The Macroeconomic Effects of Housing Wealth, Housing Finance, and Limited Risk-Sharing in General Equilibrium

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Housing Wealth Is Large and Volatile

- Residential real estate large and volatile component of household wealth.
- Houses accounted for 25% of net worth in 2000 but 37% end of 2006.
- Large swings in house prices relative to housing fundamentals.
- Price-rent ratios reached unusual heights in 2006 but have since declined sharply.
Price-Rent Ratios in the Data
What is the Role of Housing in the Macroeconomy?

- To what extent is national house price appreciation attributable to:
  - A liberalization in housing finance?
  - An infusion of foreign governmental capital into U.S. bond markets?

- How do movements in house prices affect expectations of future housing fundamentals and future home price appreciation?

- How do housing wealth and housing finance affect
  1. Risk premia in housing and equity markets,
  2. Cross-sectional risk-sharing,
  3. Life-cycle wealth/savings patterns,
  4. Housing “wealth effects” on consumer spending?
Our Goal: A Sufficiently General Model

Goal: provide theoretical answers using a model that accounts for the endogenous interactions among

1. financial and housing wealth,
2. output, investment, and consumption,
3. rates of return and risk premia (housing and equity markets),
4. consumption and wealth inequality.
Our Goal: A Sufficiently General Model

- Study a two-sector general equilibrium model of housing and non-housing production with heterogeneous agents, aggregate and idiosyncratic risk, limited risk-sharing.

- Use model to study consequences of three systemic changes in housing finance.
  1. Collateralized borrowing constraints
  2. Housing transactions costs
  3. Secular decline in interest rates driven by influx of foreign governmental capital

- All three changed markedly during or preceding period of rapid home price appreciation 2000-2006.

- Some changes have been reversed in aftermath of credit crisis of 2007/2008.
Changes in Housing Finance

- Housing boom 2000-2006:
  - **Widespread relaxation borrowing constraints**: (rising LTV ratios, prime and sub-prime, end of 2006 100% financing routine).
  - **Declining transactions costs**: Sharp drop in cost of mortgage refinance, home equity withdrawal, fees/charges (McCarthy and Stiendel ’07; Mian and Sufi ’09).
  - **Sustained depression interest rates**: real rate on 10-yr T-bond $3.6\% \downarrow 0.93\%$, 2000-2006.

- Credit crisis 2007-2009:
  - Back to more normal minimum combined (1st and 2nd mortgage) LTV ratio $\leq 75-80\%$ of appraised value.
  - Anecdotal evidence: transactions costs moving back up.
Foreign Holdings of U.S. Treasuries

- Foreign ownership U.S. Treasuries: **13.5% to 61%** 1984-2008
Decline in Rates Coincided with Surge Foreign Capital

- In model, interest rates determined by market clearing.

- One specification: introduce foreign demand for safe asset, “foreign capital.”

- Foreign capital modeled as exogenous and perfectly inelastic.

- Kohn ’02: governmental entities have regulatory motive for holding safe asset.

- Krishnamurthy and Vissing-Jorgensen ’08: demand for U.S. Treasuries by governmental holders extremely inelastic.
  - When governmental holders receive funds, they buy Treasuries, regardless of price.
Some Key Findings

- House prices relative to measures of fundamental value are volatile.

- A financial market liberalization (FML) drives price-rent ratios up because it drives risk premia down.

- Procyclical increases in equilibrium house price-rent ratios reflect expectations of lower future housing returns, not higher future rents.

- Financial market liberalization plus foreign capital leads to a shift in the composition of wealth towards housing, increases financial wealth inequality, but is ambiguous for consumption inequality.

- A financial market liberalization leads to a short-run boom in consumption, but a short-run bust in investment.
Two Production Sectors, Consumption and Housing

- Time is discrete, a period = one year.

- Two sectors: **consumption** and **housing** output:
  
  \[ Y_{C,t} \equiv Z_{C,t} K_{C,t}^{\alpha} N_{C,t}^{1-\alpha}, \quad Y_{H,t} = Z_{H,t} K_{H,t}^{\nu} N_{H,t}^{1-\nu} \]

- Capital accumulates
  
  \[ K_{C,t+1} = (1 - \delta) K_{C,t} + I_{C,t} \quad K_{H,t+1} = (1 - \delta) K_{H,t} + I_{H,t} \]

- **Y_{H,t} residential investment** $\Rightarrow$ housing stock evolves $H_t$
  
  \[ H_{t+1} = (1 - \delta_H) H_t + Y_{H,t} \]
Two Production Sectors, Consumption and Housing

