Mortgage Leverage and House Prices

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How do house prices respond to lending standards?

- Lenders limit mortgage payment size relative to income.
- How do house prices respond to changes in these rules?

*Important for understanding the boom, effects of regulation.*
Approach

- Lenders rely on software created by Fannie Mae or Freddie Mac.
- In 1999 Freddie tightened DTI rules (not public).

\[
\text{DTI} = \frac{\text{mortgage payment + other obligations}}{\text{income}}
\]

- Counties affected differently, depends on lender ties to Freddie.
Main result

Debt-to-income limits have a large effect on house prices:

1. Consistent with response of constrained households in short run.
2. Continues to build over several years, suggesting feedback.
1. **Institutional Background**

2. Data and descriptive statistics

3. Policy change

4. Results

5. Model
Institutional Background
Automated underwriting software

- Software:
  - Freddie’s Loan Prospector (LP)
  - Fannie’s Desktop Underwriter (DU)

- Determines if Fannie or Freddie will buy a mortgage:
  - Public rule: loan < conforming limit ($453,100 in 2018).
  - Proprietary rules relating to income, collateral and credit score.

- Could also be used for subprime/jumbo loans:
  - “[Fannie and Freddie are] promoting the use of DU and LP for such non-conforming non-agency loan types as jumbos and subprime loans.” Mortgage Banking, 1999
Software differences lead to local variation in DTI policy

Use Freddie Mac county market share from before the change.

Relationships exclusive and persistent.

*Mortgage Banking, 1999:*

- “It’s very **expensive to do both** [Fannie and Freddie’s software]. There’s the upfront costs and there’s all kinds of ancillary costs . . . So most lenders are opting to go with one based on where they have their primary business relationship.”

- “As soon as one comes out with something, it’s usually just a matter of time before the other does too. In the end they’re pretty close overall. I’m not sure every correspondent, broker or lender really needs both systems. There’s **tremendous overlap** and the product differentiation between the two is not a huge issue.”
1 Institutional Background

2 Data and descriptive statistics

3 Policy change

4 Results

5 Model
Data and descriptive statistics
Data

1. Document policy change:
   • GSE Single Family Loan Performance
     – DTI, LTV, credit score for loans GSEs purchased.
     – Available from 1999.
   • GSE Public Use Database
     – Loan-to-income, LTV for loans GSEs purchased.
     – Available from 1993.

2. Calculate local exposure to Freddie Mac:
   • HMDA
     – Loan-to-income, census tract, lender, was loan sold to Fannie/Freddie.

3. Measure effect on house prices
   • CoreLogic county house price index.
   • Similar results using FHFA house prices.
County exposure to Freddie Mac (1998)

\[ \text{Freddie}_c = \frac{\# \text{ Loans in county } c \text{ sold to Freddie}}{\# \text{ Loans in county } c \text{ sold to Freddie or Fannie}} \]
Freddie exposure and other variables

- Counties are similar with respect to a number of variables (average DTI, underserved share, subprime share, share sold to Fannie/Freddie)

- Hower, high Freddie counties:
  - less coastal
  - less densely populated
  - lower median income

**Approach:** Within state variation, include controls and show divergence in prices coincides with policy [also similar results with reweighting].
1 Institutional Background

2 Data and descriptive statistics

3 Policy change

4 Results

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Policy change
Timing of change

Change is not publicly announced $\rightarrow$ rely on data:

$\mathbb{I}[\widetilde{DTI}_i > 50] = \gamma_s + \beta_t + \epsilon_i$
Freddie applied tighter DTI rules until after the crisis.
Freddie applied tighter DTI rules until after the crisis.
1 Institutional Background
2 Data and descriptive statistics
3 Policy change
4 Results
5 Model
Results
Show that in more exposed counties (relative to less exposed):

1. High DTI lending declines.
2. House prices decline.
3. Price decline continues for several years after change.
High DTI share declines in more exposed counties

\[
\text{High } \text{DTI}_{c,t} = \gamma_c + \gamma_{s,t} + \beta \text{Post}_t \cdot \text{Freddie}_{c,1998} + \alpha \text{Post}_t \cdot \text{Controls}_c + \epsilon_{c,t}
\]

<table>
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<th>Share DTI $&gt; 50$</th>
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<tr>
<td></td>
<td>(1)</td>
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<tr>
<td>Post $\times$ Freddie</td>
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<tr>
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<td>Controls</td>
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</tr>
<tr>
<td>Number of Observations</td>
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</table>

Debt-to-income tightening reduces house prices

\[ \log(\text{Price}_{c,t}) = \gamma_c + \gamma_{s,t} + \beta_t \text{Freddie Share}_{c,1998} + \epsilon_{c,t} \]
House prices decline in more exposed counties

\[ \Delta \log(\text{Price}_c) = \gamma_s + \beta \text{Freddie share}_{c,1998} + \alpha \text{Controls}_c + \epsilon_c \]

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<td>49</td>
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<tr>
<td>Number of Observations</td>
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</table>
Relative decline continues for several years

\[ \Delta \log(\text{Price}_c) = \gamma_s + \beta \text{Freddie share}_{c,1998} + \alpha \text{Controls}_c + \epsilon_c \]

