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


- Key insight: Household portfolios and MPC heterogeneity are important for the conduct of monetary policy.

We focus on the role of housing and mortgage debt 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 could be at play:

› wealth effects due to endogenous movements in house prices
› liquidity effects on mortgage lending standards
› cash-flow effects (e.g., Flodén et al. 2016)
› redistribution channel (e.g., Auclert 2015)
What is the role of housing and mortgage debt in the transmission of monetary policy?
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- Any asymmetry between *contractionary* and *expansionary* policy?
Questions

What is the role of housing and mortgage debt in the transmission of monetary policy?

- Any asymmetry between contractionary and expansionary policy?

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

What is the role of housing and mortgage debt in the transmission of monetary policy?

- Any asymmetry between contractionary and expansionary policy?
- Does effectiveness of monetary policy depend on the distribution of LTV ratios?
- How to manage a liquidity trap induced by a housing bust?
Questions

What is the role of housing and mortgage debt in the transmission of monetary policy?

▶ Any asymmetry between contractionary and expansionary policy?

▶ Does effectiveness of monetary policy depend on the distribution of LTV ratios?

▶ How to manage a liquidity trap induced by a housing bust?

How to answer?

▶ Develop an Heterogenous Agents New Keynesian model with frictional housing market and long-term mortgages.
Today

- An AiyaGali-HANK model with housing 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
HOUSEHOLDS

- Continuum of infinitely lived households with time separable preferences

- Preferences over consumption $c$, housing services $s$ and leisure $l$

- Stochastic (uninsured) labor productivity

- Can save in one-period uncontingent bonds
Housing

Owner-occupied housing

- Houses come in a set of discrete sizes $h \in \mathcal{H}$
- A house of size $h$ generates $s = \omega h$, $\omega > 1$.

Rental housing

- A linear, reversible technology converts one unit of the final good into apartment space.
  - Apartment size $a$ generates $s = a$ services.
- Partial segmentation in housing market: $a_{max} < h_{min}$. 
Owner Occupied Housing Market

- Housing market is subject to search frictions: takes time to sell a house.

▶ Leverage an insight from the labor search literature (Menzio and Shi, JPE 2011).

▶ Directed search (price posting) with various submarkets.

▶ Risk-neutral real estate brokers intermediate all trades.

▶ "Block-recursive" structure.
Owner Occupied Housing Market

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- Leverage an insight from the labor search literature (Menzio and Shi, JPE 2011).
  - Directed search (price posting) with various submarkets
  - Risk-neutral real estate brokers intermediate all trades.
  - “Block-recursive” structure.
Directed Search in the Housing Market

- Owners of house size $h$ who wish to sell choose:
  - List at price $x_s$, meet a broker with probability $p_s(\theta_s(x_s, h))$
  - Sellers face a tradeoff between price and liquidity.
  - Room for the LTV distribution to affect prices and liquidity.
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- Real estate brokers:
  - Free entry with cost $\kappa_s h$ to enter $(x_s, h)$
  - Probability finding a seller, $\alpha_s(\theta_s(x_s, h))$
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- $\theta_s(x_s, h)$ (and probabilities) in a submarket only depends on $p_i^H$ and $x_s$. 
Mortgages

- Collateralized, long-term, adjustable rate nominal debt contract.
- Option to **default**: Forfeit house to the bank and incur utility cost $\xi_f$
- Option to **refinance** at an origination cost of $\zeta$
- Mortgages amortized at rate $r_{mt} = (1 + \phi) \left(1 + r_t\right) \left(1 + \pi_t\right)$
- Price at origination $q_0(r_{mt}, m, b', h, z)$ reflect all idiosyncratic default and refi risk.
- Required to pay fraction $\chi$ of balance each period $\Rightarrow$ effective duration is $1/\chi$
Banks finance mortgages by bundling future stream of payments from originated mortgages into mortgage-backed securities ($MBS_t$).
**Financial Sector**

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

- Perfect competition loan-by-loan in mortgage sector ⇒
  - *Ex-ante* zero profits from each type of loan.

\[ q_0 \]
Financial Sector

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- Perfect competition loan-by-loan in mortgage sector $\Rightarrow$
  - *Ex-ante* zero profits from each type of loan.

- *Ex-post* losses or profits (because of unanticipated shocks) absorbed by government via GSEs (e.g. Fannie/Freddie).
  - Aggregate state and monetary policy *still* affects contemporaneous pricing of mortgages, $q_0$. 
Final Good Producers

- Aggregate a continuum of intermediate goods.
- Each intermediate good faces downward sloping demand function.
Production and Prices

Final Good Producers

- Aggregate a continuum of intermediate goods.
- Each intermediate good faces downward sloping demand function.

