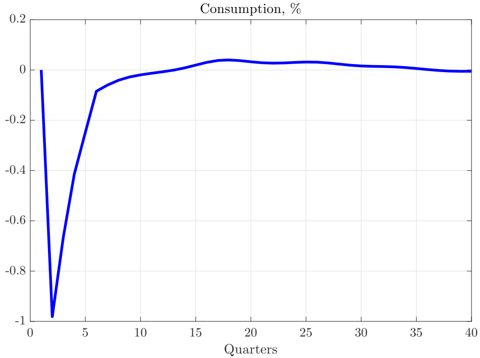
Inflation and Real Rate

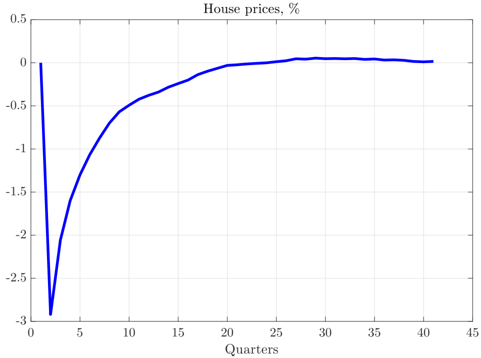




- Model cannot generate hump-shaped impulse responses.
  - No capital, no capital adjustment costs, no external habits.

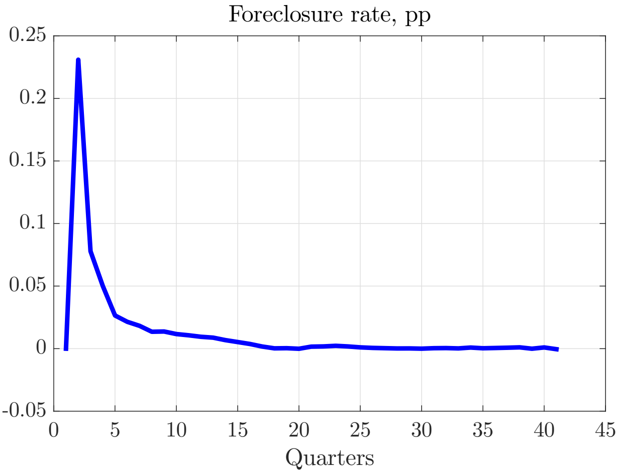
Consumption and House Prices





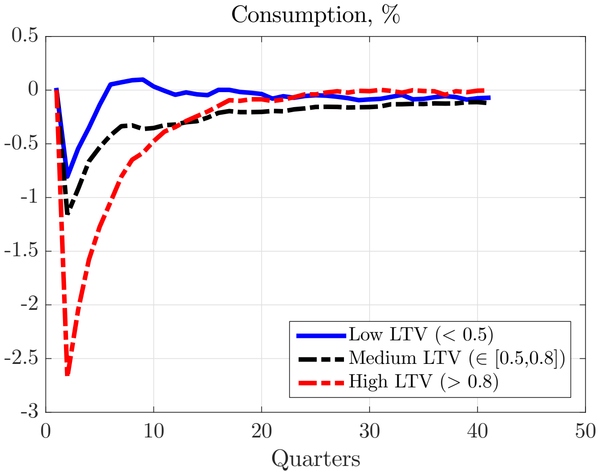
- Consumption responds significantly to monetary shock.
- Rise in the financing cost decreases house prices.
  - House prices are very elastic to monetary policy.

Foreclosures



- Increase in real rates increases mortgage payments
- Lower house prices and higher TOM accompanied by higher foreclosures.

Consumption response by LTV



- Effect of monetary shocks are heterogeneous.
  - High-LTV households respond most.

Decomposing the Transmission of Monetary Policy

Decomposing the Channels

- Consumption as a function of price paths and government policies.

$$\left\{C_t\left(\{T_t, \tau_t, w_t, P_t, p_t^h, i_t, q_t^m\}_{t\geq 0}\right)\right\}_{t\geq 0}$$

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- Total impact of monetary shock on consumption:

$$(\Delta C)_t = \overbrace{C_t\left(\{T_t, \tau_t, w_t, P_t, p_t^h, i_t, q_t^m\}_{t\geq 0}\right)}^{\text{Equilibrium Consumption}} - \overbrace{C_t\left(\{\bar{T}, \bar{\tau}, \bar{w}, \bar{P}, \bar{p^h}, \bar{i}, \bar{q^m}\}_{t\geq 0}\right)}^{\text{Steady State Consumption}}$$

