Joint Dynamics of House Prices and Foreclosures

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CBRT

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1 The views expressed are those of the authors and should not be attributed to the Central Bank of Turkey.
Real House Price Index - FHFA

![Real House Price Index - FHFA chart](chart.png)
Foreclosures Started

![Graph showing the percentage of foreclosures started over time from 1979 Q4 to 2012 Q4.]
What do we do?

- Model the relation between house prices and foreclosures
- Incorporate realistic structure for mortgages and allow foreclosures

Analyze the feedback mechanism between house prices and foreclosures in response to three unexpected permanent shocks:
- Higher risk-free interest rate
- Tighter credit constraints (higher minimum down payment requirement)
- Higher unemployment rate

Explore the effect of two policies:
- Monetary Policy: Lower interest rates
- Macroprudential Policy: Tighter credit constraints
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**Introduction**

**Contribution**

**Literature Review**

- **Life-cycle housing model**

- **Endogenous credit terms and default**

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

- **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
Environment (cont.)

- Perfect competition among risk-neutral lenders
- Mortgage holders can default on the mortgage
- Terms of mortgage contracts are endogenous (down payment and mortgage interest rate)
- There is 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
Environment (cont.)

- 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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- Four possible housing status: inactive renter, active renter, owner and mover
  - 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): $V^m = \max\{V^{hr}, V^{hd}\}$
Value Functions

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Purchaser’s Problem

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

\[
c + m(d, r_m, j) + p_h - d = y(z, j) + a(1 + r)
\]

\[
d' = (d - m(d, r_m, j))(1 + r_m)
\]
Seller’s and Defaulter’s Problem

**Seller’s Problem:**

$$V_{jhr}(z; d, r_m) = \max_{c, a'} \left\{ u_r(c) + \beta EV_{j+1} (a', z') \right\}$$

$$c + a' + p_r = y(z, j) + p_h(1 - \phi_h)(1 + \epsilon_h) - d$$
Seller’s and Defaulter’s Problem

- **Seller’s Problem:**

\[
V_{jr}^H (z; d, r_m) = \max_{c, a'} \left\{ u_r (c) + \beta EV_{j+1}^r (a', z') \right\}
\]

\[
c + a' + p_r = y (z, j) + p_h (1 - \phi_h) (1 + \epsilon_h) - d
\]

- **Defaulter’s Problem:**

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

\[
c + a' + p_r = y (z, j) + \max\{(1 - \phi_i) p_h - d, 0\}
\]
Lender’s Problem

Expected continuation value of the mortgage contract:

\[
V_j^l(z; d, r^m) = \begin{cases} 
  a & \text{if hh sells} \\
  \min \{ p_h(1 - \phi_h), d \} & \text{if hh defaults} \\
  d - \frac{d'}{1+r_m} + \frac{1}{1+r+\tau} EV_j^l(z'; d', r_m) & \text{if hh stays}
\end{cases}
\]
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>$\phi_h$</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>
</tr>
<tr>
<td>$\beta$</td>
<td>discount factor</td>
<td>0.95</td>
</tr>
<tr>
<td>$\phi_l$</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>
</tr>
<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>
</tr>
</tbody>
</table>
Who are the Purchasers?

Rent vs Own Decision

Asset

Income

RENT

OWN

Arslan, Guler, Taskin

House Prices and Foreclosures

Sao Paulo, 15 August 2014
Who are the Sellers and Defaulters?

Sell vs Default Decision

Debt/House Price vs Income

Sell: Income and Debt/House Price combinations leading to selling.
Default: Income and Debt/House Price combinations leading to defaulting.
Mortgage Rate as a Function of Downpayment
## Comparison of Housing Tenures

<table>
<thead>
<tr>
<th>Tenure</th>
<th>Share</th>
<th>Income</th>
<th>Wealth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defaulter</td>
<td>4.4%</td>
<td>0.76</td>
<td>0.84</td>
</tr>
<tr>
<td>Renter</td>
<td>26.8%</td>
<td>0.59</td>
<td>0.72</td>
</tr>
<tr>
<td>Owner</td>
<td>68.8%</td>
<td>1.13</td>
<td>3.6</td>
</tr>
<tr>
<td>w/ mortgage</td>
<td>31.7%</td>
<td>0.99</td>
<td>1.40</td>
</tr>
<tr>
<td>w/ neg. equity</td>
<td>3.2%</td>
<td>0.76</td>
<td>0.15</td>
</tr>
<tr>
<td>no mortgage</td>
<td>68.3%</td>
<td>1.19</td>
<td>4.69</td>
</tr>
</tbody>
</table>
## Tenure Choices - Renter

<table>
<thead>
<tr>
<th>Type</th>
<th>Share</th>
<th>Income</th>
<th>Wealth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renter</td>
<td>26.8%</td>
<td>0.59</td>
<td>0.72</td>
</tr>
<tr>
<td>Rent</td>
<td>78.7%</td>
<td>0.45</td>
<td>0.26</td>
</tr>
<tr>
<td>Buy-mortgage</td>
<td>15.3%</td>
<td>1.02</td>
<td>0.47</td>
</tr>
<tr>
<td>Buy-outright</td>
<td>5.9%</td>
<td>1.32</td>
<td>7.56</td>
</tr>
</tbody>
</table>
## Tenure Choices - Owner with Mortgage