Intermediate Firms

- Intermediate good production is linear in labor services:
  \[ mc = w \]
- Price adjustment costs à la Rotemberg (1982).
GOVERNMENT AND CENTRAL BANK

Fiscal Authority

- Taxes labor income and provides nominal transfers
- Taxes intermediate firms profits
- Issues nominal bonds
- Faces nominal expenditures growing at $\Pi$
- Absorbs aggregate risk in mortgage market
Government and Central Bank

Fiscal Authority

- Taxes labor income and provides nominal transfers
- Taxes intermediate firms profits
- Issues nominal bonds
- Faces nominal expenditures growing at $\Pi$
- Absorbs aggregate risk in mortgage market

Monetary Authority

- Follows a simple Taylor rule that responds to only inflation.
- Monetary-fiscal coordination: transfers are adjusted to keep real govt debt constant.
- Real rate follows the fisher equation.
Calibration and Model Fit
Calibration

- Calibrate the steady state of the model to US economy prior to the Great Recession (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

<table>
<thead>
<tr>
<th>Moment</th>
<th>Model</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home ownership rate</td>
<td>66%</td>
<td>63%</td>
</tr>
<tr>
<td>Median net worth (rel. to mean income)</td>
<td>0.79</td>
<td>1.06</td>
</tr>
<tr>
<td>Mean mortgage debt (rel. to median income)</td>
<td>2.10</td>
<td>1.87</td>
</tr>
<tr>
<td>Foreclosure rate (%)</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Mean seller time on the market (weeks)</td>
<td>17.1</td>
<td>17.3</td>
</tr>
<tr>
<td>Mean REO time on the market (weeks)</td>
<td>29</td>
<td>52</td>
</tr>
</tbody>
</table>
## LTV Distribution

<table>
<thead>
<tr>
<th>Moment</th>
<th>Model</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median mortgage debt</td>
<td>1.54</td>
<td>1.55</td>
</tr>
<tr>
<td>Fraction of homeowners with a mortgage</td>
<td>99%</td>
<td>82%</td>
</tr>
<tr>
<td>Median LTV</td>
<td>0.68</td>
<td>0.49</td>
</tr>
<tr>
<td>Percent with LTV &gt; 70%</td>
<td>44.7</td>
<td>28.5</td>
</tr>
<tr>
<td>Percent with LTV &gt; 80%</td>
<td>14.6</td>
<td>18.1</td>
</tr>
<tr>
<td>Percent with LTV &gt; 90%</td>
<td>9.6</td>
<td>9.4</td>
</tr>
<tr>
<td>Percent with LTV &gt; 95%</td>
<td>5.4</td>
<td>5.8</td>
</tr>
</tbody>
</table>
Distribution of MPCs

![Distribution of MPCs](image-url)
We follow Blundell, Pistaferri, Preston (AER, 2008) to estimate MPC out of transitory income changes. Regress \( \Delta c_t \) on \( \Delta y_t \), instrumenting with future income growth \( \Delta y_{t+1} \).

MPC of homeowners by LTV:

<table>
<thead>
<tr>
<th>LTV Type</th>
<th>MPC (All)</th>
<th>MPC (Model)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High LTV (≥ 0.85)</td>
<td>0.27</td>
<td>(0.01)</td>
</tr>
<tr>
<td>Low LTV (&lt; 0.85)</td>
<td>0.19</td>
<td>(0.00)</td>
</tr>
</tbody>
</table>
Relationship Between MPC and LTV

- We follow Blundell, Pistaferri, Preston (AER, 2008) to estimate MPC out of transitory income changes.
  - Regress $\Delta c_t$ on $\Delta y_t$, instrumenting with future income growth $\Delta y_{t+1}$.

- MPC of homeowners by LTV:

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<tr>
<th>LTV Category</th>
<th>All</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>High LTV ($\geq 0.85$)</td>
<td>0.27</td>
<td>0.17</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td></td>
</tr>
<tr>
<td>Low LTV ($&lt; 0.85$)</td>
<td>0.19</td>
<td>0.07</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td></td>
</tr>
</tbody>
</table>

- The model can generate significant differences in the MPCs between the high- and low-LTV groups.
Steady State Behavior
Distressed homeowners list their house at low prices (fire sale).

Typical homeowners increase their selling price as LTV increases.
In Walrasian model, having negative equity is a necessary condition for default.