- Adj costs capital, $\phi_i(\cdot)$, deduction from earnings.
- No new shares issued. Dividends = earnings:

$$D_{C,t} = Y_{C,t} - w_t N_{C,t} - I_{C,t} - \phi_C \left( \frac{I_{C,t}}{K_{C,t}} \right) K_{C,t}.$$ 

$$D_{H,t} = p_t^H Y_{H,t} - w_t N_{H,t} - I_{H,t} - \phi_H \left( \frac{I_{H,t}}{K_{H,t}} \right) K_{H,t}.$$ 

$p_t^H$ relative price housing

- Firms maximize value; SDF = $\frac{\beta^k \Lambda_{t+k}}{\Lambda_t}$:

$$V_{C,t} = \max_{N_{C,t}, I_{C,t}} E_t \sum_{k=0}^{\infty} \frac{\beta^k \Lambda_{t+k}}{\Lambda_t} D_{C,t+k}.$$ 

$$V_{H,t} = \max_{N_{H,t}, I_{H,t}} E_t \sum_{k=0}^{\infty} \frac{\beta^k \Lambda_{t+k}}{\Lambda_t} D_{H,t+k}.$$
Individuals

- A overlapping generations, indexed by \( a = 1, \ldots, A \).
- 2 life stages: working & retirement.
  - Live for a max of \( A = 80 \) (100 years).
  - Workers live from 21 \((a = 1)\) to 65 \((a = 45)\), then retire.
  - Retired workers die with age-dependent probability.
- Intraperiod utility function
  \[
  U(C_{a,t}, H_{a,t}) = \frac{\bar{C}_{a,t}^{1 - \frac{1}{\sigma}}}{1 - \frac{1}{\sigma}} \quad \bar{C}_{a,t} = \left[ \chi C_{a,t}^{\frac{\varepsilon - 1}{\varepsilon}} + (1 - \chi) H_{a,t}^{\frac{\varepsilon - 1}{\varepsilon}} \right]^{\frac{\varepsilon}{\varepsilon - 1}}.
  \]
- Budget Constraint:
  \[
  C_{a,t}^i + B_{a+1,t+1}^i q_t + \theta_{a+1,t+1}^i \left( V_{C,t}^e + V_{H,t}^e \right) \leq
  W_{a,t}^i + (1 - \tau) w_t L_{a,t}^i + p_t^H \left( (1 - \delta_H) H_{a,t}^i - H_{a+1,t+1}^i \right) - F_{a,t}^i
  \]
Frictions

- Heterogeneity in income: $Y_{a,t}^i = w_t L_{a,t}^i$
  - Calibrated as Storesletten, Telmer, and Yaron.

- Collateral (downpayment) constraint:
  \[ W_{a+1,t+1}^i \geq - (1 - \varpi) p_t^H H_{a,t+1}^i \]
  - Individuals may borrow no more than $(1 - \varpi)$ of value of house.
  - Maximum combined (mortgage and home equity) LTV ratio $(1 - \varpi)$

- Fixed and variable costs to changing housing consumption

- Cost to participate in stock market
Model

- Equilibrium is standard:
  - Households and Firms maximize
  - Bond, Risky Capital, Housing, Labor markets clear

- Bond market clearing: \( q_t = q(\mu_t, Z_t) \) is such that

\[
\int_S B_{a,t}^i d\mu + B_t^F = 0 \quad B_t^F \geq 0
\]

- Rent and national housing return implied by Euler Equation:

\[
\frac{\partial U}{\partial C_{a,t}^i} = \frac{1}{\rho_t^H} \beta E_t \left[ \frac{\partial U}{\partial C_{a+1,t+1}^i} \left( \frac{\partial U}{\partial H_{a+1,t+1}^i} + p_{t+1}^H (1 - \delta_H) \right) \right]
\]

\[
\text{Rent: } \text{AVG}_i \left( \frac{\partial U/\partial H_{a+1,t+1}^i}{\partial U_{t+1}/\partial C_{a+1,t+1}^i} \right)
\]
Three Alternative Parameterizations

- **Model 1**: Baseline with “normal” collateral requirements and transactions costs.
  - Combined LTV $\leq 75\%$ appraised value.
  - Costs: any change housing cons.; mortgages, home equity extraction, improvements, additions, refinancing.
  - No foreign capital, $B_t^F = 0 \ \forall t$.

- **Model 2**: Identical to Model 1 but has undergone a FML.
  - Combined LTV (mortgage and home equity) cannot exceed 99% of appraised value.
  - Housing transactions costs decline by 50%.
  - No foreign capital. $B_t^F = 0 \ \forall t$.

