Joint Dynamics of House Prices and Foreclosures

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November 2013
Real House Price Index - FHFA

The chart above illustrates the Real House Price Index from 1975:Q1 to 2013:Q4. The index shows a trend of overall increase with fluctuations, peaking around 2007:Q2 and then declining sharply. The data is sourced from the FHFA.
Foreclosures Started

[Graph showing the percentage of foreclosures started over time from 1979 Q4 to 2012 Q4.]

AGT (CBRT and IUB)  House Prices and Foreclosures  November 2013
What do we do?

- Model the relation between house prices and foreclosures
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- Incorporate realistic structure for mortgages and allow foreclosures
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  - Higher risk-free interest rate
- Explore the effect of two policies:
  - Monetary Policy: Lower interest rates
  - Macroprudential Policy: Tighter credit constraints
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Introduction

Motivation

Literature Review

- Life-cycle housing model
Literature Review

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- Endogenous credit terms and default

- Endogenous house prices and foreclosures
  - Chatterjee and Eyigungor (2011)

- Determinants of Foreclosures
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- Determinants of Foreclosures
Environment

- Life-cycle model with deterministic time horizon
- Utility from both consumption good and housing
- They either rent or own a house
- Households are subject to idiosyncratic income shocks
- Households are subject to moving shocks
- Purchase of a house can be done through a mortgage
Perfect competition among risk-neutral lenders

Mortgage holders can default on the mortgage

Terms of mortgage contracts are endogenous (downpayment and mortgage interest rate)

Only fixed-rate mortgages (FRM) and maturity is determined by the age of the individual (but allow for prepayment)

Selling a house is entitled to an idiosyncratic capital gain/loss

Fixed house supply
Fixed house size and no explicit refinancing (but allow for implicit refinancing)

No unsecured borrowing
Value Functions

- Four possible housing status: inactive renter, active renter, owner and mover
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  - Inactive Renter: Renter with default flag (cannot purchase a house): \( V^d \)
  - Active Renter: Can stay as a renter or purchase a house:
    \( V^r = \max \{ V^{rr}, V^{rh} \} \)
  - Owner: Can stay in the house, sell the house or default on the mortgage (if any):
    \( V^h = \max \{ V^{hh}, V^{hr}, V^{hd} \} \)
  - Mover: Can sell the house or default on the mortgage (if any):
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Purchaser’s Problem

\[ V_j^{rh} (a, z) = \max_{c, a'} \left\{ u_h (c) + \beta E \left[ (1 - \psi) V_{j+1}^h (a', z'; r^m) + \psi V_{j+1}^m (a', z') \right] \right\} \]

\[ c + qa' + p^h = y (z, j) + a \]

\[ q = \begin{cases} \frac{1}{1+r^m} & \text{if } a' \geq 0 \\ \frac{1}{1-(1+r^m)^{-M}} & \text{if } a' < 0 \end{cases} \]

\[ a' \in \Psi (\tilde{a}, r^m; a, z, j) \text{ with } \tilde{a} \geq -p^h (1 - \phi) \]
Seller’s and Defaulter’s Problem

Seller’s Problem:

\[ V^{hr}_j (a, z; \kappa) = \max_{c, a'} \left\{ u_r(c) + \beta EV^{r}_{j+1}(a', z') \right\} \]

\[ c + \frac{a'}{1 + r} = y(z, j) + a + p^h (1 - \varphi_h) (1 + \kappa) \]
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**Defaulter’s Problem:**

\[ V_{j}^{hd} (a, z) = \max_{c, a'} \left\{ u_r (c) + \beta E \left[ \delta V_{j+1}^{r} (a', z') + (1 - \delta) V_{j+1}^{d} (a', z') \right] \right\} \]

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c + \frac{a'}{1 + r} = y(z, j) + a + p^h (1 - \varphi_h) (1 + \kappa)
\]

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\]

\[
c + \frac{a'}{1 + r} = y(z, j)
\]

- **Necessary condition for default:**

\[
a + p^h (1 - \varphi_h) (1 + \kappa_{\text{min}}) \leq 0
\]
Lender’s Problem

Expected continuation value of the mortgage contract:

\[
V_j^l (a, z, r^m) = \begin{cases}
    a & \text{if hh sells} \\
    p^h (1 - \varphi_l) & \text{if hh defaults} \\
    \frac{a'}{1+r^m} - a + \frac{1}{1+r} EV_{j+1}^l (a', z', r^m) & \text{if hh stays}
\end{cases}
\]
Lender’s Problem

- Expected continuation value of the mortgage contract:

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\end{cases} \]

- At the time of origination we need to have (which pins down \( r^m \)):

\[ V_j^l (a, z, r^m) = -a \]
Functional Forms

Preferences:

\[ u_r (c) = \frac{c^{1-\sigma}}{1-\sigma} \]
\[ u_h (c) = u_r (c(1+\gamma)) \]
Functional Forms

Preferences:

\[ u_r(c) = \frac{c^{1-\sigma}}{1 - \sigma} \]
\[ u_h(c) = u_r(c(1 + \gamma)) \]