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<td></td>
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<td>(2)</td>
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<tr>
<td>Freddie Share</td>
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<td>-7.79***</td>
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<td>(2.72)</td>
<td>(2.57)</td>
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<td>Controls</td>
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<td>Number of Counties</td>
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<td>Number of States</td>
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<tr>
<td>Number of Observations</td>
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</table>
House price response: 1990 – 2010

\[ \log(Price_{c,t}) = \gamma_c + \gamma_{s,t} + \beta_t \text{Freddie Share}_{c,1998} + \alpha_t \text{Controls}_c + \epsilon_{c,t} \]
House price response excl. top 20 CBSAs: 1990 – 2010

\[
\log(\text{Price}_{c,t}) = \gamma_c + \gamma_{s,t} + \beta_t \text{Freddie Share}_{c,1998} + \alpha_t \text{Controls}_c + \epsilon_{c,t}
\]
log(Price_{c,t}) = \gamma_c + \gamma_{s,t} + \beta_t Freddie Share_{c,1998} + \alpha_t Controls_c + \epsilon_{c,t}
House price response (binary; reweighted): 1990 – 2010

\[
\log(\text{Price}_{c,t}) = \gamma_c + \gamma_{s,t} + \beta_t \text{High Freddie Share}_{c,1998} + \epsilon_{c,t}
\]
House price response (CBSA FE): 1990 – 2010

\[
\log(\text{Price}_{c,t}) = \gamma_c + \gamma_{cbsa,t} + \beta_t \text{Freddie Share}_{c,1998} + \epsilon_{c,t}
\]
House price response (CBSA FE; binary; reweighted): 1990 – 2010

\[
\log(\text{Price}_{c,t}) = \gamma_c + \gamma_{cbsa,t} + \beta_t \text{High Freddie Share}_{c,1998} + \epsilon_{c,t}
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Model
Model of housing demand

- Receive utility from housing services and non-housing consumption:

\[ u(H_i, C_i) = \alpha_i \log H_i + (1 - \alpha_i) \log C_i \]

- Allocate income across both, given cost of housing services:

\[ y_i = C_i + uPH_i \]

\( u \) is user cost (interest rate + property tax + depreciation - price growth)

**But:** must buy the housing asset (at price \( P \)) to consume housing.

Means choice is restricted by available downpayment and income in presence of LTV and DTI constraints.
If households above the new DTI cutoff (50%) respond by cutting loan size (i.e. holding income and downpayment fixed):

$$\% \Delta P \approx \frac{P(\text{constrained by DTI})}{1 + \epsilon} \frac{\bar{y}}{f(r)P\bar{H}} \left( 0.5 - \frac{\sum_i DTI_i 1[DTI_i > 50]}{\sum_i 1[DTI_i > 50]} \right)$$

- $f(r)$ is fixed rate payment per $1$ of debt, $r$ is Freddie 30-year rate.
- Compute constrained share using diff. between Fannie and Freddie share $DTI > 50$, times share using mortgage.
- Use median income for $\bar{y}$ and median house price for $P\bar{H}$.
- $\epsilon$ is the housing supply elasticity.
- Compute mean DTI conditional on $DTI > 50$ using Fannie data.
Comparison with empirical results

![Graph showing cumulative price effect since 1998 (%). The x-axis represents years from 1998 to 2004, and the y-axis represents the cumulative price effect. The graph compares the estimated effect of policy with the direct effect from DTI distribution. The estimated effect shows a steady decrease over the years, while the direct effect from DTI distribution has some fluctuations but overall shows a decrease.]
Effect on unconstrained households

More exposed locations have weaker house price history.
With adaptive expectations, user cost is higher ($u = r + \tau + \delta - g$):

- Calibrate a rule to match Case, Shiller & Thompson (2012):
  $$g = A(\lambda) \sum_{j=0}^{t-t_0} (1 - \lambda)^j g_{t-j} \text{ where } \lambda = 0.11.$$

- Compute $g$ adjusting for policy effect and get $\%\Delta_{\text{user cost}}$ (difference between exposed and unexposed areas).
Effect on unconstrained households

More exposed locations have weaker house price history. With adaptive expectations, user cost is higher \((u = r + \tau + \delta - g)\):

\[
\% \Delta P \approx \frac{1}{1 + \epsilon} \left[ - P(\text{responds to user cost change}) \cdot \% \Delta \text{user cost} \right.
\]

\[
+ P(\text{constrained by DTI}) \cdot \frac{\bar{y}}{f(r)P\bar{H}} \left( 0.5 - \frac{\sum_i DTI_i 1[DTI_i > 50]}{\sum_i 1[DTI_i > 50]} \right) \right]
\]

- Use \(\delta = 2\%\), \(\tau = 1.2\%\), \(\epsilon = 0.1\).

- Assume high LTV and affected groups with DTI > 50 do not respond to user cost change.
Comparison with empirical results

Cumulative price effect since 1998 (%)


Estimated effect of policy
Direct effect from DTI dist.
Add effect on user cost

Estimated effect of policy
Direct effect from DTI dist.
Add effect on user cost
Conclusion

- Debt-to-income policies have a large effect on house prices.
- The effect builds over time.
- Not just policy: policy + expectations?