- In our model even homeowners with positive equity may default.
Policy Experiments
Monetary policy shocks

- We assume that the economy is initially in steady state in period $t = 0$.

- **The experiment:** In period $t = 1$ monetary authority hits the economy with a persistent contractionary shock, $\eta_1 = 100$bp.
  
  $\epsilon_t = \rho_\epsilon \epsilon_{t-1} + \eta_t$, $\rho_\epsilon = 0.60$, $\epsilon_0 = 0$.

- Simulate perfect foresight transition of the economy response to a one-time unexpected monetary shock at time $t = 1$. 
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 against monetary shocks.
Increase in real rates increases mortgage payments
Decline in house prices (along with an increase in the TOM) accompanied by jump in 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.

\[ C_t(\{T_t, \tau_t, w_t, P_t, p^h_t, i_t, q^m_t\}_{t \geq 0}) \]
Decomposing the Channels

- Consumption as a function of price paths and government policies.
  \[ \{ C_t(\{T_t, \tau_t, w_t, P_t, p^h_t, i_t, q^m_t\}_{t \geq 0}) \}_{t \geq 0} \]

- Total impact of monetary shock on consumption:

\[ (\Delta C)_t = C_t(\{T_t, \tau_t, w_t, P_t, p^h_t, i_t, q^m_t\}_{t \geq 0}) - C_t(\{\bar{T}, \bar{\tau}, \bar{w}, \bar{P}, \bar{p}^h, \bar{i}, \bar{q}^m\}_{t \geq 0}) \]
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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):

\[
(\Delta C)_t^i = C_t(\{\bar{T}, \bar{\tau}, \bar{w}, P_t, \bar{p}^h, i_t, q^m\}_{t \geq 0}) - C_t(\{\bar{T}, \bar{\tau}, \bar{w}, \bar{P}, \bar{p}^h, \bar{i}, \bar{q}^m\}_{t \geq 0})
\]
Higher interest rates lead to fall in consumption.
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.
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 responds to a contraction more than it does to an expansion.
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 result 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.

- Preliminary 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

<table>
<thead>
<tr>
<th>Parameter(s)</th>
<th>Interpretation</th>
<th>Value(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Gamma$</td>
<td>Income process</td>
<td>GKOS 2016</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>Risk aversion</td>
<td>2</td>
</tr>
<tr>
<td>$\varphi$</td>
<td>Frisch elasticity</td>
<td>0.33</td>
</tr>
<tr>
<td>$\phi$</td>
<td>Mortgage servicing cost</td>
<td>0.025</td>
</tr>
<tr>
<td>$\varsigma$</td>
<td>Mortgage initiation cost</td>
<td>0.4%</td>
</tr>
<tr>
<td>$\nu$</td>
<td>Maximum LTV</td>
<td>125%</td>
</tr>
<tr>
<td>$\phi_T$</td>
<td>Taylor rule coefficient</td>
<td>1.25</td>
</tr>
<tr>
<td>$\tau$</td>
<td>Tax rate</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>Government spending (quarterly)</td>
<td>0.0425</td>
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<tbody>
<tr>
<td>$\beta$</td>
<td>Discount factor</td>
<td>0.95</td>
</tr>
<tr>
<td>$\phi_h$</td>
<td>Taste for housing</td>
<td>0.4244</td>
</tr>
<tr>
<td>$\gamma_h$</td>
<td>Elasticity of substitution $c, h$</td>
<td>0.5</td>
</tr>
<tr>
<td>$\lambda_s$</td>
<td>Elasticity of match. fnc.</td>
<td>0.8922</td>
</tr>
<tr>
<td>$\kappa_s$</td>
<td>Min house price that sells w. prob 1</td>
<td>0.7538</td>
</tr>
<tr>
<td>$h$</td>
<td>Size of smallest house</td>
<td>2.9486</td>
</tr>
<tr>
<td>$h_r$</td>
<td>Size of largest rental apartment</td>
<td>2.4287</td>
</tr>
<tr>
<td>$\xi_F$</td>
<td>Utility cost of foreclosure</td>
<td>0.0153</td>
</tr>
<tr>
<td>$\eta$</td>
<td>Efficiency loss due to foreclosure</td>
<td>1.53%</td>
</tr>
</tbody>
</table>
VAR evidence: Monetary policy shocks, house prices and delinquencies

Graphs by irfname, impulse variable, and response variable
Role of house prices

Drop in house prices explains 20% of the consumption response.
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
Monetary policy less effective in a low LTV economy.
HOUSE PRICES AND FORECLOSURES

A. Hedlund (Missouri) Monetary Policy and Housing 35 / 35