Income process:

\[ y(z, j) = \exp(f(j) + z) \]
\[ z' = \rho z + \varepsilon \]
## Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Explanation</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\sigma$</td>
<td>risk aversion</td>
<td>2</td>
</tr>
<tr>
<td>$\rho$</td>
<td>persistence of income</td>
<td>0.84</td>
</tr>
<tr>
<td>$\sigma_\varepsilon$</td>
<td>std of innovation to AR(1)</td>
<td>0.34</td>
</tr>
<tr>
<td>$\varphi_h$</td>
<td>selling cost for a household</td>
<td>10%</td>
</tr>
<tr>
<td>$r$</td>
<td>risk-free interest rate - initial</td>
<td>2%</td>
</tr>
<tr>
<td>$\delta$</td>
<td>prob. of being an active renter</td>
<td>0.14</td>
</tr>
<tr>
<td>$u$</td>
<td>unemployment shock</td>
<td>0.05</td>
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<tr>
<td>$\beta$</td>
<td>discount factor</td>
<td>0.95</td>
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<tr>
<td>$\varphi_l$</td>
<td>selling cost for a lender</td>
<td>10.7%</td>
</tr>
<tr>
<td>$\gamma_h/\gamma_r$</td>
<td>utility advantage of ownership</td>
<td>1.37</td>
</tr>
<tr>
<td>$\psi$</td>
<td>moving probability</td>
<td>4%</td>
</tr>
</tbody>
</table>
## Steady State Analysis

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Data</th>
<th>Model: ( r=2% )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homeownership rate</td>
<td>68.8%</td>
<td>68.8%</td>
</tr>
<tr>
<td>Wealth-income ratio</td>
<td>4</td>
<td>4.1</td>
</tr>
<tr>
<td>Moving rate-owners</td>
<td>6.5%</td>
<td>6.3%</td>
</tr>
<tr>
<td>Foreclosure rate</td>
<td>1.7%</td>
<td>1.7%</td>
</tr>
<tr>
<td>Price to income ratio</td>
<td>3.0</td>
<td>3.0</td>
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<tr>
<td>Average down payment ratio</td>
<td>21.1</td>
<td>25.5%</td>
</tr>
<tr>
<td>Loan-to-Value ratio</td>
<td>58.4</td>
<td>53.3%</td>
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</tbody>
</table>
Who are the Purchasers?

Rent vs Own Decision

Asset

Income

RENT

OWN

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Who are the Sellers and Defaulters?

![Graph showing the decision between selling or defaulting based on income and debt/house price ratio.]

- **Sell vs Default Decision**
  - **Debt/House Price**
  - **Income**

**SELL**

**DEFAULT**

- **AGT (CBRT and IUB)**
- **House Prices and Foreclosures**
- **November 2013**
Mortgage Rate as a Function of Downpayment

Mortgage Interest Rate vs Downpayment

- **unemployed**
- **median income**
- **high income**

AGT (CBRT and IUB)  
House Prices and Foreclosures  
November 2013
Foreclosure Dynamics

Foreclosure Rate over the Life-Cycle

- Red: unemployed
- Dashed: median income
- Blue: high income

Age vs. Foreclosure Rate

November 2013
Quantitative Exercise

- We consider three unexpected shocks:
  - Higher risk free interest rate (an increase from 2% to 3%)
  - Tighter credit constraints (minimum down payment increases from 0% to 20%)
  - Higher unemployment rate (an increase from 5% to 6.5%)
- We analyze both steady-state and transitional dynamics
## Steady State Comparison

<table>
<thead>
<tr>
<th>Statistic</th>
<th>SS1</th>
<th>SS2</th>
<th>SS3</th>
<th>SS4</th>
<th>SS5</th>
</tr>
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<tr>
<td>r=2%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>λ=0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>u=5%</td>
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<tr>
<td>Price to income ratio</td>
<td>3.0</td>
<td>2.68</td>
<td>2.80</td>
<td>2.82</td>
<td>2.51</td>
</tr>
<tr>
<td>Foreclosure rate</td>
<td>1.7%</td>
<td>0.2%</td>
<td>0%</td>
<td>1.2%</td>
<td>0%</td>
</tr>
<tr>
<td>Down payment ratio</td>
<td>25.5%</td>
<td>33%</td>
<td>33%</td>
<td>27.5%</td>
<td>35.4%</td>
</tr>
<tr>
<td>Mortgage Premium</td>
<td>0.1%</td>
<td>0.001%</td>
<td>0%</td>
<td>0.03%</td>
<td>0%</td>
</tr>
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Transitional Dynamics - Interest Rate Shock

- Only risk free interest rate shock (an increase from 2% to 3%)
Transitional Dynamics - Financial Shock

- Only financial shock (min down payment increases from 0% to 20%)
Transitional Dynamics - Unemployment Shock

- Only unemployment shock (an increase from 5% to 6.5%)
Transitional Dynamics - All Three Shocks

- All three shocks together

House Price–All Shocks

Foreclosure Rate–All Shocks

House Prices and Foreclosures

November 2013
Transitional Dynamics - Comparison

- All three shocks together

**House Price—Comparison of Shocks**

- all shocks
- interest rate shock
- financial shock
- unemployment shock

**Foreclosure Rate—Comparison of Shocks**

- all shocks
- interest rate shock
- financial shock
- unemployment shock

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FED lowers the interest rate two periods after the shocks to 0.5% and commits to this policy for a certain period of time.
Timing of Monetary Policy

- FED lowers the interest rate on impact of the shocks to 0.5% and commits to this policy for 6 periods.
Macroprudential Policy

- Ex-ante macroprudential policy: Minimum down payment requirement is set to 20%.
Build a model of housing and mortgage with endogenous credit terms and default.
Conclusion

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- The transition analysis is important to understand the foreclosure and price dynamics
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Tighter credit constraints would result a less volatility in the housing market
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- The transition analysis is important to understand the foreclosure and price dynamics

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- Tighter credit constraints would result in less volatility in the housing market

- Need to do welfare analysis