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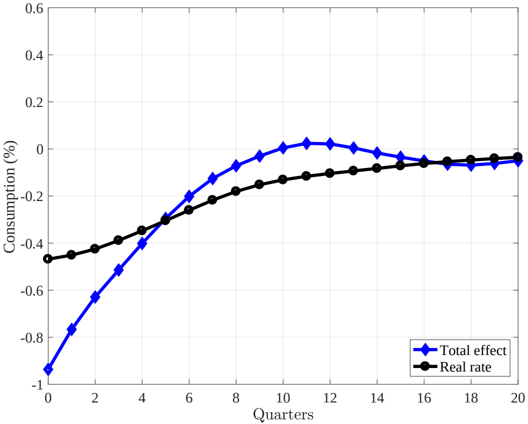
- Start from SS path and add one equilibrium path each time. For example, to identify the role of real rates (direct effect):

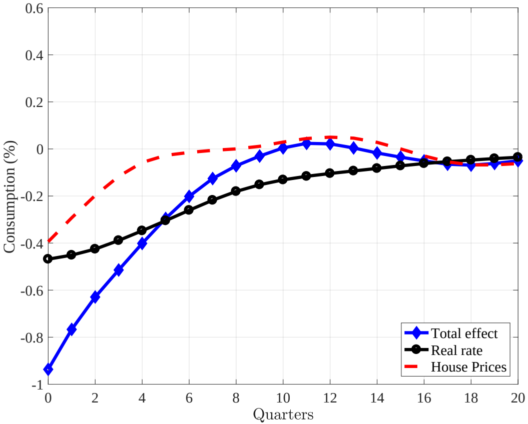
$$(\Delta C)_t^i = C_t\left(\{\bar{T}, \bar{\tau}, \bar{w}, P_t, \bar{p^h}, i_t, \bar{q^m}\}_{t\geq 0}\right) - C_t\left(\{\bar{T}, \bar{\tau}, \bar{w}, \bar{P}, \bar{p^h}, \bar{i}, \bar{q^m}\}_{t\geq 0}\right)$$

Decomposing the Effects: Real Rate



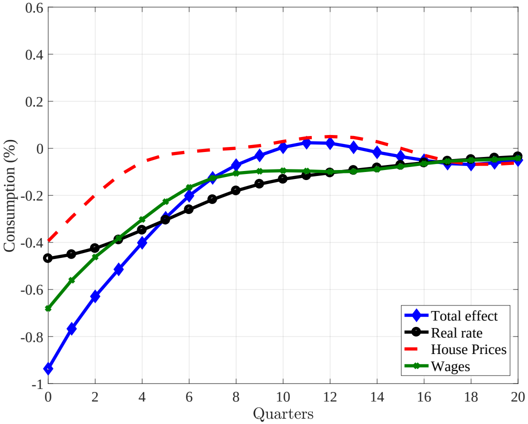
- Higher interest rates lead to fall in consumption.

Decomposing the Effects: Housing&Mortages



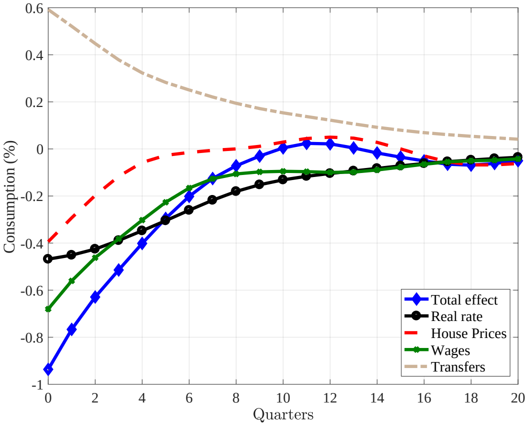
- Houses and mortgages are important for the transmission of monetary policy.

Decomposing the Effects: Wages



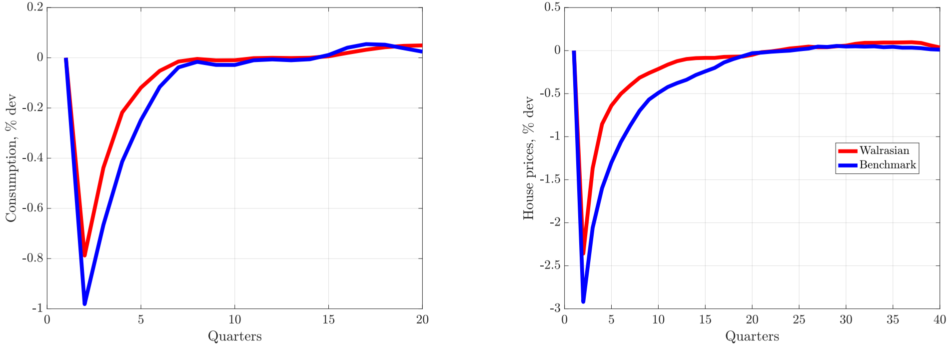
- GE (labor supply+wage) effects leads to large decline in consumption.