<table>
<thead>
<tr>
<th></th>
<th>Share</th>
<th>Income</th>
<th>Wealth</th>
</tr>
</thead>
<tbody>
<tr>
<td>w/ mortgage</td>
<td>31.7%</td>
<td>0.99</td>
<td>1.40</td>
</tr>
<tr>
<td>No Moving Shock</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stay</td>
<td>93%</td>
<td>1.05</td>
<td>1.41</td>
</tr>
<tr>
<td>Sell</td>
<td>5.7%</td>
<td>0.25</td>
<td>1.60</td>
</tr>
<tr>
<td>Default</td>
<td>1.3%</td>
<td>0.25</td>
<td>0.21</td>
</tr>
<tr>
<td>Moving Shock</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sell</td>
<td>90.2%</td>
<td>1.04</td>
<td>1.54</td>
</tr>
<tr>
<td>Default</td>
<td>9.8%</td>
<td>0.61</td>
<td>0.18</td>
</tr>
</tbody>
</table>
## Tenure Choices - Owner with Negative Equity

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<th>Wealth</th>
</tr>
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<tr>
<td><strong>w/ neg. equity</strong></td>
<td>3.2%</td>
<td>0.76</td>
<td>0.15</td>
</tr>
<tr>
<td><strong>No Moving Shock</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stay</td>
<td>89.9%</td>
<td>0.81</td>
<td>0.16</td>
</tr>
<tr>
<td>Sell</td>
<td>0%</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Default</td>
<td>10.1%</td>
<td>0.26</td>
<td>0.14</td>
</tr>
<tr>
<td><strong>Moving Shock</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sell</td>
<td>17.7%</td>
<td>1.27</td>
<td>0.22</td>
</tr>
<tr>
<td>Default</td>
<td>82.3%</td>
<td>0.65</td>
<td>0.14</td>
</tr>
</tbody>
</table>
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>
</thead>
<tbody>
<tr>
<td><strong>r = 2%</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>λ = 0%</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>u = 5%</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Price to income ratio</strong></td>
<td>3.0</td>
<td>2.68</td>
<td>2.80</td>
<td>2.82</td>
<td>2.51</td>
</tr>
<tr>
<td><strong>Foreclosure rate</strong></td>
<td>1.7%</td>
<td>0.2%</td>
<td>0%</td>
<td>1.2%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Down payment ratio</strong></td>
<td>25.5%</td>
<td>33%</td>
<td>33%</td>
<td>27.5%</td>
<td>35.4%</td>
</tr>
<tr>
<td><strong>Mortgage Premium</strong></td>
<td>0.1%</td>
<td>0.001%</td>
<td>0%</td>
<td>0.03%</td>
<td>0%</td>
</tr>
</tbody>
</table>
Transitional Dynamics - Interest Rate Shock

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

Share of Mortgage Holders with Negative Equity

Time
Share

0 0.02 0.04 0.06 0.08 0.1 0.12 0.14 0.16 0.18
5 10 15 20 25 30 35 40 45
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](image1)

![Foreclosure Rate - All Shocks](image2)
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
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%.

---

![House Price–Macroprudential Policy](image)

- **House Price–Macroprudential Policy**: Graph showing the impact of macroprudential policy on house prices over time.

![Foreclosure Rate–Macroprudential Policy](image)

- **Foreclosure Rate–Macroprudential Policy**: Graph showing the impact of macroprudential policy on foreclosure rates over time.
Conclusion

- Build a model of housing and mortgage with endogenous credit terms and default.

- The transition analysis is important to understand the foreclosure and price dynamics.

- Monetary policy is more effective in the housing market if implemented on impact.

- Tighter credit constraints (macroprudential policy) would result in a less volatile housing market.
## Model Robustness

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Benchmark</th>
<th>One period Mortgage</th>
<th>No Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homeownership rate</td>
<td>SS1 68.8%</td>
<td>SS1 68.8%</td>
<td>SS1 68.8%</td>
</tr>
<tr>
<td>Price to income ratio</td>
<td>SS2 2.68</td>
<td>SS2 2.99</td>
<td>SS2 2.85</td>
</tr>
<tr>
<td>Foreclosure rate</td>
<td>SS1 0.2%</td>
<td>SS1 0.3%</td>
<td>SS1 0%</td>
</tr>
<tr>
<td>Down payment ratio</td>
<td>SS2 33%</td>
<td>SS2 51%</td>
<td>SS2 34%</td>
</tr>
<tr>
<td>Mortgage Premium</td>
<td>SS1 0.1%</td>
<td>SS1 0.002%</td>
<td>SS1 0%</td>
</tr>
</tbody>
</table>