- **Model 3**: Identical to Model 2 except add exogenous foreign demand for risk-free asset, $B_t^F > 0$. 
## Calibration of Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Baseline, Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Production</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>{\phi_K(\cdot), \phi_H(\cdot)}</td>
<td>adj. cost</td>
<td>{\varphi \left( \frac{1}{K} - \delta \right)^2, \varphi \left( \frac{1}{K} - \delta \right)^2 }</td>
<td></td>
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<tr>
<td>2</td>
<td>\delta</td>
<td>depreci., K_C, K_H</td>
<td>10% p.a.</td>
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<tr>
<td>3</td>
<td>\delta_H</td>
<td>depreciation, H</td>
<td>2.5% p.a.</td>
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<tr>
<td>4</td>
<td>\alpha</td>
<td>capital share, Y_C</td>
<td>0.36</td>
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<tr>
<td>5</td>
<td>\nu</td>
<td>capital share, Y_H</td>
<td>0.30</td>
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<td><strong>Preferences</strong></td>
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<td></td>
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<tr>
<td>6</td>
<td>\sigma</td>
<td>risk aversion</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>\beta</td>
<td>time disc factor</td>
<td>0.94</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>\varepsilon</td>
<td>elast of sub, C, H</td>
<td>1</td>
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<td>9</td>
<td>\chi</td>
<td>weight on C</td>
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<td><strong>Demographics and Income</strong></td>
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<td></td>
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<td>G_a</td>
<td>age earnings profile</td>
<td>SCF</td>
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<td>\pi_{a+1</td>
<td>a}</td>
<td>survival prob</td>
<td>mortality tables</td>
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<tr>
<td>12</td>
<td>\sigma_E</td>
<td>st. dev ind earnings, E</td>
<td>0.0768</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>\sigma_R</td>
<td>st. dev ind earnings, R</td>
<td>0.1298</td>
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<td><strong>Transactions Costs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>F</td>
<td>participation cost, K</td>
<td>\approx 1% \overline{C}^i</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>\psi_0</td>
<td>fixed trans cost, H</td>
<td>\approx 3% \overline{C}^i</td>
<td>\approx 1.5% \overline{C}^i</td>
</tr>
<tr>
<td>16</td>
<td>\psi_1</td>
<td>variable trans cost, H</td>
<td>\approx 5% p^H_t H^i</td>
<td>\approx 2.5% p^H_t H^i</td>
</tr>
<tr>
<td>17</td>
<td>\omega</td>
<td>collateral constr</td>
<td>25%</td>
<td>1%</td>
</tr>
<tr>
<td><strong>Foreign Supply</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>B^F</td>
<td>foreign capital</td>
<td>0</td>
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</tr>
</tbody>
</table>

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Baseline Model

- Baseline model does well with RBC moments
- Baseline model does well with distribution of wealth and housing by across age and income
- As in the data, house priced and price/rent ratios are strongly procyclical.
- As in the data, high price/rent ratios forecast **low future returns and excess returns** on real estate, **not high future rents**.
  - In response to high price/rent residential investment increases. The expanded housing stock results in lower future rent, and higher collateral values (leading to lower risk and returns).
- As in the data, FML + For Dem leads to large increase in financial wealth inequality, but smaller increase in total inequality because of housing wealth.
## Baseline Model: Financial Moments

<table>
<thead>
<tr>
<th></th>
<th>FoF CRSP (53-08)</th>
<th>FoF CRSP (72-08)</th>
<th>Fr Mac CRSP (72-08)</th>
<th>Model 1 Baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>( E[R_E - R_f] )</td>
<td>6.24%</td>
<td>4.94%</td>
<td>4.94%</td>
<td>3.95%</td>
</tr>
<tr>
<td>( \text{Std}[R_E] )</td>
<td>19.11</td>
<td>19.43</td>
<td>19.43</td>
<td>11.0</td>
</tr>
<tr>
<td>( E[R_H - R_f] )</td>
<td>8.27%</td>
<td>8.12%</td>
<td>7.45%</td>
<td>12.83%</td>
</tr>
<tr>
<td>( \text{Std}[R_H] )</td>
<td>4.91</td>
<td>5.87</td>
<td>4.32</td>
<td>5.79</td>
</tr>
<tr>
<td>( E[R_f] )</td>
<td>1.62%</td>
<td>1.66%</td>
<td>1.66%</td>
<td>1.67%</td>
</tr>
<tr>
<td>( \text{Std}[R_f] )</td>
<td>2.49%</td>
<td>3.01%</td>
<td>3.01%</td>
<td>3.38%</td>
</tr>
<tr>
<td>( 	ext{SR}[R_E] )</td>
<td>0.34</td>
<td>0.27</td>
<td>0.27</td>
<td>0.31</td>
</tr>
<tr>
<td>( 	ext{SR}[R_H] )</td>
<td>1.49</td>
<td>1.22</td>
<td>1.36</td>
<td>1.78</td>
</tr>
</tbody>
</table>