Decomposing the Effects: Transfers



- Transfers becomes significantly positive because of countercyclical markups.

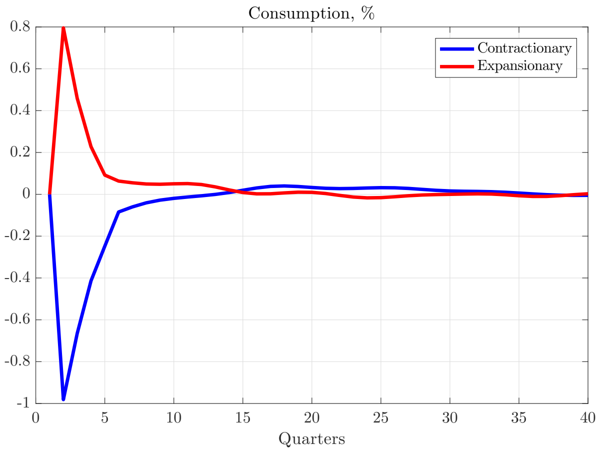
The Role of Search Frictions



- Solve version of model with Walrasian housing markets.
  - Frictions amplify and propagate shocks

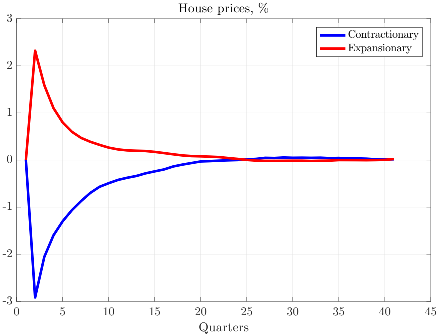
Asymmetric effects

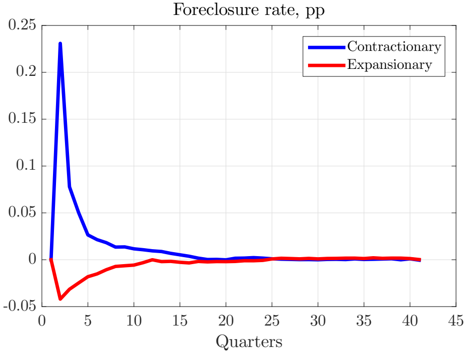
Consumption



- Consumption responds to a contraction more than it does to an expansion.

House prices and foreclosures





- House prices and foreclosures respond more to contractionary shocks.

The Role of LTV Distribution

- The nonlinearities in the joint distribution of the LTV and the MPC lead to asymmetries between expansionary and contractionary shocks.
- Different LTV distributions may results in different responses of consumption against the same monetary shock.
- Preliminary results support this intuition that the efficacy of monetary policy may depend on the LTV distribution.
  - In low LTV environment monetary policy is less effective.

Conclusion

- Develop a HANK model of housing and mortgages to study monetary policy.
  - Houses and mortgages and their joint distribution are important for monetary policy.
- Tightening has larger effects on consumption than expansion.
- Results suggest that monetary policy is more effective in environments with high mortgage debt.
- Exciting avenues for future research
  - How do **the different types of mortgage** affect the efficacy of monetary policy?
    - e.g. US vs Sweden vs Denmark or ARM vs FRM.
  - Unconventional monetary policy in a housing-bust induced liquidity trap study.

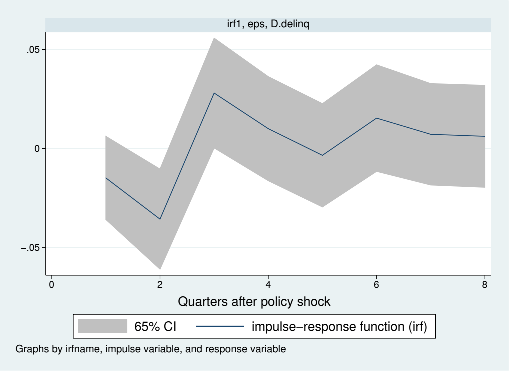
Externally calibrated parameters

Parameter(s)	Interpretation	Value(s)
Γ	Income process	GKOS 2016
σ	Risk aversion	2
φ	Frisch elasticity	0.33
ϕ	Mortgage servicing cost	0.025
ς	Mortgage initiation cost	0.4%
ν	Maximum LTV	125%
ϕ_T	Taylor rule coefficient	1.25
τ	Tax rate	0.2
	Government spending (quarterly)	0.0425