\( E[R_E - R_f] \) = \text{equity premium}

\( \text{Std}[R_E] \) = \text{volatile } R_E

\( E[R_H - R_f] \) = \text{housing premium}

\( \text{Std}[R_H] \) = \text{stable } R_H

\( E[R_f] \) = \text{low risk-free rate}

\( \text{Std}[R_f] \) = \text{stable risk-free rate}

\( 	ext{SR}[R_E] \) = \text{Sharpe ratio, equity}

\( 	ext{SR}[R_H] \) = \text{Sharpe ratio, housing}
# Shifts in the Composition of Wealth

## Housing Wealth Divided by Total Net Worth

<table>
<thead>
<tr>
<th></th>
<th>young</th>
<th>old</th>
<th>all</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1 (Baseline)</td>
<td>1.55</td>
<td>0.46</td>
<td>0.49</td>
</tr>
<tr>
<td>Model 2 (FML)</td>
<td>1.69</td>
<td>0.52</td>
<td>0.56</td>
</tr>
<tr>
<td>Model 3 (FML + For Cap)</td>
<td>2.09</td>
<td>0.53</td>
<td>0.58</td>
</tr>
</tbody>
</table>

- Young hold much more wealth in $H_t$ than old.
- FML + Foreign capital shifts composition of wealth towards Housing for all age groups.
- Model 1 to Model 3: ratio rises by 35% and 15%, **young and old**. Data 2000-2007: ratio rises by 37% and 21%.

Data source: Survey of Consumer Finances

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The Macroeconomic Effects of Housing Wealth, Housing Finance
### Annual Return Moments: FML v.s. Baseline

<table>
<thead>
<tr>
<th></th>
<th>Model 1 Baseline</th>
<th>Model 2 FML</th>
<th>Model 3 FML + For Cap</th>
</tr>
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<tbody>
<tr>
<td>$E[R_E - R_f]$</td>
<td>3.95%</td>
<td>3.16%</td>
<td>6.47%</td>
</tr>
<tr>
<td>$E[R_H - R_f]$</td>
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<td>4.14%</td>
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</tr>
<tr>
<td>SR[$R_E$]</td>
<td>0.31</td>
<td>0.24</td>
<td>0.36</td>
</tr>
<tr>
<td>SR[$R_H$]</td>
<td>1.78</td>
<td>1.0</td>
<td>1.10</td>
</tr>
<tr>
<td>$E[P^H/R]$</td>
<td>6.73</td>
<td>8.46</td>
<td>9.17</td>
</tr>
</tbody>
</table>

- Financial market liberalization **reduces risk premia** in equity and housing assets.
- Reflects greater amount of risk-sharing/insurance possible after a FML.
- Consistent with greater risk sharing, consumption inequality declines.
### Annual Return Moments: FML v.s. Baseline

<table>
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▶ Financial market liberalization **increases interest rates**: HHs endog respond to improved risk-sharing/insurance opportunities by reducing **precautionary saving**.

▶ Financial market liberalization **increases price-rent ratios by 23%**: entirely due to decline in risk-premia which more than offsets the rise in interest rates.
### Annual Return Moments: FML v.s. Baseline

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- **Model 1 to Model 3**: rise in P/R = 36%. **Data**: 2000-2007 rise in P/R = 31% (FoF), 31% (Freddie Mac), 43% (CS)
- Foreign capital begets decline in interest rates of g.t. 50%, commensurate with decline in real rates 2000-2007.
Transition Dynamics: Price-Rent Ratios + Components

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Macro Effects of a Financial Liberalization

- Transition dynamics: Model 1 to Model 2 (FML).
- FML $\Rightarrow$ short-run **boom** in aggregate consumption.
- FML $\Rightarrow$ short-run **bust** in investment b/c a FML drives interest rates up; GDP doesn’t rise.
Conclusions

- **House prices** relative to measures of fundamental value are volatile.

- A financial market liberalization drives price-rent ratios up because it drives **risk-premia down**.

- Procyclical increases in equilibrium price-rent ratios reflect **lower future returns**, not higher future rental growth.

- Financial market liberalization plus foreign capital shifts **composition** of wealth towards **housing**, increases financial wealth inequality, ambiguous for consumption inequality.

- A financial market liberalization leads to a short-run **boom** in consumption, but a short-run **bust** in investment.