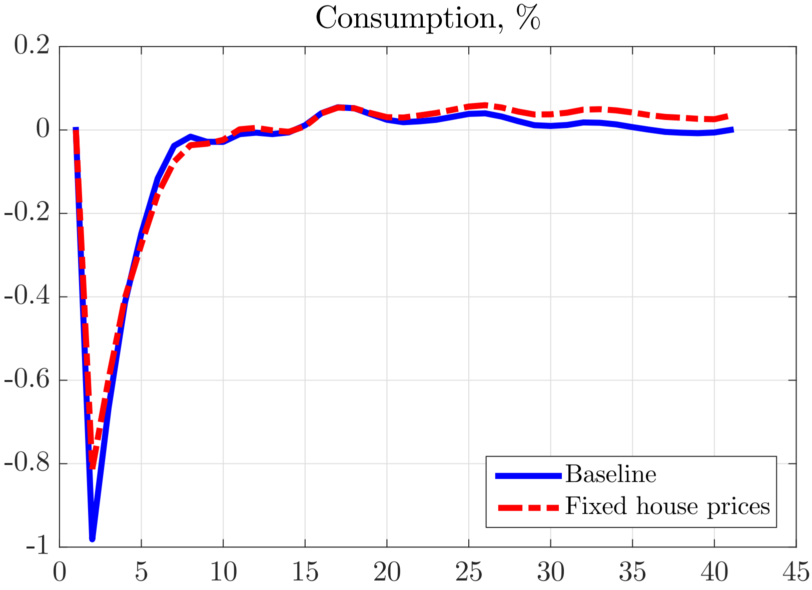
Internally calibrated parameters

Parameter	Interpretation	Value(s)
β	Discount factor	0.95
ϕ_h	Taste for housing	0.4244
γ_h	Elasticity of substitution c, h	0.5
λ_s	Elasticity of match. fnc.	0.8922
κ_s	Min house price that sells w. prob 1	0.7538
$\underline{h}$	Size of smallest house	2.9486
$\underline{h_r}$	Size of largest rental apartment	2.4287
ξ_F	Utility cost of foreclosure	0.0153
η	Efficiency loss due to foreclosure	1.53%

VAR evidence: Monetary policy shocks, house prices and delinquencies



Role of house prices

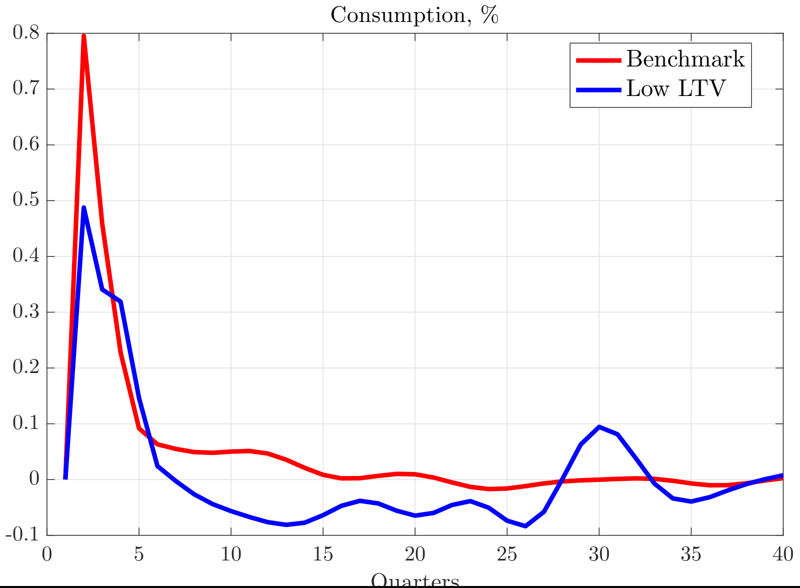


Monetary policy in a low-LTV economy

How does the LTV distribution affect the effectiveness of monetary policy?

- LTV distribution moves for various reasons (housing cycles).
- Is monetary policy more or less effective in times, where there is less mortgage debt?
- Simple experiment to answer this question
  - decrease the LTV limit exogenously to 80%
  - expansionary policy

Consumption



House prices and foreclosures